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**PCEP Extensions for MPLS-TE LSP Path Protection with stateful PCE  
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Abstract

A stateful Path Computation Element (PCE) is capable of computing as well as controlling via Path Computation Element Protocol (PCEP) Multiprotocol Label Switching Traffic Engineering Label Switched Paths (MPLS LSP). Furthermore, it is also possible for a stateful PCE to create, maintain, and delete LSPs. This document describes PCEP extension to associate two or more LSPs to provide end-to-end path protection.

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## [1.](#) Introduction

[RFC5440] describes PCEP for communication between a Path Computation Client (PCC) and a PCE or between one a pair of PCEs. A PCE computes paths for MPLS-TE LSPs based on various constraints and optimization criteria.

Stateful pce [[I-D.ietf-pce-stateful-pce](#)] specifies a set of extensions to PCEP to enable stateful control of paths such as MPLS TE LSPs between and across PCEP sessions in compliance with [[RFC4657](#)]. It includes mechanisms to effect LSP state synchronization between PCCs and PCEs, delegation of control of LSPs to PCEs, and PCE control of timing and sequence of path computations within and across PCEP sessions and focuses on a model where LSPs are configured on the PCC and control over them is delegated to the PCE. Furthermore, a mechanism to dynamically instantiate LSPs on a PCC based on the requests from a stateful PCE or a controller using stateful PCE is specified in [[I-D.ietf-pce-pce-initiated-lsp](#)].

Path protection refers to a paradigm in which the working LSP is protected by one or more protection LSP(s). When the working LSP fails, protection LSP(s) is/are activated. When the working LSPs are



computed and controlled by the PCE, there is benefit in a mode of operation where protection LSPs are as well.

This document specifies a stateful PCEP extension to associate two or more LSPs for the purpose of setting up path protection. The proposed extension covers the following scenarios:

1. A protection LSP is initiated on a PCC by a stateful PCE which retains the control of the LSP. The PCE is responsible for computing the path of the LSP and updating the PCC with the information about the path.
2. A PCC initiates a protection LSP and retains the control of the LSP. The PCC computes the path and updates the PCE with the information about the path as long as it controls the LSP.
3. A PCC initiates a protection LSP and delegates the control of the LSP to a stateful PCE. The PCE may compute the path for the LSP and update the PCC with the information about the path as long as it controls the LSP.

Note that protection LSP can be established (e.g., using RSVP-TE signaling) prior to the failure (in which case the LSP is said to be in standby mode) or post failure of the corresponding working LSP according to the operator choice/policy.

## **2. Terminology**

The following terminologies are used in this document:

AGID: Association Group ID.

ERO: Explicit Route Object.

LSP: Label Switched Path.

PCC: Path Computation Client.

PCE: Path Computation Element

PCEP: Path Computation Element Protocol.

PPAG: Path Protection Association Group.

TLV: Type, Length, and Value.



### 3. PCEP Extensions

LSPs are not associated by listing the other LSPs with which they interact, but rather by making them belong to an association group referred to as "Path Protection Association Group" (PPAG) in this document. All LSPs join a PPAG individually. PPAG is based on the generic Association object used to associate two or more LSPs specified in [[I-D.minei-pce-association-group](#)]. A member of a PPAG can take the role of working or protection LSP. This document defines a new association type called "Path Protection Association Type" of value TBD. A PPAG can have one working LSP and one or more protection LSPs. The source and destination of all LSPs within a PPAG MUST be the same.

The format of the Association object used for PPAG is shown in Figure 1:

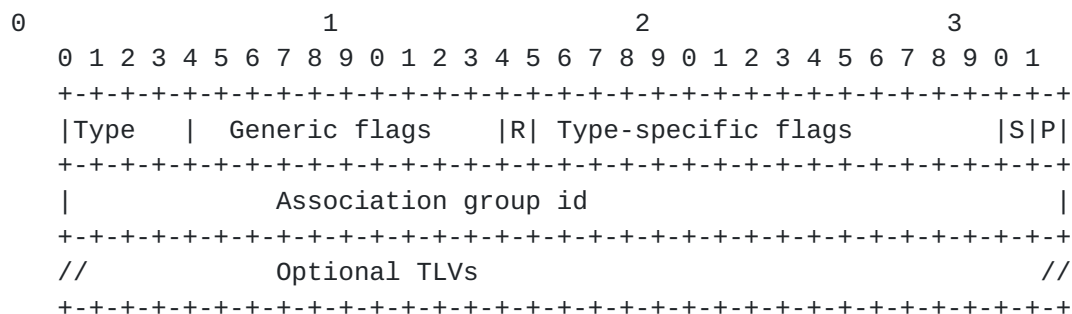


Figure 1: The Association Object format

Type - TBD for the Path Protection Association Type

The description of the flags are as follows:

The 'P' Flag indicates whether the LSP associated with the PPAG is working or protection LSP. If this flag is set, the LSP is protection LSP.

The 'S' Flag if P flag is set, S flag indicates whether the protection LSP associated with the PPAG is in standby mode (e.g., signaled via RSVP-TE prior to failure). The S flag is ignored if P flag is set to 0.



## **4. Operation**

A PCE can create/update working and protection LSPs independently. However, it can add a protection LSP to a PPAG only after adding a working LSP to that group. As specified in [\[I-D.minei-pce-association-group\]](#), Association Group ID (AGID) is allocated by PCC. In order to reserve an AGID, PCE sends an association object with AGID of 0 either in PCInitiate message or PCUpd message for a working LSP, with both the P and S flags set to 0. Upon receiving an association object with AGID of 0, PCC MUST allocate a new AGID and send it the PCE via PCRpt message. Once the PCE receives the AGID, it can either create one or more protection LSP(s) and add it/them to the PPAG or simply add already existing LSP(s) to the PPAG.

A PCE can remove a protection LSP from a PPAG as specified in [\[I-D.minei-pce-association-group\]](#).

A PCC can associate a set of LSPs under its control for path protection purpose. Similarly, the PCC can remove one or more LSPs under its control from the corresponding PPAG. In both cases, the PCC must report the change in association to PCE(s) via PCRpt message.

The forwarding behavior after failure of the protected LSP, in particular how and whether traffic will be load balanced among protection paths will be detailed in a future version of this document.

### **4.1. State Synchronization**

During state synchronization, a PCC MUST report all the existing path protection association groups as well as any path protection flags to PCE(s). Following the state synchronization, the PCE MUST remove all stale path protection associations.

### **4.2. Error Handling**

All LSPs (working or protection) within a PPAG MUST have the same source and destination. If a PCE attempts to add an LSP to a PPAG and the source and/or destination of the LSP is/are different from the LSP(s) in the PPAG, the PCC MUST send PCErr with Error-Type= TBD (Path Protection Association Error) and Error-Value = 1 (End points mismatch).





## 5. IANA considerations

### 5.1. Association Type

This document defines a new association type for path protection as follows:

Association Type Value	Association Name	Reference
1	Path Protection Association	This document

### 5.2. PCEP Errors

This document defines new Error-Type and Error-Value related to path protection association as follows:

Error-Type	Meaning
25	Path Protection Association error: Error-value=1: End-Points mismatch

## 6. Security Considerations

The same security considerations apply in head end as described in [\[I-D.ietf-pce-pce-initiated-lsp\]](#)

## 7. References

### 7.1. Normative References

[I-D.ietf-pce-pce-initiated-lsp]

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