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PCEP Extensions for Establishing Relationships Between Sets of LSPs  
and Virtual Networks

[draft-leedhody-pce-vn-association-00.txt](#)

Abstract

This document describes how to extend PCE association mechanism introduced by [PCE-Association] to further associate sets of LSPs with a higher-level structure such as a virtual network requested by clients or applications. This extended association mechanism can be used to facilitate virtual network control using PCE architecture.

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## [1. Introduction](#)

The Path Computation Element communication Protocol (PCEP) provides mechanisms for Path Computation Elements (PCEs) to perform path

computations in response to Path Computation Clients' (PCCs) requests.

[I-D.ietf-pce-stateful-pce-app] describes general considerations for a stateful PCE deployment and examines its applicability and benefits, as well as its challenges and limitations through a number of use cases. [I-D.ietf-pce-stateful-pce] describes a set of extensions to PCEP to provide stateful control. A stateful PCE has access to not only the information carried by the network's Interior Gateway Protocol (IGP), but also the set of active paths and their reserved resources for its computations. The additional state allows the PCE to compute constrained paths while considering individual LSPs and their interactions.

[I-D.ietf-pce-pce-initiated-lsp] describes the setup, maintenance and teardown of PCE-initiated LSPs under the stateful PCE model. Within the hierarchical PCE architecture, a PCE is used to initiate or delete LSPs to a PCC.

[I-D.ietf-pce-association-group] introduces a generic mechanism to create a grouping of LSPs. This grouping can then be used to define association between sets of LSPs or between a set of LSPs and a set of attributes.

[ACTN-REQ] describes various Virtual Network (VN) operations initiated by a customer/application. In this context, there is a need for associating a set of LSPs with a VN "construct" to facilitate VN operations in PCE architecture. This association allows the PCEs to identify which LSPs belong to a certain VN.

This document specifies a PCEP extension to associate a set of LSPs based on Virtual Network or customer.

### **1.1. 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].

## **2. Terminology**

The terminology is as per [[RFC4655](#)], [[RFC5440](#)], [[RFC6805](#)], and [I-D.ietf-pce-stateful-pce].

## **3. Operation Overview**

As per [[I-D.ietf-pce-association-group](#)], LSPs are associated with other LSPs with which they interact by adding them to a common association group. In this draft, this grouping is used to define associations between a set of LSPs and a virtual network.

One new optional Association Object-type is defined based on the generic Association object -

- o VN Association Group (VNAG)

Thus this document defines one new association type called "VN Association Type" of value TBD1. The scope and handling of VNAG identifier is similar to the generic association identifier defined in [[I-D.ietf-pce-association-group](#)].

## **4. Extensions to PCEP**

[I-D.ietf-pce-association-group] introduces the ASSOCIATION object, the format of VNAG is as follows:

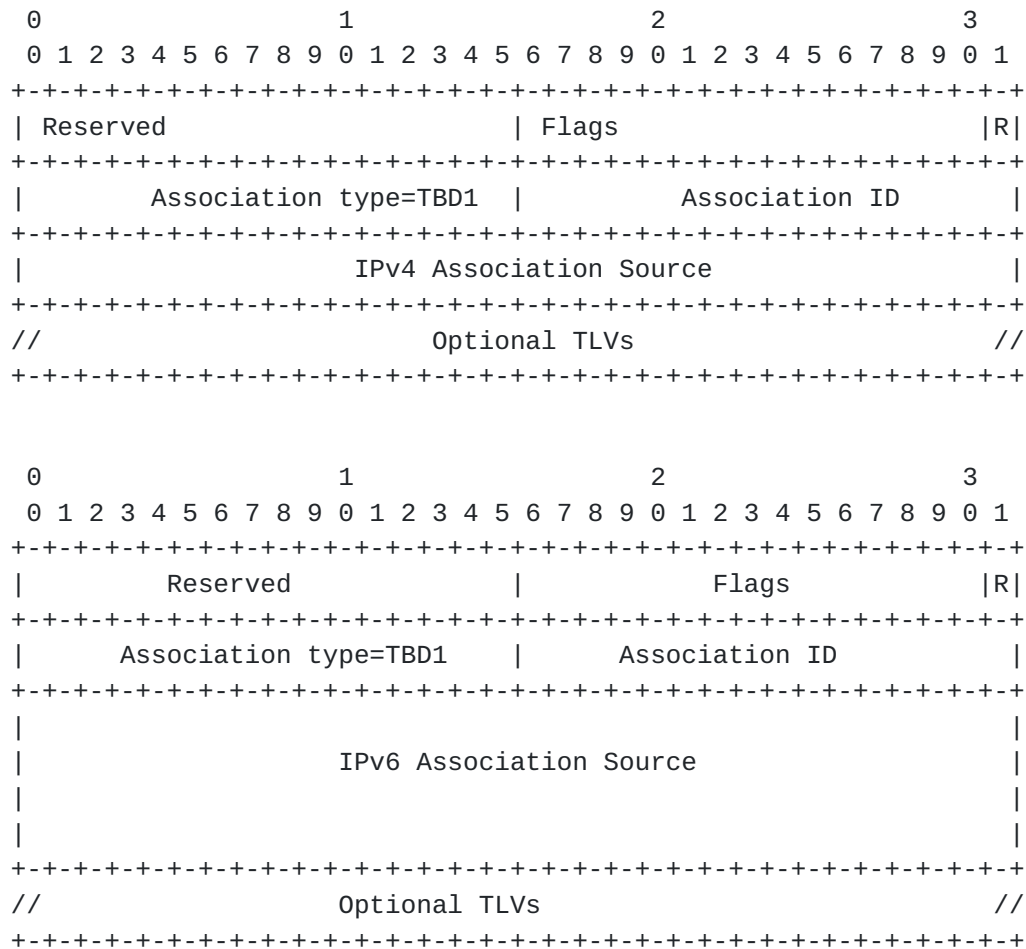


Figure 1: The VNAG Object formats

Please refer to [[I-D.ietf-pce-association-group](#)] for the definition of each field in Figure 1. This document defines one mandatory TLV.

o VIRTUAL-NETWORK-TLV: Used to communicate the VN Identifier.

The format of VIRTUAL-NETWORK-TLV is as follows.

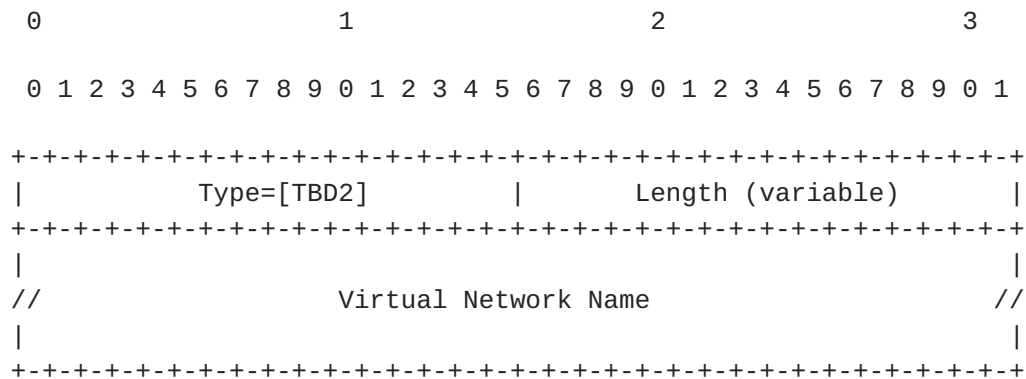


Figure 2: The VIRTUAL-NETWORK-TLV formats

Type: TBD2 (to be allocated by IANA)

Length: Variable Length

Virtual Network Name(variable): symbolic name for the VN.

The VIRTUAL-NETWORK-TLV MUST be included in VNAG object. If a PCEP speaker receives the VNAG object without the VIRTUAL-NETWORK-TLV, it MUST send a PCERR message with Error-Type= 6 (mandatory object missing) and Error-Value=TBD3 (VIRTUAL-NETWORK-TLV missing) and close the session.

## 5. Applicability to H-PCE architecture

The ability to compute shortest constrained TE LSPs in Multiprotocol Label Switching (MPLS) and Generalized MPLS (GMPLS) networks across multiple domains has been identified as a key motivation for PCE development. [RFC6805] describes a Hierarchical PCE (H-PCE) architecture which can be used for computing end-to-end paths for inter-domain MPLS Traffic Engineering (TE) and GMPLS Label Switched Paths (LSPs). Within the hierarchical PCE architecture, the parent PCE is used to compute a multi-domain path based on the domain connectivity information. A child PCE may be responsible for a single domain or multiple domains, it is used to compute the intra-domain path based on its domain topology information.

[I-D.ietf-dhodylee-stateful-HPCE] introduces general considerations for stateful PCE(s) in hierarchical PCE architecture. In

particular, the behavior changes and additions to the existing stateful PCE mechanisms in the context of a H-PCE architecture.

In Stateful H-PCE architecture, the Parent PCE receives a virtual network creation request by its client over its Northbound API. This VN is uniquely identified by an Association ID in VNAG as well as the VIRTUAL-NETWORK name. This VN may comprise multiple LSPs in the network in a single domain or across multiple domains.

As the Parent PCE computes the optimum E2E paths for each tunnel in VN, it MUST associate each LSP with the VN to which it belongs. Parent PCE sends a PCInitiate Message with this association information in the VNAG Object (See [Section 4](#) for details). This in effect binds an LSP that is to be instantiated at the child PCE with the VN.

Whenever changes occur with the instantiated LSP in a domain network, the domain child PCE reports the changes using a PCRpt Message in which the VNAG Object indicates the relationship between the LSP and the VN.

Whenever an update occurs with VNs in the Parent PCE (via the client's request), the parent PCE sends an PCUpd Message to inform each affected child PCE of this change.

## **[6. Security Considerations](#)**

TDB

## **[7. IANA Considerations](#)**

### **[7.1. Association Object Type Indicator](#)**

This document defines the following new association type originally defined in [[I-D.ietf-pce-association-group](#)].

Value	Name	Reference
TBD1	VN Association Type	[This I.D.]

## 7.2. PCEP TLV Type Indicator

This document defines the following new PCEP TLV; IANA is requested to make the following allocations from this registry at <http://www.iana.org/assignments/pcep/pcep.xhtml>; see PCEP TLV Type Indicators.

Value	Name	Reference
TBD2	VIRTUAL-NETWORK-TLV	[This I.D.]

## 7.3. PCEP Error

IANA is requested to make the following allocations from this registry at <http://www.iana.org/assignments/pcep/pcep.xhtml>; see PCEP-ERROR Object Error Types and Values.

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

Error-Type	Meaning
6	Mandatory Object missing
	Error-value=TBD3: VIRTUAL-NETWORK TLV missing

## 8. References

### 8.1. Normative References

- [I-D.ietf-pce-stateful-pce] E. Crabbe, I. Minei, J. Medved, and R. Varga, "PCEP Extensions for Stateful PCE", [draft-ietf-pce-stateful-pce](#), work in progress.
- [I-D.ietf-pce-pce-initiated-lsp] E. Crabbe, et. al., "PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model", [draft-ietf-pce-pce-initiated-lsp](#), work in progress.
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[draft-dhodylee-pce-stateful-hpce](#), work in progress.

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- [RFC4655] Farrel, A., Vasseur, J.-P., and J. Ash, "A Path Computation Element (PCE)-Based Architecture", [RFC 4655](#), August 2006.
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- [I-D.ietf-pce-stateful-pce-app] Zhang, X., ED, and Minei, I., ED,  
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