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Path Computation Element Communication Protocol (PCEP) Extensions for remote-initiated GMPLS LSP Setup

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Abstract

[RFC8281] specifies procedures that can be used for creation and deletion of PCE-initiated LSPs in the active stateful PCE model. However, this specification focuses on MPLS networks, and does not cover remote instantiation of paths in GMPLS-controlled networks. This document complements [RFC8281] by addressing the requirements for remote-initiated GMPLS LSPs.

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 [RFC2119].

Status of This Memo

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1. Introduction

The Path Computation Element communication Protocol (PCEP) provides mechanisms for Path Computation Elements (PCEs) to perform route computations in response to Path Computation Clients (PCCs) requests. PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model draft [RFC8231] describes a set of extensions to PCEP to enable active control of MPLS-TE and GMPLS network.

[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. This enables realization of a dynamic network that is centrally controlled and deployed. However, this specification is focused on MPLS networks, and does not cover the GMPLS networks (e.g., WSON, OTN, SONET/ SDH, etc. technologies). This document complements [RFC8281] by addressing the requirements for remote-initiated GMPLS LSPs. These requirements are covered in Section 2 of this draft. The PCEP extensions for remote initiated GMPLS LSPs are specified in Section 3.

2. Requirements for Remote-Initiated GMPLS LSPs

[RFC8281] specifies procedures that can be used for creation and deletion of PCE-initiated LSPs under the active stateful PCE model. However, this specification does not address GMPLS requirements outlined in the following:

- o GMPLS support multiple switching capabilities on per TE link basis. GMPLS LSP creation requires knowledge of LSP switching capability (e.g., TDM, L2SC, OTN-TDM, LSC, etc.) to be used [RFC3471] , [RFC3473] .

- o GMPLS LSP creation requires knowledge of the encoding type (e.g., lambda photonic, Ethernet, SONET/ SDH, G709 OTN, etc.) to be used by the LSP [RFC3471] , [RFC3473].

- o GMPLS LSP creation requires information of the generalized payload (G-PID) to be carried by the LSP [RFC3471] , [RFC3473].

- o GMPLS LSP creation requires specification of data flow specific traffic parameters (also known as Tspec), which are technology specific.

- o GMPLS also specifics support for asymmetric bandwidth requests [RFC6387] .

- o GMPLS extends the addressing to include unnumbered interface identifiers, as defined in [RFC3477] .

- o In some technologies path calculation is tightly coupled with label selection along the route. For example, path calculation in a WDM network may include lambda continuity and/ or lambda feasibility constraints and hence a path computed by the PCE is associated with a specific lambda (label). Hence, in such networks, the label information needs to be provided to a PCC in order for a PCE to initiate GMPLS LSPs under the active stateful PCE model. I.e., explicit label control may be required.

o GMPLS specifics protection context for the LSP, as defined in [RFC4872] , [RFC4873].

3. PCEP Extensions for Remote-Initiated GMPLS LSPs

LSP initiate (PCInitiate) message defined in [RFC8281] needs to be extended to include GMPLS specific PCEP objects as follows:

3.1. Generalized Endpoint in LSP Initiate Message

This document does not modify the usage of END-POINTS object for PCE initiated LSPs as specified in [RFC8281] . It augments the usage as specified below.

END-POINTS object has been extended by [I-D.ietf-pce-gmpls-pcep-extensions] to include a new object type called "Generalized Endpoint". PCInitiate message sent by a PCE to a PCC to trigger a GMPLS LSP instantiation SHOULD include the END-POINTS with Generalized Endpoint object type. Furthermore, the END-POINTS object MUST contain "label request" TLV. The label request TLV is used to specify the switching type, encoding type and GPID of the LSP being instantiated by the PCE.

If the END-POINTS Object of type Generalized Endpoint is missing the label request TLV, the PCC MUST send a PCErr message with Error-type=6 (Mandatory Object missing) and Error-value= TBA (label request TLV missing).

If the PCC does not support the END-POINTS Object of type Generalized Endpoint, the PCC MUST send a PCErr message with Error-type = 3 (Unknown Object), Error-value = 2(unknown object type).

The unnumbered endpoint TLV can be used to specify unnumbered endpoint addresses for the LSP being instantiated by the PCE. The END-POINTS MAY contain other TLVs defined in [I-D.ietf-pce-gmpls-pcep-extensions].

3.2. GENERALIZED-BANDWIDTH object in LSP Initiate Message

LSP initiate message defined in [RFC8281] can optionally include the BANDWIDTH object. However, the following possibilities cannot be represented in the BANDWIDTH object:

o Asymmetric bandwidth (different bandwidth in forward and reverse direction), as described in [RFC6387] .

o Technology specific GMPLS parameters (e.g., Tspec for SDH/SONET, G.709, ATM, MEF, etc.) are not supported.

GENERALIZED-BANDWIDTH object has been defined in [I-D.ietf-pce-gmpls-pcep-extensions] to address the above-mentioned limitation of the BANDWIDTH object.

This document specifies the use of GENERALIZED-BANDWIDTH object in PCInitiate message. Specifically, GENERALIZED-BANDWIDTHobject MAY be included in the PCInitiate message. The GENERALIZED-BANDWIDTH object in PCInitiate message is used to specify technology specific Tspec and asymmetrical bandwidth values for the LSP being instantiated by the PCE.

3.3. Protection Attributes in LSP Initiate Message

This document does not modify the usage of LSPA object for PCE initiated LSPs as specified in [RFC8281] . It augments the usage of LSPA object in LSP Initiate Message to carry the end-to-end protection context this also includes the protection state information.

The LSP Protection Information TLV of LSPA in the PCInitiate message can be used to specify protection attributes of the LSP being instantiated by the PCE.

3.4. ERO in LSP Initiate Object

This document does not modify the usage of ERO object for PCE initiated LSPs as specified in [RFC8281]. It augments the usage as specified in the following sections.

3.4.1. ERO with explicit label control

As mentioned earlier, there are technologies and scenarios where active stateful PCE requires explicit label control in order to instantiate an LSP.

Explicit label control (ELC) is a procedure supported by RSVP-TE, where the outgoing label(s) is (are) encoded in the ERO. [I-D.ietf-pce-gmpls-pcep-extensions] extends the ERO object of PCEP to include explicit label control. The ELC procedure enables the PCE to provide such label(s) directly in the path ERO.

The extended ERO object in PCInitiate message can be used to specify label along with ERO to PCC for the LSP being instantiated by the active stateful PCE.

3.4.2. ERO with Path Keys

There are many scenarios in packet and optical networks where the route information of an LSP may not be provided to the PCC for confidentiality reasons. A multi-domain or multi-layer network is an example of such networks. Similarly, a GMPLS User- Network Interface (UNI) [RFC4208] is also an example of such networks.

In such scenarios, ERO containing the entire route cannot be provided to PCC (by PCE). Instead, PCE provides an ERO with Path Keys to the PCC. For example, in the case UNI interface between the router and the optical nodes, the ERO in the LSP Initiate Message may be constructed as follows:

- o The first hop is a strict hop that provides the egress interface information at PCC. This interface information is used to get to a network node that can extend the rest of the ERO. (Please note that in the cases where the network node is not directly connected with the PCC, this part of ERO may consist of multiple hops and may be loose).

- o The following(s) hop in the ERO may provide the network node with the path key [RFC5520] that can be resolved to get the contents of the route towards the destination.

- o There may be further hops but these hops may also be encoded with the path keys (if needed).

This document does not change encoding or processing roles for the path keys, which are defined in [RFC5520].

3.4.3. Switch Layer Object

[I-D.ietf-pce-inter-layer-ext] specifies the SWITCH-LAYER object which defines and specifies the switching layer (or layers) in which a path MUST or MUST NOT be established. A switching layer is expressed as a switching type and encoding type. [I-D.ietf-pce-gmpls-pcep-extensions], which defines the GMPLS extensions for PCEP, suggests using the SWITCH-LAYER object. Thus, SWITCH-LAYER object can be used in the PCInitiate message to specify the switching layer (or layers) of the LSP being remotely initiated.

3.5. LSP delegation and cleanup

LSP delegation and cleanup procedure specified in [I-D.ietf-pce-gmpls-pcep-extensions] are equally applicable to GMPLS LSPs and this document does not modify the associated usage.

4. Security Considerations

The security considerations described in [RFC8281] apply to the extensions described in this document.

5. IANA Considerations

5.1. PCEP-Error Object

This document defines the following new Error-Value:

Error-type	Error Value	Reference
6	Error-value = TBA: Label Request TLV Missing	this document

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7. Acknowledgements

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