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**PCEP Extensions for Receiving SRLG Information**  
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Abstract

The Path Computation Element (PCE) provides functions of path computation in support of traffic engineering (TE) in networks controlled by Multi-Protocol Label Switching (MPLS) and Generalized MPLS (GMPLS).

This document provides extensions for the Path Computation Element Protocol (PCEP) to receive Shared Risk Link Group (SRLG) information during path computation via encoding this information in the path computation reply message.

The document is currently dead as there is little interest in this as of now.

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## **1. Introduction**

As per [\[RFC4655\]](#), PCE based path computation model is deployed in large, multi-domain, multi-region, or multi-layer networks. In such case PCEs may cooperate with each other to provide end to end optimal path.

It is important to understand which TE links in the network might be at risk from the same failures. In this sense, a set of links can constitute a 'shared risk link group' (SRLG) if they share a resource whose failure can affect all links in the set [\[RFC4202\]](#). H-LSP (Hierarchical LSP) or S-LSP (Stitched LSP) can be used for carrying one or more other LSPs as described in [\[RFC4206\]](#) and [\[RFC6107\]](#). H-LSP and S-LSP may be computed by PCE(s) and further form as a TE link. The SRLG information of such LSPs can be obtained during path computation itself and encoded in the PCEP Path Computation Reply (PCRep) message. [\[I-D.zhang-ccamp-gmpls-uni-app\]](#) describes the use of a PCE for end to end User-Network Interface (UNI) path computation.

Note that [\[RFC8001\]](#) specifies a extension to Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) where SRLG information is collected at the time of signaling. But in case a PCE or cooperating PCEs are used for path computation it is recommended that SRLG information is provided by the PCE(s) during the path computation itself to the ingress (PCC) rather than receiving this information during signaling.

Further, for other path setup types (PST), (such as segment routing (SR), PCE as central controller (PCECC)) using a PCEP based approach for SRLG information is useful.

[\[RFC7926\]](#) describes a scaling problem with SRLGs in multi-layer environment and introduce a concept of Macro SRLG (MSRLG). Lower layer SRLG are abstracted at the time of path computation and can be the basis to generate such a Macro SRLG at the PCE.

The document is currently dead as there is little interest in this as of now.

### **1.1. 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.



## **2. Terminology**

The following terminology is used in this document.

CPS: Confidential Path Segment. A segment of a path that contains nodes and links that the policy requires not to be disclosed outside the domain.

PCE: Path Computation Element. An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints.

SRLG: Shared Risk Link Group.

UNI: User-Network Interface.

## **3. Usage of SRLG**

[RFC4202] states that a set of links can constitute a 'shared risk link group' (SRLG) if they share a resource whose failure can affect all links in the set. For example, two fibers in the same conduit would be in the same SRLG. If an LSR is required to have multiple diversely routed LSPs to another LSR, the path computation should attempt to route the paths so that they do not have any links in common, and such that the path SRLGs are disjoint.

In case a PCE or cooperating PCEs are used for path computation, the SRLG information is provided by the PCE(s). For example, disjoint paths for inter-domain or inter-layer LSPs. In order to achieve path computation for a secondary (backup) path, a PCC may request the PCE for a route that must be SRLG disjoint from the primary (working) path. The Exclude Route Object (XRO) [[RFC5521](#)] is used to specify SRLG information to be explicitly excluded.

## **4. PCEP Requirements**

Following key requirements are identified for PCEP to receive SRLG information during path computation:

SRLG Indication: The PCEP speaker SHOULD be capable of indicating whether the SRLG information of the path is to be received during the path computation procedure to PCE.

SRLG: If requested, the SRLG information SHOULD be received during the path computation and encoded in the PCEP message from PCE.



S (SRLG - 1 bit): when set, in a PCReq message, this indicates that the SRLG information of the path SHOULD be provided in the PCRep message. Otherwise, when cleared, this indicates that the SRLG information SHOULD NOT be included in the PCRep message. In a PCRep message, when the S bit is set this indicates that the returned path in ERO also carry the SRLG information; otherwise (when the S bit is cleared), the





returned path does not carry SRLG information. Further incase of PCRpt [RFC8231] message for delegated LSP the flag indicates that when PCE computes the path, it SHOULD provide the SRLG information in PCUpd [RFC8231] message. Incase of PCUpd and PCInitiate [RFC8281] message, the flag indicates that the ERO also carry the SRLG information.

## 5.2. SRLG Subobject in ERO

As per [RFC5440], ERO is used to encode the path and is carried within a PCRep message to provide the computed path when computation was successful. Further as per [RFC8231] and [RFC8281], the ERO is also encoded in PCUpd and PCInitiate message for stateful operations.

The SRLG of a path is the union of the SRLGs of the links in the path [RFC4202]. The SRLG subobject is defined in [RFC8001] for ROUTE\_RECORD object (RRO). The same subobject format (reproduced below) can be used by the ERO object in the PCEP messages.

```

      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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      Type      |      Length      |D|      Reserved      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                  SRLG ID 1 (4 octets)                  |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
~                  .....                  ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                  SRLG ID n (4 octets)                  |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The meaning and description of Type, Length, D-Bit and SRLG ID can be found in [RFC8001]. Reserved field MUST be set to zero on transmission and MUST be ignored on receipt.

The SRLG subobject should be encoded inside the ERO object in the PCEP messages by the PCE when the S-Bit is set in the SRLG-INFO TLV (inside LSPA object). Incase no SRLG information is present for the path, an empty SRLG subobject with Length as 4 (and no SRLG-IDs) is included.

## 6. Other Considerations

### 6.1. Other Path Setup Types

Initially PCEP was used for LSPs that are set up using the RSVP-TE signaling protocol. However, other TE path setup methods are



possible within the PCE architecture such as SR  
[[I-D.ietf-pce-segment-routing](#)].

[RFC8001] describes SRLG information collection via RSVP-TE extension, which can not be used for Segment Routing (SR), making PCE the best source for the SRLG information for SR.

## **[6.2.](#) Backward Compatibility**

If a PCE receives a PCEP message and the PCE does not understand the new TLV in the LSPA object, then as per [[RFC5440](#)], it would ignore the TLV. In which case, the PCC will receive ERO with no SRLG subobject and can determine that the PCE does not support the PCEP extension as defined in this document.

If PCEP speaker receives a PCEP message with SRLG subobject that it does not support or recognize, it would act according to the existing processing rules of the ERO as per [[RFC5440](#)].

## **[6.3.](#) Confidentiality via PathKey**

[RFC5520] defines a mechanism to hide the contents of a segment of a path, called the Confidential Path Segment (CPS). The CPS may be replaced by a path-key that can be conveyed in the PCEP and signaled within in a RSVP-TE ERO.

When path-key confidentiality is used, encoding SRLG information in PCRep along with the path-key could be useful to compute a SRLG disjoint backup path at the later instance.

The path segment that needs to be hidden (that is, CPS) MAY be replaced in the ERO with a PKS. The PCE MAY use the SRLG Sub-objects in the ERO along with the PKS sub-object.

## **[6.4.](#) Coherent SRLG IDs**

In a multi-layer multi-domain scenario, SRLG ids may be configured by different management entities in each layer/domain. In such scenarios, maintaining a coherent set of SRLG IDs is a key requirement in order to be able to use the SRLG information properly. Thus, SRLG IDs must be unique. Note that current procedure is targeted towards a scenario where the different layers and domains belong to the same operator, or to several coordinated administrative groups. Ensuring the aforementioned coherence of SRLG IDs is beyond the scope of this document. Further scenarios, where coherence in the SRLG IDs cannot be guaranteed are out of the scope of the present document and are left for further study.



## **7. Security Considerations**

The procedures defined in this document permit the transfer of SRLG data between layers or domains during the path computation of LSPs, subject to policy at the PCE. It is recommended that PCE policies take the implications of releasing SRLG information into consideration and behave accordingly during path computation. Other security concerns are discussed in [\[RFC5440\]](#). An analysis of the security issues for routing protocols that use TCP (including PCEP) is provided in [\[RFC6952\]](#), while [\[RFC8253\]](#) discusses a TLS based approach to provide secure transport for PCEP.

## **8. Manageability Considerations**

### **8.1. Control of Function and Policy**

A PCE involved in inter-domain or inter-layer path computation should be capable of being configured with a SRLG processing policy to specify if the SRLG IDs of the domain or specific layer network can be exposed to the PCEP peer outside the domain or layer network, or whether they should be summarized, mapped to values that are comprehensible to PCC outside the domain or layer network, or removed entirely.

### **8.2. Information and Data Models**

[\[RFC7420\]](#) describes the PCEP MIB and [\[I-D.ietf-pce-pcep-yang\]](#) specify PCEP YANG, there are no new MIB Objects or YANG changes for this document.

### **8.3. Liveness Detection and Monitoring**

Mechanisms defined in this document do not imply any new liveness detection and monitoring requirements in addition to those already listed in [\[RFC5440\]](#).

### **8.4. Verify Correct Operations**

Mechanisms defined in this document do not imply any new operation verification requirements in addition to those already listed in [\[RFC5440\]](#) and [\[RFC8231\]](#).

### **8.5. Requirements On Other Protocols**

Mechanisms defined in this document do not imply any new requirements on other protocols. Note that, [\[RFC8001\]](#) provide similar requirements for signaling protocol.



## 8.6. Impact On Network Operations

Mechanisms defined in this document do not have any impact on network operations in addition to those already listed in [RFC5440] and [RFC8231].

## 9. IANA Considerations

IANA assigns values to PCEP parameters in registries defined in [RFC5440]. IANA is requested to make the following additional assignments.

### 9.1. New TLV

IANA maintains the "Path Computation Element Protocol (PCEP) Numbers" registry and the "PCEP TLV Type Indicators" sub-registry. IANA is requested to allocate a codepoint for -

Type	Meaning	Reference
TBD	SRLG-INFO	This document

This document requests that a new sub-registry, named "SRLG-INFO TLV Flag Field", is created within the "Path Computation Element Protocol (PCEP) Numbers" registry to manage the Flag field of the this TLV. New values are to be assigned by Standards Action [RFC8126]. Each bit should be tracked with the following qualities:

- o Bit number (counting from bit 0 as the most significant bit)
- o Capability description
- o Defining RFC

The following values are defined in this document:

Bit	Description	Reference
31	SRLG (S-bit)	This document

### 9.2. New Subobjects for the ERO Object

PCEP uses the ERO registry maintained for RSVP at <http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml>. Within this registry IANA maintains sub-registry for ERO subobject at [http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters-25](http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml#rsvp-parameters-25)





Upon approval of this document, IANA is requested to make identical additions to the registry as follows (which is un-assigned right now):

Subobject Type	Reference
34            SRLG sub-object	[This I.D.]

Note that, an allocation for SRLG sub-object for RRO in RSVP-TE is made for [[RFC8001](#)].

## **10. Acknowledgments**

Special thanks to the authors of [[RFC8001](#)]. This document borrows some of text from it.

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