

PCE Working Group
Internet-Draft
Intended status: Experimental
Expires: March 31, 2018

D. Dhody
R. Palleti
U. Palle
V. Kondreddy
Huawei Technologies
September 27, 2017

**Supporting Explicit Inclusion or Exclusion of Abstract Nodes for a
Subset of P2MP Destinations in Path Computation Element Communication
Protocol (PCEP).**

[draft-dhody-pce-pcep-p2mp-per-destination-12](#)

Abstract

The ability to determine paths of point-to-multipoint (P2MP) Multiprotocol Label Switching (MPLS) and Generalized MPLS (GMPLS) Traffic Engineering Label Switched Paths (TE LSPs) is one the key requirements for Path Computation Element (PCE). The PCEP has been extended for intra and inter domain path computation via PCE(s) for P2MP TE LSP.

This document describes the motivation and PCEP extension for explicitly specifying abstract nodes for inclusion or exclusion for a subset of destinations during P2MP path computation via PCE(s).

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on March 31, 2018.

Copyright Notice

Copyright (c) 2017 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction	2
1.1.	Requirements Language	3
2.	Terminology	3
3.	Motivation	4
3.1.	Domain Sequence Tree in Inter Domain P2MP Path Computation	4
3.2.	Explicit inclusion or exclusion of abstract nodes	6
4.	Detailed Description	6
4.1.	Objective	7
4.2.	Request Message Format	7
4.3.	Report Message Format	9
4.4.	Backward Compatibility	10
5.	IANA Considerations	10
6.	Security Considerations	10
7.	Manageability Considerations	10
7.1.	Control of Function and Policy	10
7.2.	Information and Data Models	11
7.3.	Liveness Detection and Monitoring	11
7.4.	Verify Correct Operations	11
7.5.	Requirements On Other Protocols	11
7.6.	Impact On Network Operations	11
8.	Acknowledgments	11
9.	References	11
9.1.	Normative References	11
9.2.	Informative References	12
	Authors' Addresses	13

[1.](#) Introduction

The PCE architecture is defined in [\[RFC4655\]](#). [\[RFC5862\]](#) lay out the requirements for PCEP to support P2MP path computation. [\[I-D.ietf-pce-rfc6006bis\]](#) describe an extension to PCEP to compute optimal constrained intra-domain (G)MPLS P2MP TE LSPs. [\[RFC7334\]](#) describes the mechanism for inter-domain P2MP path computation.

Further [[I-D.ietf-pce-rfc6006bis](#)] describes mechanism to specify a list of nodes that can be used as branch nodes or a list of nodes that cannot be used as branch nodes via Branch Node Capability (BNC) object. The BNC object is used to specify which nodes have the capability to act as a branch nodes or which nodes lack the capability. It supports IPv4 and IPv6 prefix sub-objects only.

This document explains the need to add the capability to explicitly specify any abstract nodes (not just nodes with branch node capability) for inclusion or exclusion for a subset of destinations.

[RFC7334] describes the core-tree procedure to compute inter-domain P2MP tree. It assumes that, due to deployment and commercial limitations, the sequence of domains for a path (the path domain tree) will be known in advance. For a group of destination which belong to a particular destination domain, the domain-sequence needs to be encoded separately as described in [[RFC7897](#)]. The mechanism, as described in this document, of explicitly specifying abstract nodes for inclusion or exclusion for a subset of destinations can be used for this purpose, where abstract nodes are domains.

Stateful PCEs are shown to be helpful in many application scenarios, in both MPLS and GMPLS networks, as illustrated in [[RFC8051](#)]. These scenarios apply equally to P2P and P2MP TE LSPs. [[RFC8231](#)] provides the fundamental extensions needed for stateful PCE to support general functionality for P2P TE LSP. [[I-D.ietf-pce-pce-initiated-lsp](#)] provides the an extensions needed for stateful PCE-initiated P2P TE LSP. Complementarily, [[I-D.ietf-pce-stateful-pce-p2mp](#)] focuses on the extensions that are necessary in order for the deployment of stateful PCEs to support P2MP TE LSPs.

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.

IRO: Include Route Object.

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 Protocol.

P2MP: Point-to-Multipoint

P2P: Point-to-Point

RR0: Record Route Object

RSVP: Resource Reservation Protocol

TE LSP: Traffic Engineering Label Switched Path.

XR0: Exclude Route Object.

3. Motivation

3.1. Domain Sequence Tree in Inter Domain P2MP Path Computation

[RFC7334] describes the core-tree procedure for inter-domain path computation. The procedure assumes that the sequence of domains for a path (the path domain tree) will be known in advance due to deployment and commercial limitations (e.g., inter-AS peering agreements).

In the Figure 1 below, D1 is the root domain; D4, D5 and D6 are the destination domains. The ingress is Ro in domain D1; egresses are M, N in Domain D4; R, S in Domain D5; and U, V in Domain D6.

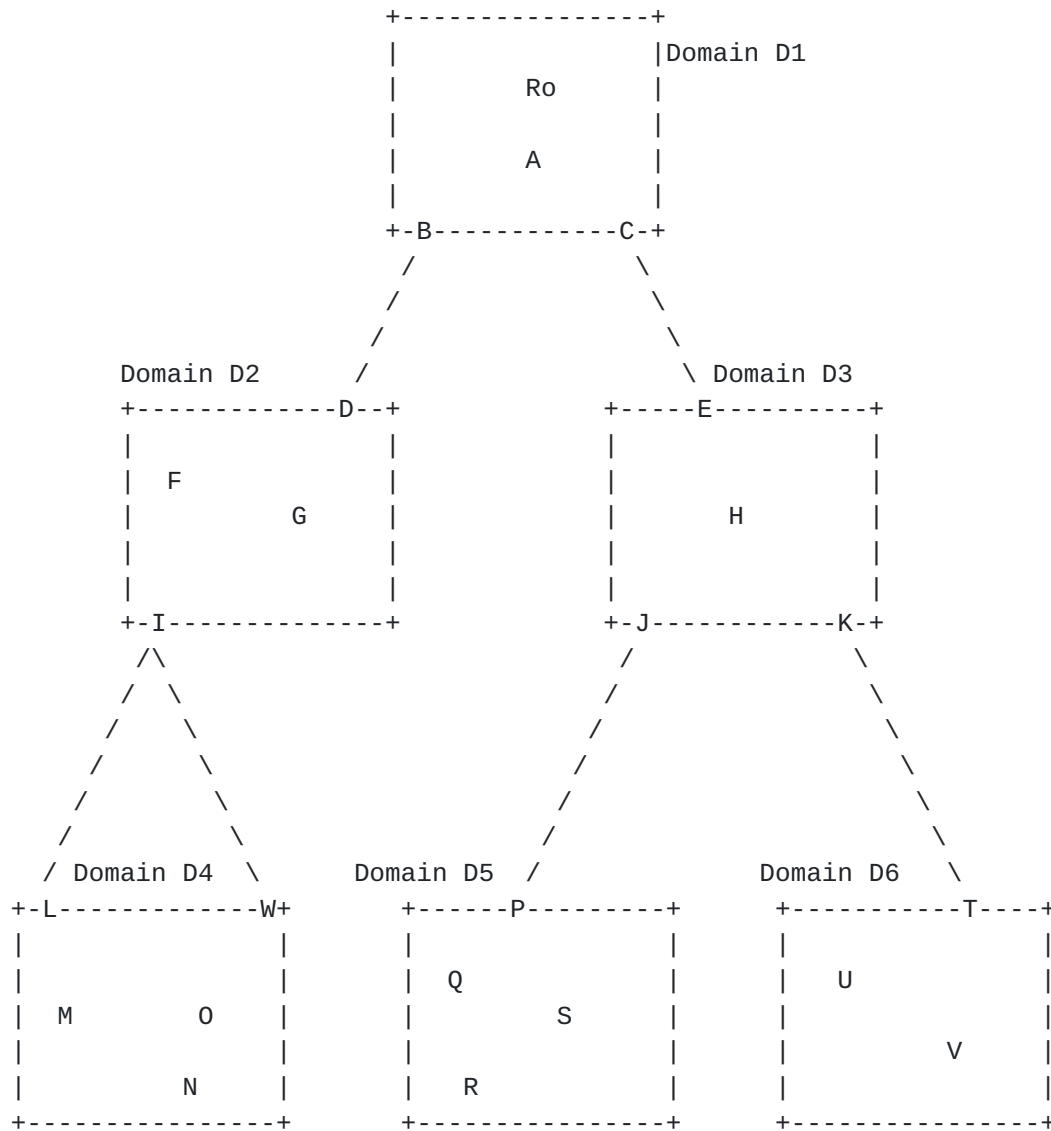


Figure 1: Domain Topology Example

The domain tree can be represented as a series of domain sequences:

Domain D1, Domain D3, Domain D6

Domain D1, Domain D3, Domain D5

Domain D1, Domain D2, Domain D4

Since destinations in different destination domain will have different domain sequence within the domain tree, it requires following encoding that binds destinations to a particular domain sequence.

- o Destination M and N: D1-D2-D4
- o Destination R and S: D1-D3-D5
- o Destination U and V: D1-D3-D6

An extension in P2MP Path Computation request is needed to support this. (Refer [Section 4.2](#))

The abstract nodes MAY include (but not limited to) domain subobjects - AS number and IGP Area as described in [[RFC7897](#)].

[3.2.](#) Explicit inclusion or exclusion of abstract nodes

[I-D.ietf-pce-rfc6006bis] describes four possible types of leaves in a P2MP request encoded in P2MP END-POINTS object.

- o New leaves to add
- o Old leaves to remove
- o Old leaves whose path can be modified/reoptimized
- o Old leaves whose path must be left unchanged

[I-D.ietf-pce-rfc6006bis] only allows to encode a list of nodes that have (or have not) the branch node capability by using the Branch Node Capability (BNC) Object. This object apply to all destinations (old and new) in the P2MP tree.

For an existing P2MP tree with an overloaded branch node, when adding a set of new leaves, administrator may want to exclude that particular branch node to balance the final P2MP tree. This cannot be achieved via the BNC object but by explicitly excluding a particular node or including a different node, for the P2MP END-POINTS object for new leaves only.

Administrator at the Ingress can exert stronger control by providing explicit inclusion or exclusion of any abstract nodes (not limited to specifying nodes with branch node capability) for a group (subset) of destinations and not all destinations.

[4.](#) Detailed Description

4.1. Objective

[I-D.ietf-pce-rfc6006bis] and [[I-D.ietf-pce-stateful-pce-p2mp](#)] defines Request Message Format and Objects, along with <end-point-rro-pair-list>. This section introduce the use of <IRO> and <XRO> which are added to the <end-point-rro-pair-list>.

To allow abstract nodes to be explicitly included or excluded for a subset of destinations (encoded in one <END-POINTS> object), changes are made as shown below.

The abstract node (encoded as subobject in <IRO> and <XRO>) MAY be an absolute hop, IP-Prefix, AS or IGP Area. The subobjects are described in [[RFC3209](#)], [[RFC3477](#)], [[RFC4874](#)] and [[RFC7897](#)].

Note that one P2MP Path request can have multiple <END-POINTS> objects and each P2MP <END-POINTS> object may have multiple destinations, the <pce-list>, <IRO> and <XRO> is applied for all destinations in one such P2MP <END-POINTS> object.

4.2. Request Message Format

The format of PCReq message, with [[I-D.ietf-pce-stateful-pce-p2mp](#)] as base, is modified as follows:


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

where:

```
<svec-list>::= <SVEC>
               [<OF>]
               [<metric-list>]
               [<svec-list>]

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

<request>::= <RP>
             <end-point-pce-iro-xro-rro-pair-list>
             [<LSP>]
             [<OF>]
             [<LSPA>]
             [<BANDWIDTH>]
             [<metric-list>]
             [<IRO>|<BNC>]
             [<LOAD-BALANCING>]

<end-point-pce-iro-xro-rro-pair-list>::=
             <END-POINTS>
             [<IRO>]
             [<XRO>]
             [<RRO-List>][<BANDWIDTH>]
             [<end-point-pce-iro-xro-rro-pair-list>]

<RRO-List>::=(<RRO>|<SRRO>)[<RRO-List>]
<metric-list>::=<METRIC>[<metric-list>]
```

From [[I-D.ietf-pce-rfc6006bis](#)] and [[I-D.ietf-pce-stateful-pce-p2mp](#)], usage of <end-point-rro-pair-list> is changed to <end-point-pce-iro-xro-rro-pair-list> in this document.

[I-D.ietf-pce-rfc6006bis] describes Branch Node Capability (BNC) Object which is different from the use of <IRO> and <XRO> to specify inclusion/exclusion of abstract nodes for a subset of destinations as described here.

4.3. Report Message Format

[I-D.ietf-pce-stateful-pce-p2mp] defines a report message format and objects. This document extends the message to allow explicit inclusion and exclusion of abstract nodes for a group of destinations.

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

Where:

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

```
<state-report> ::= [<SRP>]
                   <LSP>
                   <end-point-intended-path-pair-list>
                   [<actual_attribute_list>]
                   <end-point-actual-path-pair-list>]
                   <intended-attribute-list>
```

Where:

```
<end-point-intended-path-pair-list> ::=
    [<END-POINTS>]
    [<S2LS>]
    [<IRO>]
    [<XRO>]
    <intended_path>
    [<end-point-intended-path-pair-list>]
```

```
<end-point-actual-path-pair-list> ::=
    [<END-POINTS>]
    [<S2LS>]
    <actual_path>
    [<end-point-actual-path-pair-list>]
```

```
<intended_path> ::= (<ERO>|<SERO>)
                    [<intended_path>]
```

```
<actual_path> ::= (<RRO>|<SRRRO>)
                  [<actual_path>]
```

<intended_path> is represented by the ERO, SERO object. The <actual_attribute_list> consists of the actual computed and signaled values of the <BANDWIDTH> and <metric-lists> objects defined in [RFC5440](#). <actual_path> is represented by the RRO, SERO object.

The <end-point-intended-path-pair-list> is extended to add the IRO and XRO object for a group of destinations in the END-POINTS object.

4.4. Backward Compatibility

A legacy implementation that does not support explicit inclusion or exclusion of abstract nodes for a subset of P2MP destinations will act according to the procedures set out in [RFC5440], that is it will find the P2MP Path Request message out of order with respect to the format specified in [I-D.ietf-pce-rfc6006bis] and [I-D.ietf-pce-stateful-pce-p2mp].

5. IANA Considerations

There are no new IANA allocation in this document.

6. Security Considerations

PCEP security mechanisms as described in [RFC5440], [I-D.ietf-pce-rfc6006bis], [RFC7334] and [I-D.ietf-pce-stateful-pce-p2mp] are applicable for this document.

The new explicit inclusion or exclusion of abstract nodes for a subset of P2MP destination defined in this document allow finer and more specific control of the path computed by a PCE. Such control increases the risk if a PCEP message is intercepted, modified, or spoofed because it allows the attacker to exert control over the path that the PCE will compute or to make the path computation impossible. Therefore, the security techniques described in [RFC5440], [I-D.ietf-pce-rfc6006bis], [RFC7334] and [I-D.ietf-pce-stateful-pce-p2mp] are considered more important.

Note, however, that the route exclusion mechanisms also provide the operator with the ability to route around vulnerable parts of the network and may be used to increase overall network security.

7. Manageability Considerations

7.1. Control of Function and Policy

Mechanisms defined in this document do not add any new control function/policy requirements in addition to those already listed in [I-D.ietf-pce-rfc6006bis] and [I-D.ietf-pce-stateful-pce-p2mp].

7.2. Information and Data Models

Mechanisms defined in this document do not imply any new MIB requirements.

7.3. 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 [[I-D.ietf-pce-rfc6006bis](#)] and [[I-D.ietf-pce-stateful-pce-p2mp](#)].

7.4. Verify Correct Operations

Mechanisms defined in this document do not imply any new operation verification requirements in addition to those already listed in [[I-D.ietf-pce-rfc6006bis](#)] and [[I-D.ietf-pce-stateful-pce-p2mp](#)].

7.5. Requirements On Other Protocols

Mechanisms defined in this document do not imply any requirements on other protocols in addition to those already listed in [[I-D.ietf-pce-rfc6006bis](#)] and [[I-D.ietf-pce-stateful-pce-p2mp](#)].

7.6. Impact On Network Operations

Mechanisms defined in this document do not have any impact on network operations in addition to those already listed in [[I-D.ietf-pce-rfc6006bis](#)] and [[I-D.ietf-pce-stateful-pce-p2mp](#)].

8. Acknowledgments

We would like to thank Pradeep Shastry, Suresh babu, Quintin Zhao, Daniel King and Chen Huaimo for their useful comments and suggestions.

9. References

9.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

- [RFC5440] Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation Element (PCE) Communication Protocol (PCEP)", [RFC 5440](#), DOI 10.17487/RFC5440, March 2009, <<https://www.rfc-editor.org/info/rfc5440>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in [RFC 2119](#) Key Words", [BCP 14](#), [RFC 8174](#), DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [RFC8231] Crabbe, E., Minei, I., Medved, J., and R. Varga, "Path Computation Element Communication Protocol (PCEP) Extensions for Stateful PCE", [RFC 8231](#), DOI 10.17487/RFC8231, September 2017, <<https://www.rfc-editor.org/info/rfc8231>>.
- [I-D.ietf-pce-rfc6006bis]
Zhao, Q., Dhody, D., Palleti, R., and D. King, "Extensions to the Path Computation Element Communication Protocol (PCEP) for Point-to-Multipoint Traffic Engineering Label Switched Paths", [draft-ietf-pce-rfc6006bis-04](#) (work in progress), September 2017.
- [I-D.ietf-pce-pce-initiated-lsp]
Crabbe, E., Minei, I., Sivabalan, S., and R. Varga, "PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model", [draft-ietf-pce-pce-initiated-lsp-10](#) (work in progress), June 2017.
- [I-D.ietf-pce-stateful-pce-p2mp]
Palle, U., Dhody, D., Tanaka, Y., and V. Beeram, "Path Computation Element (PCE) Protocol Extensions for Stateful PCE usage for Point-to-Multipoint Traffic Engineering Label Switched Paths", [draft-ietf-pce-stateful-pce-p2mp-04](#) (work in progress), July 2017.

9.2. Informative References

- [RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", [RFC 3209](#), DOI 10.17487/RFC3209, December 2001, <<https://www.rfc-editor.org/info/rfc3209>>.
- [RFC3477] Kompella, K. and Y. Rekhter, "Signalling Unnumbered Links in Resource ReSerVation Protocol - Traffic Engineering (RSVP-TE)", [RFC 3477](#), DOI 10.17487/RFC3477, January 2003, <<https://www.rfc-editor.org/info/rfc3477>>.

- [RFC4655] Farrel, A., Vasseur, J., and J. Ash, "A Path Computation Element (PCE)-Based Architecture", [RFC 4655](#), DOI 10.17487/RFC4655, August 2006, <<https://www.rfc-editor.org/info/rfc4655>>.
- [RFC4874] Lee, CY., Farrel, A., and S. De Cnodder, "Exclude Routes - Extension to Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)", [RFC 4874](#), DOI 10.17487/RFC4874, April 2007, <<https://www.rfc-editor.org/info/rfc4874>>.
- [RFC5862] Yasukawa, S. and A. Farrel, "Path Computation Clients (PCC) - Path Computation Element (PCE) Requirements for Point-to-Multipoint MPLS-TE", [RFC 5862](#), DOI 10.17487/RFC5862, June 2010, <<https://www.rfc-editor.org/info/rfc5862>>.
- [RFC7334] Zhao, Q., Dhody, D., King, D., Ali, Z., and R. Casellas, "PCE-Based Computation Procedure to Compute Shortest Constrained Point-to-Multipoint (P2MP) Inter-Domain Traffic Engineering Label Switched Paths", [RFC 7334](#), DOI 10.17487/RFC7334, August 2014, <<https://www.rfc-editor.org/info/rfc7334>>.
- [RFC7897] Dhody, D., Palle, U., and R. Casellas, "Domain Subobjects for the Path Computation Element Communication Protocol (PCEP)", [RFC 7897](#), DOI 10.17487/RFC7897, June 2016, <<https://www.rfc-editor.org/info/rfc7897>>.
- [RFC8051] Zhang, X., Ed. and I. Minei, Ed., "Applicability of a Stateful Path Computation Element (PCE)", [RFC 8051](#), DOI 10.17487/RFC8051, January 2017, <<https://www.rfc-editor.org/info/rfc8051>>.

Authors' Addresses

Dhruv Dhody
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: dhruv.ietf@gmail.com

Ramanjaneya Reddy Palleti
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

E-Mail: ramanjaneya.palleti@huawei.com

Udayasree Palle
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

E-Mail: udayasreereddy@gmail.com

Venugopal Reddy Kondreddy
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

E-Mail: venugopalreddyk@huawei.com

