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Path Computation Element (PCE) Communication Protocol (PCEP) extension for associating Policies and Label Switched Paths (LSPs) draft-ietf-pce-association-policy-15

Abstract

This document introduces a simple mechanism to associate policies to a group of Label Switched Paths (LSPs) via an extension to the Path Computation Element (PCE) Communication Protocol (PCEP). The extension allows a PCEP speaker to advertise to a PCEP peer that a particular LSP belongs to a particular Policy Association Group.

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1. Introduction

[RFC5440] describes the Path Computation Element Communication Protocol (PCEP) which enables the communication between a Path Computation Client (PCC) and a Path Control Element (PCE), or between two PCEs based on the PCE architecture [RFC4655]. [RFC5394] provides

additional details on policy within the PCE architecture and also provides context for the support of PCE Policy.

PCEP Extensions for Stateful PCE Model [RFC8231] describes a set of extensions to PCEP to enable active control of Multiprotocol Label Switching Traffic Engineering (MPLS-TE) and Generalized MPLS (GMPLS) tunnels. [RFC8281] describes the set-up and teardown of PCE-initiated LSPs under the active stateful PCE model, without the need for local configuration on the PCC, thus allowing for a dynamic network. Currently, the LSPs can either be signaled via Resource Reservation Protocol Traffic Engineering (RSVP-TE) or can be segment routed as specified in [RFC8664].

[RFC8697] introduces a generic mechanism to create a grouping of LSPs which can then be used to define associations between a set of LSPs and a set of attributes (such as configuration parameters or behaviors) and is equally applicable to stateful PCE (active and passive modes) and stateless PCE.

This document specifies a PCEP extension to associate one or more LSPs with policies using the generic association mechanism.

A PCEP speaker may want to influence the PCEP peer with respect to path selection and other policies. This document describes a PCEP extension to associate policies by creating Policy Association Group (PAG) and encoding this association in PCEP messages. The specification is applicable to both stateful and stateless PCEP sessions.

Note that the actual policy definition and the associated parameters are out of scope of this document.

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.

Association parameters: As described in [RFC8697], the combination of the mandatory fields Association type, Association ID and Association Source in the ASSOCIATION object uniquely identify the association group. If the optional TLVs - Global Association

Source or Extended Association ID are included, then they are included in combination with mandatory fields to uniquely identify the association group.

Association information: As described in [RFC8697], the ASSOCIATION object could include other optional TLVs based on the association types, that provide 'information' related to the association.

LSR: Label Switch Router.

MPLS: Multiprotocol Label Switching.

PAG: Policy Association Group.

PAT: Policy Association Type.

PCC: Path Computation Client; any client application requesting a path computation to be performed by a Path Computation Element.

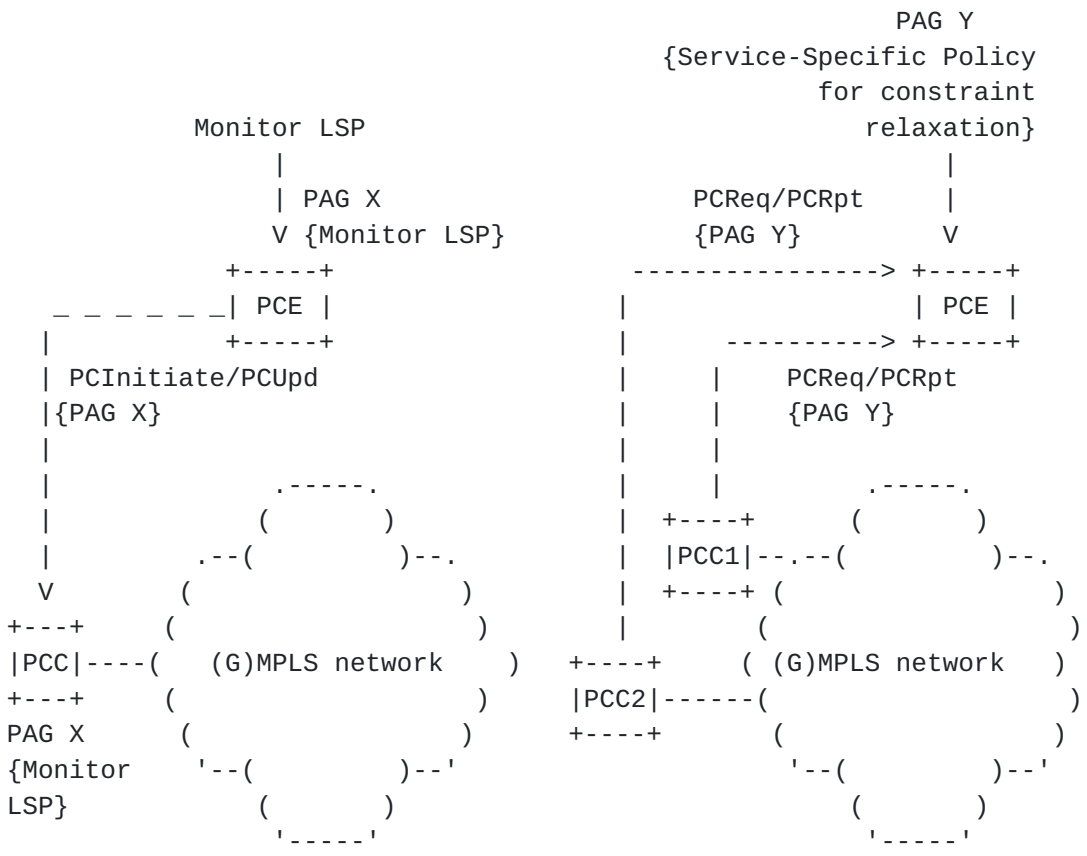
PCE: Path Computation Element; an entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints.

PCEP: Path Computation Element Communication Protocol.

3. Motivation

Paths computed using PCE can be subjected to various policies at both the PCE and the PCC. For example, in a centralized traffic engineering (TE) scenario, network operators may instantiate LSPs and specify policies for traffic accounting, path monitoring, telemetry, etc., for some LSPs via the Stateful PCE. Similarly, a PCC could request a user-specific or service-specific policy to be applied at the PCE, such as constraints relaxation policy to meet optimal QoS and resiliency.

PCEP speaker can use the generic mechanism as per [RFC8697] to associate a set of LSPs with a policy, without the need to know the details of such a policy, which simplifies network operations, avoids frequent software upgrades, as well as provides an ability to introduce new policies faster.



Case 1: Policy requested by PCE and enforced by PCC

Case 2: Policy requested by PCC and enforced by PCE

Figure 1: Sample use-cases for carrying policies over PCEP

3.1. Policy based Constraints

In the context of Policy-Enabled Path Computation Framework [RFC5394], path computation policies may be applied at either a PCC or a PCE or both. Consider a Label Switch Router (LSR) with a policy enabled PCC, it receives a service request via signaling, including over a Network-Network Interface (NNI) or User-Network Interface (UNI) reference point, or receives a configuration request over a management interface to establish a service. The PCC may also apply user-specific or service-specific policies to decide how the path selection process should be constrained, that is, which constraints, diversities, optimization criterion, and constraint relaxation strategies should be applied in order for the service LSP(s) to have a likelihood to be successfully established and provide necessary QoS and resilience against network failures. The user-specific or service-specific policies applied to PCC and are then passed to the

PCE along with the Path computation request, in the form of constraints [RFC5394].

PCEP speaker can use the generic mechanism as per [RFC8697] to associate a set of LSPs with policy and its resulting path computation constraints. This would simplify the path computation message exchanges in PCEP.

4. Overview

As per [RFC8697], LSPs are associated with other LSPs with which they interact by adding them to a common association group. Grouping can also be used to define the association between LSPs and policies associated to them. As described in [RFC8697], the association group is uniquely identified by the combination of the following fields in the ASSOCIATION object: Association Type, Association ID, Association Source, and (if present) Global Association Source or Extended Association ID. This document defines a new Association type, called "Policy Association", of value 3 (early-allocated by IANA), based on the generic ASSOCIATION object. This new Association type is also called "PAT", for "Policy Association Type".

[RFC8697] specifies the mechanism for the capability advertisement of the Association types supported by a PCEP speaker by defining a ASSOC-Type-List TLV to be carried within an OPEN object. This capability exchange for the PAT MUST be done before using the policy association. Thus the PCEP speaker MUST include the PAT in the ASSOC-Type-List TLV and MUST receive the same from the PCEP peer before using the Policy Association Group (PAG) in PCEP messages.

This Association type is operator-configured [RFC8697] association in nature and created by the operator manually on the PCEP peers. An LSP belonging to this association is conveyed via PCEP messages to the PCEP peer. Operator-configured Association Range MUST NOT be set for this association-type, and MUST be ignored, so that the full range of association identifier can be utilized.

A PAG can have one or more LSPs. The association parameters including association identifier, Association type (PAT), as well as the association source IP address is manually configured by the operator and is used to identify the PAG as described in [RFC8697]. The Global Association Source and Extended Association ID MAY also be included.

As per the processing rules specified in section 6.4 of [RFC8697], if a PCEP speaker does not support this Policy Association type, it would return a PCErr message with Error-Type 26 "Association Error" and Error-Value 1 "Association type is not supported". Since the PAG

is opaque in nature, the PAG and the policy MUST be configured on the PCEP peers as per the operator-configured association procedures. All further processing is as per section 6.4 of [RFC8697]. If a PCE speaker receives PAG in a PCEP message, and the policy association information is not configured, it MUST return a PCErr message with Error-Type 26 "Association Error" and Error-Value 4 "Association unknown".

Associating a particular LSP to multiple policy groups is authorized from a protocol perspective, however, there is no assurance that the PCEP speaker will be able to apply multiple policies. If a PCEP speaker does not support handling of multiple policies for an LSP, it MUST NOT add the LSP into the association group and MUST return a PCErr with Error- Type 26 (Association Error) and Error-value 7 (Cannot join the association group).

5. Policy Association Group

Association groups and their memberships are defined using the ASSOCIATION object defined in [RFC8697]. Two object types for IPv4 and IPv6 are defined. The ASSOCIATION object includes "Association type" indicating the type of the association group. This document add a new Association type (PAT).

PAG may carry optional TLVs including but not limited to -

- POLICY-PARAMETERS-TLV: Used to communicate opaque information useful to apply the policy, described in Section 5.1.

- VENDOR-INFORMATION-TLV: Used to communicate arbitrary vendor specific behavioral information, described in [RFC7470].

5.1. Policy Parameters TLV

The POLICY-PARAMETERS-TLV is an optional TLV that can be carried in ASSOCIATION object (for PAT) to carry opaque information needed to apply the policy at the PCEP peer. In some cases to apply a PCE policy successfully, it is required to also associate some policy parameters that need to be evaluated. This TLV is used to carry those policy parameters. The TLV could include one or more policy related parameters. The encoding format and the order MUST be known to the PCEP peers, this could be done during the configuration of the policy (and its association parameters) for the PAG. The TLV format is as per the format of the PCEP TLVs, as defined in [RFC5440], and shown in Figure 2. Only one POLICY-PARAMETERS-TLV can be carried and only the first occurrence is processed and any others MUST be ignored.

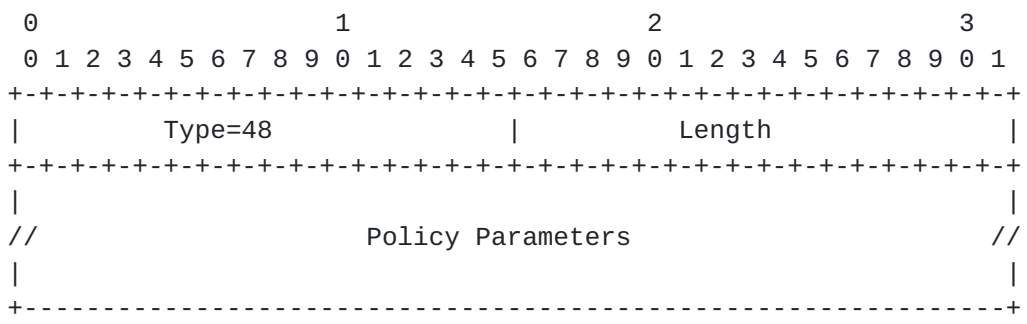


Figure 2: The POLICY-PARAMETERS-TLV format

The type of the POLICY-PARAMETERS-TLV is 48 (early-allocated by IANA) and it has a variable length. The Value field is variable and padded to a 4-byte alignment; padding is not included in the Length field. The PCEP peer implementation needs to be aware of the encoding format, order, and meaning of the 'Policy Parameters' well in advance based on the policy. Note that from the protocol point of view this data is opaque and can be used to carry parameters in any format understood by the PCEP peers and associated to the policy. The exact use of this TLV is beyond the scope of this document. Examples are included for illustration purposes in Appendix A.

If the PCEP peer is unaware of the policy parameters associated with the policy and it receives the POLICY-PARAMETERS-TLV, it MUST reject the PCEP message and send a PCErr message with Error-Type 26 "Association Error" and Error-Value TBD3 "Not expecting policy parameters". Further, if one or more parameters in the POLICY-PARAMETERS-TLV received by the PCEP speaker are considered as unacceptable in the context of the associated policy (e.g. out of range value, badly encoded value...), the PCEP speaker MUST reject the PCEP message and send a PCErr message with Error-Type 26 "Association Error" and Error-Value TBD4 "Unacceptable policy parameters".

Note that, the vendor-specific behavioral information is encoded in VENDOR-INFORMATION-TLV which can be used along with this TLV.

6. Implementation Status

[Note to the RFC Editor - remove this section before publication, as well as remove the reference to RFC 7942.]

This section records the status of known implementations of the protocol defined by this specification at the time of posting of this Internet-Draft, and is based on a proposal described in [RFC7942].

The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs. Please note that the listing of any individual implementation here does not imply endorsement by the IETF. Furthermore, no effort has been spent to verify the information presented here that was supplied by IETF contributors. This is not intended as, and must not be construed to be, a catalog of available implementations or their features. Readers are advised to note that other implementations may exist.

According to [RFC7942], "this will allow reviewers and working groups to assign due consideration to documents that have the benefit of running code, which may serve as evidence of valuable experimentation and feedback that have made the implemented protocols more mature. It is up to the individual working groups to use this information as they see fit".

6.1. Cisco's Implementation

- Organization: Cisco Systems, Inc.
- Implementation: IOS-XR PCE and PCC.
- Description: The PCEP extension specified in this document is used to convey traffic steering policies.
- Maturity Level: In shipping product.
- Coverage: Partial.
- Contact: mkoldych@cisco.com

7. Security Considerations

The security considerations described in [RFC8697], [RFC8231], [RFC5394], and [RFC5440] apply to the extensions described in this document as well. In particular, a malicious PCEP speaker could be spoofed and used as an attack vector by creating spurious policy associations as described in [RFC8697]. Further as described in [RFC8697], a spurious LSP can have policies that are inconsistent with those of the legitimate LSPs of the group and thus cause problems in handling of the policy for the legitimate LSPs. It should be noted that, Policy association could provide an adversary with the opportunity to eavesdrop on the relationship between the LSPs. [RFC8697] suggest that the implementations and operators to use indirect values as a way to hide any sensitive business relationships. Thus, securing the PCEP session using Transport Layer

Security (TLS) [RFC8253], as per the recommendations and best current practices in BCP 195 [RFC7525], is RECOMMENDED.

Further, extra care needs to be taken by the implementation with respect to POLICY-PARAMETERS-TLV while decoding, verifying, and applying these policy variables. This TLV parsing could be exploited by an attacker and thus extra care must be taken while configuring policy association that uses POLICY-PARAMETERS-TLV and making sure that the data is easy to parse and verify before use.

8. IANA Considerations

8.1. Association object Type Indicators

This document defines a new Association type. The sub-registry "ASSOCIATION Type Field" of the "Path Computation Element Protocol (PCEP) Numbers" registry was originally defined in [RFC8697]. IANA is requested to confirm the early-allocated codepoint.

Value	Name	Reference
3	Policy Association	[This.I-D]

8.2. PCEP TLV Type Indicators

The following TLV Type Indicator value is requested within the "PCEP TLV Type Indicators" subregistry of the "Path Computation Element Protocol (PCEP) Numbers" registry. IANA is requested to confirm the early-allocated codepoint.

Value	Description	Reference
48	POLICY-PARAMETERS-TLV	[This.I-D]

8.3. PCEP Errors

This document defines new Error-Values for Error-type 26 "Association Error" defined in [RFC8697]. IANA is requested to allocate new error values within the "PCEP- ERROR Object Error Types and Values" subregistry of the PCEP Numbers registry as follows:

Error-Type	Meaning	Error-value	Reference
26	Association Error		[RFC8697]
		TBD3: Not expecting policy parameters	[This.I-D]
		TBD4: Unacceptable policy parameters	[This.I-D]

9. Manageability Considerations

9.1. Control of Function and Policy

An operator MUST be allowed to configure the policy associations at PCEP peers and associate it with the LSPs. They MAY also allow configuration to related policy parameters, in which case the operator MUST also be allowed to set the encoding format and order to parse the associated policy parameters TLV.

9.2. Information and Data Models

[RFC7420] describes the PCEP MIB, there are no new MIB Objects for this document.

The PCEP YANG module is defined in [I-D.ietf-pce-pcep-yang]. This module supports associations as defined in [RFC8697] and thus supports the Policy Association groups.

An implementation SHOULD allow the operator to view the PAG configured. Further implementation SHOULD allow to view associations reported by each peer, and the current set of LSPs in the PAG.

9.3. 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], [RFC8231], and [RFC8281].

9.4. Verify Correct Operations

Mechanisms defined in this document do not imply any new operation verification requirements in addition to those already listed in [RFC5440], [RFC8231], and [RFC8281].

9.5. Requirements on Other Protocols

Mechanisms defined in this document do not imply any new requirements on other protocols.

9.6. 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], [RFC8231], and [RFC8281].

10. Acknowledgments

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A special thanks to the authors of [RFC8697], this document borrowed some of the text from it. The authors would like to thank Aijun Wang, Peng Shuping, and Gyan Mishra for their useful comments.

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11. References

11.1. Normative References

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Appendix A. Example of Policy Parameters

An example could be a monitoring and telemetry policy P1 that is dependent on a profile (GOLD/SILVER/BRONZE) as set by the operator. The PCEP peers need to be aware of the policy P1 (and its associated characteristics) in advance as well the fact that the policy parameter will encode the profile of type string in the POLICY-PARAMETERS-TLV. As an example, LSP1 could encode the PAG with the POLICY-PARAMETERS-TLV with a string "GOLD".

Another example where the path computation at PCE could be dependent on when the LSP was configured at the PCC. For such a policy P2, the time-stamp can be encoded in the POLICY-PARAMETERS-TLV and the exact encoding could be the 64-bit timestamp format as defined in [RFC5905].

While the above example has a single field in the POLICY-PARAMETERS-TLV, it is possible to include multiple fields, but the exact order, encoding format and meanings need to be known in advance at the PCEP peers.

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