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RSVP-TE Extensions for Collecting SRLG Information
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Abstract

This document provides extensions for the Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) to support automatic collection of Shared Risk Link Group (SRLG) information for the TE link formed by a Label Switched Path (LSP).

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1. Introduction

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].

On the other hand, as described in [RFC4206] and [RFC6107], H-LSP (Hierarchical LSP) or S-LSP (stitched LSP) can be used for carrying one or more other LSPs. Both of the H-LSP and S-LSP can be formed as a TE link. In such cases, it is important to know the SRLG information of the LSPs that will be used to carry further LSPs.

This document provides a mechanism to collect the SRLGs used by a LSP, which can then be advertized as properties of the TE-link formed by that LSP. Note that specification of the the use of the collected SRLGs is outside the scope of this document.

1.1. Applicability Example: Dual Homing

An interesting use case for the SRLG collection procedures defined in this document is achieving LSP diversity in a dual homing scenario. The use case is illustrated in Figure 1, when the overlay model is applied as defined in RFC 4208 [RFC4208] . In this example, the exchange of routing information over the User-Network Interface (UNI) is prohibited by operator policy.

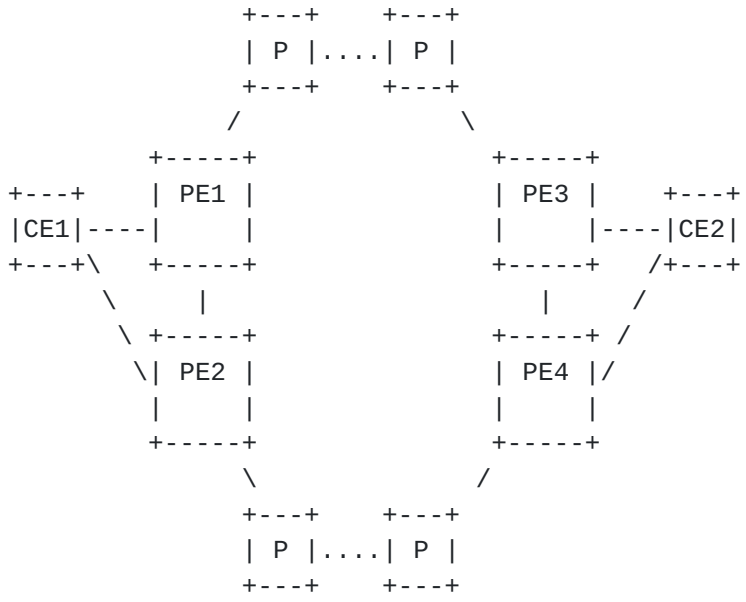


Figure 1: Dual Homing Configuration

Single-homed customer edge (CE) devices are connected to a single provider edge (PE) device via a single UNI link (which could be a bundle of parallel links, typically using the same fiber cable). This single UNI link can constitute a single point of failure. Such a single point of failure can be avoided if the CE device is connected to two PE devices via two UNI interfaces as depicted in Figure 1 above for CE1 and CE2, respectively.

For the dual-homing case, it is possible to establish two connections (LSPs) from the source CE device to the same destination CE device where one connection is using one UNI link to PE1, for example, and the other connection is using the UNI link to PE2. In order to avoid single points of failure within the provider network, it is necessary to also ensure path (LSP) diversity within the provider network in

order to achieve end-to-end diversity for the two LSPs between the two CE devices CE1 and CE2. This use case describes how it is possible to achieve path diversity within the provider network based on collected SRLG information. As the two connections (LSPs) enter the provider network at different PE devices, the PE device that receives the connection request for the second connection needs to know the additional path computation constraints such that the path of the second LSP is disjoint with respect to the already established first connection.

As SRLG information is normally not shared between the provider network and the client network, i.e., between PE and CE devices, the challenge is how to solve the diversity problem when a CE is dual-homed. For example, CE1 in Figure 1 may have requested an LSP1 to CE2 via PE1 that is routed via PE3 to CE2. CE1 can then subsequently request an LSP2 to CE2 via PE2 with the constraint that it needs to be maximally SRLG disjoint with respect to LSP1. PE2, however, does not have any SRLG information associated with LSP1, which is needed as input for its constraint-based path computation function. If CE1 is capable of retrieving the SRLG information associated with LSP1 from PE1, it can pass this information to PE2 as part of the LSP2 setup request (RSVP PATH message), and PE2 can now calculate a path for LSP2 that is SRLG disjoint with respect to LSP1. The SRLG information associated with LSP1 can already be retrieved when LSP1 is setup or at any time before LSP2 is setup.

The RSVP extensions for collecting SRLG information defined in this document make it possible to retrieve SRLG information for an LSP and hence solve the dual-homing LSP diversity problem. When CE1 sends the setup request for LSP2 to PE2, it can also request the collection of SRLG information for LSP2 and send that information to PE1. This will ensure that the two paths for the two LSPs remain mutually diverse, which is important, when the provider network is capable to restore connections that failed due to a network failure (fiber cut) in the provider network.

Note that the knowledge of SRLG information even for multiple LSPs does not allow a CE devices to derive the provider network topology based on the collected SRLG information.

2. Requirements Language

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].

3. RSVP-TE Requirements

3.1. SRLG Collection Indication

The ingress node of the LSP SHOULD be capable of indicating whether the SRLG information of the LSP is to be collected during the signaling procedure of setting up an LSP. SRLG information SHOULD NOT be collected without an explicit request for it being made by the ingress node.

3.2. SRLG Collection

If requested, the SRLG information SHOULD be collected during the setup of an LSP. The endpoints of the LSP can use the collected SRLG information, for example, for routing, sharing and TE link configuration purposes.

3.3. SRLG Update

When the SRLG information of an existing LSP for which SRLG information was collected during signaling changes, the relevant nodes of the LSP SHOULD be capable of updating the SRLG information of the LSP. This means that that the signaling procedure SHOULD be capable of updating the new SRLG information.

4. Encodings

4.1. SRLG Collection Flag

In order to indicate nodes that SRLG collection is desired, this document defines a new flag in the Attribute Flags TLV (see RFC 5420 [RFC5420]), which MAY be carried in an LSP_REQUIRED_ATTRIBUTES or LSP_ATTRIBUTES Object:

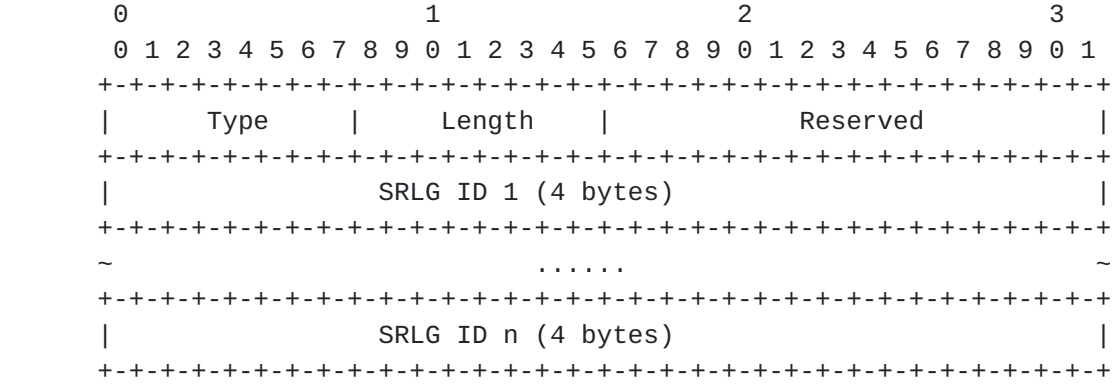
- Bit Number (temporarily 12, an early allocation has been made by IANA, see Section 8.1 for more details): SRLG Collection flag

The SRLG Collection flag is meaningful on a Path message. If the SRLG Collection flag is set to 1, it means that the SRLG information SHOULD be reported to the ingress and egress node along the setup of the LSP.

The rules of the processing of the Attribute Flags TLV are not changed.

4.2. RRO SRLG sub-object

This document defines a new RRO sub-object (ROUTE_RECORD sub-object) to record the SRLG information of the LSP. Its format is modeled on the RRO sub-objects defined in RFC 3209 [RFC3209].



Type

The type of the sub-object. The value is temporarily 34. An early allocation has been made by IANA (see Section 8.2 for more details).

Length

The Length field contains the total length of the sub-object in bytes, including the Type and Length fields. The Length depends on the number of SRLG IDs.

Reserved

This 2 byte field is reserved. It SHOULD be set to zero on transmission and MUST be ignored on receipt.

SRLG ID

This 4 byte field contains one SRLG ID. There is one SRLG ID field per SRLG collected. There MAY be multiple SRLG ID fields in an SRLG sub-object

As described in RFC 3209 [RFC3209], the RECORD_ROUTE object is managed as a stack. The SRLG sub-object SHOULD be pushed by the node before the node IP address or link identifier. The SRLG-sub-object SHOULD be pushed after the Attribute subobject, if present, and after the LABEL subobject, if requested.

RFC 5553 [RFC5553] describes mechanisms to carry a PKS (Path Key Sub-object) in the RRO so as to facilitate confidentiality in the

signaling of inter-domain TE LSPs, and allows the path segment that needs to be hidden (that is, a Confidential Path Segment (CPS)) to be replaced in the RRO with a PKS. If the CPS contains SRLG Sub-objects, these MAY be retained in the RRO by adding them again after the PKS Sub-object in the RRO. The CPS is defined in RFC 5520 [RFC5520]

A node MUST NOT push a SRLG sub-object in the RECORD_ROUTE without also pushing either a IPv4 sub-object, a IPv6 sub-object, a Unnumbered Interface ID sub-object or a Path Key sub-object.

The rules of the processing of the LSP_REQUIRED_ATTRIBUTES, LSP_ATTRIBUTE and ROUTE_RECORD Objects are not changed.

5. Signaling Procedures

5.1. SRLG Collection

Per RFC 3209 [RFC3209], an ingress node initiates the recording of the route information of an LSP by adding a RRO to a Path message. If an ingress node also desires SRLG recording, it MUST set the SRLG Collection Flag in the Attribute Flags TLV which MAY be carried either in an LSP_REQUIRED_ATTRIBUTES Object when the collection is mandatory, or in an LSP_ATTRIBUTES Object when the collection is desired, but not mandatory.

When a node receives a Path message which carries an LSP_REQUIRED_ATTRIBUTES Object and the SRLG Collection Flag set, if local policy determines that the SRLG information is not to be provided to the endpoints, it MUST return a PathErr message with:

- Error Code 2 (policy) and
- Error subcode "SRLG Recording Rejected" (value 31, an early allocation of the value has been done by IANA, see Section 8.3 for more details)

to reject the Path message.

When a node receives a Path message which carries an LSP_ATTRIBUTES Object and the SRLG Collection Flag set, if local policy determines that the SRLG information is not to be provided to the endpoints, the Path message SHOULD NOT be rejected due to SRLG recording restriction and the Path message SHOULD be forwarded without any SRLG sub-object(s) in the RRO of the corresponding outgoing Path message.

If local policy permits the recording of the SRLG information, the processing node SHOULD add local SRLG information, as defined below, to the RRO of the corresponding outgoing Path message. The processing node MAY add multiple SRLG sub-objects to the RRO if necesary. It then forwards the Path message to the next node in the

downstream direction.

If the addition of SRLG information to the RRO would result in the RRO exceeding its maximum possible size or becoming too large for the Path message to contain it, the requested SRLGs MUST NOT be added. If the SRLG collection request was contained in an LSP_REQUIRED_ATTRIBUTES Object, the processing node MUST behave as specified by RFC 3209 [RFC3209] and drop the RRO from the Path message entirely. If the SRLG collection request was contained in an LSP_ATTRIBUTES Object, the processing node MAY omit some or all of the requested SRLGs from the RRO; otherwise it MUST behave as specified by RFC 3209 [RFC3209] and drop the RRO from the Path message entirely.

Following the steps described above, the intermediate nodes of the LSP can collect the SRLG information in the RRO during the processing of the Path message hop by hop. When the Path message arrives at the egress node, the egress node receives SRLG information in the RRO.

Per RFC 3209 [RFC3209], when issuing a Resv message for a Path message which contains an RRO, an egress node initiates the RRO process by adding an RRO to the outgoing Resv message. The processing for RROs contained in Resv messages then mirrors that of the Path messages.

When a node receives a Resv message for an LSP for which SRLG Collection is specified, then when local policy allows recording SRLG information, the node SHOULD add SRLG information, to the RRO of the corresponding outgoing Resv message, as specified below. When the Resv message arrives at the ingress node, the ingress node can extract the SRLG information from the RRO in the same way as the egress node.

Note that a link's SRLG information for the upstream direction cannot be assumed to be the same as that in the downstream.

- For Path and Resv messages for a unidirectional LSP, a node SHOULD include SRLG sub-objects in the RRO for the downstream data link only.

- For Path and Resv messages for a bidirectional LSP, a node SHOULD include SRLG sub-objects in the RRO for both the upstream data link and the downstream data link from the local node. In this case, the node MUST include the information in the same order for both Path messages and Resv messages. That is, the SRLG sub-object for the upstream link is added to the RRO before the SRLG sub-object for the downstream link.

Based on the above procedure, the endpoints can get the SRLG information automatically. Then the endpoints can for instance advertise it as a TE link to the routing instance based on the procedure described in [RFC6107] and configure the SRLG information of the FA automatically.

5.2. SRLG Update

When the SRLG information of a link is changed, the LSPs using that link need to be aware of the changes. The procedures defined in Section 4.4.3 of RFC 3209 [RFC3209] MUST be used to refresh the SRLG information if the SRLG change is to be communicated to other nodes according to the local node's policy. If local policy is that the SRLG change SHOULD be suppressed or would result in no change to the previously signaled SRLG-list, the node SHOULD NOT send an update.

5.3. Compatibility

A node that does not recognize the SRLG Collection Flag in the Attribute Flags TLV is expected to proceed as specified in RFC 5420 [RFC5420]. It is expected to pass the TLV on unaltered if it appears in a LSP_ATTRIBUTES object, or reject the Path message with the appropriate Error Code and Value if it appears in a LSP_REQUIRED_ATTRIBUTES object.

A node that does not recognize the SRLG RRO sub-object is expected to behave as specified in RFC 3209 [RFC3209]: unrecognized subobjects are to be ignored and passed on unchanged.

6. Manageability Considerations

6.1. Policy Configuration

In a border node of inter-domain or inter-layer network, the following SRLG processing policy SHOULD be capable of being configured:

- Whether the SRLG IDs of the domain or specific layer network can be exposed to the nodes outside the domain or layer network, or whether they SHOULD be summarized, mapped to values that are comprehensible to nodes outside the domain or layer network, or removed entirely.

A node using RFC 5553 [RFC5553] and PKS MAY apply the same policy.

6.2. Coherent SRLG IDs

In a multi-layer multi-domain scenario, SRLG ids can 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 SHOULD 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

This document builds on the mechanisms defined in [RFC3473], which also discusses related security measures. In addition, [RFC5920] provides an overview of security vulnerabilities and protection mechanisms for the GMPLS control plane. The procedures defined in this document permit the transfer of SRLG data between layers or domains during the signaling of LSPs, subject to policy at the layer or domain boundary. It is recommended that domain/layer boundary policies take the implications of releasing SRLG information into consideration and behave accordingly during LSP signaling.

8. IANA Considerations

8.1. RSVP Attribute Bit Flags

IANA has created a registry and manages the space of the Attribute bit flags of the Attribute Flags TLV, as described in section 11.3 of RFC 5420 [RFC5420], in the "Attribute Flags" section of the "Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Parameters" registry located in http://www.iana.org/assignments/rsvp-te-parameters". IANA has made an early allocation in the "Attribute Flags" section of the mentioned registry that expires on 2015-09-11.

This document introduces a new Attribute Bit Flag:

Bit No	Name	Attribute Flags Path	Attribute Flags Resv	RRO	Reference
12 (temporary expires 2015-09-11)	SRLG collection Flag	Yes	Yes	Yes	This I-D

8.2. ROUTE_RECORD Object

IANA manages the "RSVP PARAMETERS" registry located at http://www.iana.org/assignments/rsvp-parameters. IANA has made an early allocation in the Sub-object type 21 ROUTE_RECORD - Type 1 Route Record registry. The early allocation expires on 2015-09-11.

This document introduces a new RRO sub-object:

Value	Description	Reference
34 (temporary, expires 2015-09-11)	SRLG sub-object	This I-D

8.3. Policy Control Failure Error subcodes

IANA manages the assignments in the "Error Codes and Globally-Defined Error Value Sub-Codes" section of the "RSVP PARAMETERS" registry located at http://www.iana.org/assignments/rsvp-parameters. IANA has made an early allocation in the "Sub-Codes - 2 Policy Control Failure" subsection of the the "Error Codes and Globally-Defined Error Value Sub-Codes" section of the "RSVP PARAMETERS" registry. The early allocation expires on 2015-09-11.

This document introduces a new Policy Control Failure Error sub-code:

Value	Description	Reference
21 (temporary, expires 2015-09-11)	SRLG Recording Rejected	This I-D

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10. Acknowledgements

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