

PCE Working Group
Internet-Draft
Intended status: Standards Track
Expires: January 7, 2016

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PCEP Extensions for Establishing Relationships Between Sets of LSPs
draft-minei-pce-association-group-02

Abstract

This document introduces a generic mechanism to create a grouping of LSPs in the context of a PCE. This grouping can then be used to define associations between sets of LSPs or between a set of LSPs and a set of attributes (such as configuration parameters or behaviors), and is equally applicable to the active and passive modes of a stateful PCE as well as a stateless PCE.

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](#)].

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Table of Contents

1.	Introduction	2
2.	Terminology	3
3.	Architectural Overview	3
3.1.	Motivation	3
3.2.	Operation Overview	3
4.	ASSOCIATION Object	4
4.1.	Object Definition	4
4.2.	Object Encoding in PCEP messages	5
4.3.	Processing Rules	8
5.	IANA Considerations	9
6.	Security Considerations	9
7.	Acknowledgements	9
8.	Contributors	10
9.	References	10
9.1.	Normative References	10
9.2.	Informative References	10
	Authors' Addresses	10

[1.](#) Introduction

[RFC5440] describes the Path Computation Element Protocol PCEP. PCEP enables the communication between a Path Computation Client (PCC) and a Path Control Element (PCE), or between PCE and PCE, for the purpose of computation of Multiprotocol Label Switching (MPLS) as well as Generalized MPLS (GMPLS) for Traffic Engineering Label Switched Path (TE LSP) characteristics.

Stateful pce [[I-D.ietf-pce-stateful-pce](#)] specifies a set of extensions to PCEP to enable stateful control of TE LSPs between and

across PCEP sessions in compliance with [[RFC4657](#)] and focuses on a model where LSPs are configured on the PCC and control over them is delegated to the PCE. The model of operation where LSPs are initiated from the PCE is described in [[I-D.ietf-pce-pce-initiated-lsp](#)].

This document introduces a generic mechanism to create a grouping of LSPs. This grouping can then be used to define associations between sets of LSPs or between a set of LSPs and a set of attributes (such as configuration parameters or behaviors), and is equally applicable to the active and passive modes of a stateful PCE and a stateless PCE.

[2.](#) Terminology

This document uses the following terms defined in [[RFC5440](#)]: PCC, PCE, PCEP Peer.

[3.](#) Architectural Overview

[3.1.](#) Motivation

Stateful PCE provides the ability to update existing LSPs and to instantiate new ones. To enable support for PCE-controlled make-before-break and for protection, there is a need to define associations between LSPs. For example, the association between the original and the re-optimized path in the make-before break scenario, or between the working and protection path in end-to-end protection. Another use for LSP grouping is for applying a common set of configuration parameters or behaviors to a set of LSPs.

For a stateless PCE, it might be useful to associate a path computation request to an association group, thus enabling it to associate a common set of configuration parameters or behaviors with the request.

Rather than creating separate mechanisms for each use case, this draft defines a generic mechanism that can be reused as needed.

[3.2.](#) Operation Overview

LSPs are associated with other LSPs with which they interact by adding them to a common association group. Association groups as defined in this document can be applied to LSPs originating at the same head end or different head ends. For LSPs originating at the same head end, the association can be initiated by either the PCC (head end) or by a PCE. Only a stateful PCE can initiate an association for LSPs originating at different head ends. For both

cases, the association is uniquely identified by the combination of an association identifier and the address of the PCE peer that created the association.

Multiple types of groups can exist, each with their own identifiers space. The definition of the different association types and their behaviors is outside the scope of this document. The establishment and removal of the association relationship can be done on a per LSP basis. An LSP may join multiple association groups, of different or of the same type.

In the case of a stateless PCE, associations are created out of band, and PCEP peers should be aware of the association and its significance outside of the protocol.

4. ASSOCIATION Object

4.1. Object Definition

Creation of an association group and modifications to its membership can be initiated by either the PCE or the PCC. Association groups and their memberships are defined using the ASSOCIATION object for stateful PCE.

ASSOCIATION Object-Class is to be assigned by IANA (TBD).

ASSOCIATION Object-Type is 1 for IPv4 and its format is shown in Figure 1:

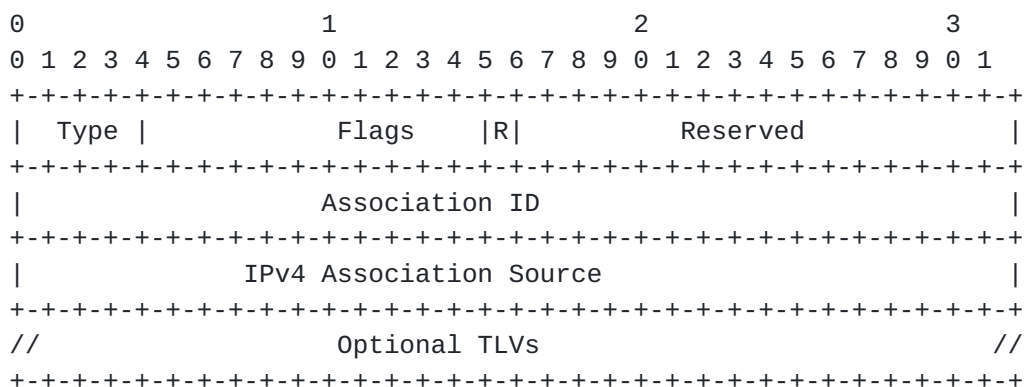


Figure 1: The IPv4 ASSOCIATION Object format

ASSOCIATION Object-Type is 2 for IPv6 and its format is shown in Figure 2:

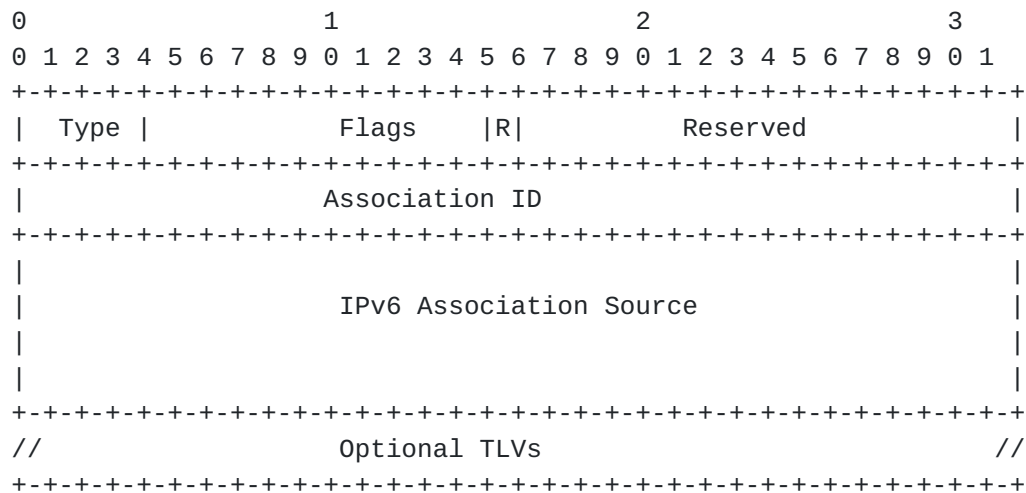


Figure 2: The IPv6 ASSOCIATION Object format

Type: 4 bits - the association type (for example protection). The association type will be defined in separate documents.

Flags: 12 bits - The following flags are currently defined:

R (Removal - 1 bit): when set, the requesting PCE peer requires the removal of an LSP from the association group.

Reserved: MUST be set to 0 and ignored upon receipt.

Association ID: 32 bits - the identifier of the association group. When combined with Type and Association Source, this value uniquely identifies an association group. The value 0xffffffff and 0x0 are reserved. The value 0xffffffff is used to indicate all association groups.

Association Source: 4 or 16 bytes - An IPv4 or IPv6 address, which is associated to the PCE peer that originated the association.

Optional TLVs: Variable - no TLVs are defined in this document.

4.2. Object Encoding in PCEP messages

The ASSOCIATION Object is OPTIONAL and MAY be carried in the Path Computation Update (PCUpd), Path Computation Report (PCRpt) and Path Computation Initiate (PCinit) messages.

When carried in PCRpt message, it is used to report the association group membership information pertaining to a LSP to a stateful PCE. It can also be used to remove an LSP from one or more association

groups by setting the R flag to 1. Unless, a PCE wants to delete an association from an LSP, it does not need to carry the ASSOCIATION object while updating other LSP attributes using the PCUpd message.

The PCRpt message is defined in [[I-D.ietf-pce-stateful-pce](#)] and updated as below:

```
<PCRpt Message> ::= <Common Header>
                    <state-report-list>
```

Where:

```
<state-report-list> ::= <state-report>[<state-report-list>]
```

```
<state-report> ::= [<SRP>]
                  <LSP>
                  [<association-list>]
                  <path>
```

Where:

```
<association-list> ::= <ASSOCIATION> [<association-list>]
```

When an LSP is delegated to a stateful PCE, the stateful PCE can initiate a new association group for this LSP, or associate it with one or more existing association groups. This is done by including the ASSOCIATION Object in a PCUpd message or in a PCInit message. A stateful PCE can also remove a delegated LSP from one or more association groups by setting the R flag to 1.

The PCUpd message is defined in [[I-D.ietf-pce-stateful-pce](#)] and updated as below:

```
<PCUpd Message> ::= <Common Header>
                    <update-request-list>
```

Where:

```
<update-request-list> ::= <update-request>[<update-request-list>]
```

```
<update-request> ::= <SRP>
                    <LSP>
                    [<association-list>]
                    <path>
```

Where: <association-list> ::= <ASSOCIATION> [<association-list>]

The PCInitiate message is defined in [[I-D.ietf-pce-pce-initiated-lsp](#)] and updated as below:


```
<PCInitiate Message> ::= <Common Header>  
                           <PCE-initiated-lsp-list>
```

Where:

```
<PCE-initiated-lsp-list> ::=  
<PCE-initiated-lsp-request>[<PCE-initiated-lsp-list>]  
  
<PCE-initiated-lsp-request> ::=  
(<PCE-initiated-lsp-instantiation>|<PCE-initiated-lsp-deletion>)  
  
<PCE-initiated-lsp-instantiation> ::= <SRP>  
                                       <LSP>  
                                       <END-POINTS>  
                                       <ERO>  
                                       [<association-list>]  
                                       [<attribute-list>]
```

Where:

```
<association-list> ::= <ASSOCIATION> [<association-list>]
```

In case of passive stateful or stateless PCE, the ASSOCIATION Object is OPTIONAL and MAY be carried in the Path Computation Request (PCReq) message.

When carried in a PCReq message, the ASSOCIATION Object is used to associate the path computation request to an association group, the association might be further informed via PCRpt message in case of passive stateful PCE later or it might be created out of band in case of stateless PCE.

The PCReq message is defined in [[RFC5440](#)] and updated in [I-D.ietf-pce-stateful-pce], it is further updated below for association:


```
<PCReq Message> ::= <Common Header>
                        [<svec-list>]
                        <request-list>
```

Where:

```
<svec-list> ::= <SVEC> [<svec-list>]
<request-list> ::= <request> [<request-list>]
```

```
<request> ::= <RP>
               <END-POINTS>
               [<LSP>]
               [<LSPA>]
               [<BANDWIDTH>]
               [<metric-list>]
               [<association-list>]
               [<RRO> [<BANDWIDTH>]]
               [<IRO>]
               [<LOAD-BALANCING>]
```

Where:

```
<association-list> ::= <ASSOCIATION> [<association-list>]
```

Note that LSP object MAY be present for the passive stateful PCE.

4.3. Processing Rules

Both a PCC and a PCE can create one or more association groups for an LSP. But a PCE peer cannot add new members for association group created by another peer. If a PCC receives a PCUpd or a PCInitiate message including an ASSOCIATION Object but the sender address does not match the association source, a PCErr message MUST be sent with Error-Type = TBD2 (Association Error) and Error-value= 1 (association source and sender source mismatch in PCUpd). Error handling for situations such as PCE failures after association groups are created and other scenarios will be included in future versions of this draft.

If a PCE peer does not recognize the ASSOCIATION object, it MUST return a PCErr message with Error-Type "Unknown Object" as described in [RFC5440]. If a PCE peer is unwilling or unable to process the ASSOCIATION object, it MUST return a PCErr message with the Error-Type "Not supported object" and follow the relevant procedures described in [RFC5440].

5. IANA Considerations

The "PCEP Parameters" registry contains a subregistry "PCEP Objects". This document request IANA to allocate the values from this registry.

Object-Class Value	Name	Reference
TBD	Association Object-Type 1: IPv4 2: IPv6	This document

This document requests IANA to create a subregistry of the "PCEP Parameters" for the bits carried in the Flags field of the ASSOCIATION object. The subregistry is called "ASSOCIATION Flags Field".

The field contains 12 bits numbered from bit 0 as the most significant bit.

Bit;	Name;	Description	Reference
15	R:	Removal	This document

This document defines new Error Type and Error-Value for the following new error conditions:

Error-Type	Meaning	Reference
TBD	Error-Value=1: association source and sender source does not match	This document

6. Security Considerations

The security considerations described in [[I-D.ietf-pce-stateful-pce](#)] apply to the extensions described in this document. Additional considerations related to a malicious PCE are introduced, as the PCE may now create additional state on the PCC through the creation of association groups.

7. Acknowledgements

We would like to thank Yuji Kamite and Joshua George for their contributions to this document. Also Thank Venugopal Reddy and Cyril Margaria for their useful comments.

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