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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.

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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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.

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.

Cooperating PCEs [RFC4655] with inter-PCE communication work together
to provide the end to end optimal path as well as the SRLG
information of this path. During inter-domain or inter-layer path
computation, the aggregating PCE (Parent PCE [RFC6805] or Ingress
PCE(1) [RFC5441] or Higher-Layer PCE [RFC5623]) should receive the
SRLG information of path segments from other PCEs and provide the end
to end SRLG information of the optimal path to the Path Computation
Client (PCC).

5. Extension to PCEP

This document defines a new TLV that can be carried in the LSPA (LSP
Attributes) object [RFC5440] so that a PCEP speaker can request SRLG
information along with the path from the PCE. The SRLG subobject
maybe carried inside the Explicit Route Object (ERO) in the PCEP
message from PCE.

5.1. SRLG Information TLV

This document specify a new TLV for the LSPA Object to indicate that
the PCE SHOULD provide the SRLG information along with the path. Its
format is shown in the following figure:

```
 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Reserved           |             Flags           |S|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                         SRLG-INFO TLV

The Type for the TLV is TBD. The length is fixed value of 4. The
value portion consist of -

   Reserved (16-bit): MUST be set to zero while sending and ignored
   on receipt.

   Flags (16-bit): Currently one flag is defined -

   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
   extention 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.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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