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LSP State Reporting Extensions in Path Computation Element Communication Protocol (PCEP)
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Abstract

The Path Computation Element Communication Protocol (PCEP) is defined in multiple RFCs for enabling communication between Path Computation Elements (PCEs) and Path Computation Clients (PCCs).

Although PCEP defines various Label Switched Path (LSP) identifiers, attributes, and constraints, there are operational attributes available on the PCC that can enhance path computation and improve the debugging experience, which are not currently supported in PCEP.

This document proposes extensions to PCEP to include:

* Support for explicit or dynamic path types
* Mechanisms to mark LSPs as eligible for use as transit LSPs

These extensions aim to address the existing gaps, enhancing the overall functionality and operational efficiency of PCEP.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on 8 January 2026.

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Table of Contents

1. Introduction

A Stateful Path Computation Element (PCE) maintains comprehensive information on the current network state, including computed Label Switched Paths (LSPs), reserved network resources, and the pending path computation requests. This information is critical for computing paths for traffic-engineering LSPs and any associated or dependent LSPs.

This document introduces the ability to encode information regarding whether a path included in an Explicit Route Object (ERO) was specified explicitly or it is the result of dynamic path computation executed by a PCE or PCC. Such information can help in debuggability and can be used by other PCEs in the network to avoid triggering unnecessary path computations for LSPs where it is not intended (e.g., PCE-initiated LSPs with explicit path).

Additionally, this document specifies a set of extensions to PCEP to enhance the accuracy of path computations by considering LSP transit eligibility, for example as described in case of LSP stitching in [I-D.ietf-pce-stateful-interdomain].

The mechanisms described in this document are applicable to all path setup types.

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 terminologies are used in this document:

* ERO: Explicit Route Object.
* PCE: Path Computation Element.
* PCEP: Path Computation Element Protocol.
* LSP: Label Switched Path.

3. Object Formats

3.1. STATEFUL-PCE-CAPABILITY TLV

A new flag is proposed for the STATEFUL-PCE-CAPABILITY TLV, originally defined in Section 5.4 of [RFC8231].

* T (TRANSIT-ELIGIBLE-CAPABILITY): If set, indicates that the PCEP peer supports the advertisement of the Transit Eligible flag in the LSP-EXTENDED-FLAG as described in Section 4.2.

3.2. LSP-EXTENDED-FLAG TLV

New flags are introduced in the LSP-EXTENDED-FLAG TLV, which was initially defined in Section 3.1 of [RFC9357].

* X (Explicit): If set, indicates that the path encoded in the ERO is explicitly specified and not dynamically computed by the PCEP peer.
* T (Transit Eligible): If set, indicates that the binding value of the LSP can be used in paths computed for other LSPs.

4. Operation

4.1. Explicit or Dynamic Path

For instance, if an operator requests the creation of a PCE-Initiated Candidate Path with an Explicit Path, then such path will be encoded in the ERO object of the PCInitiate message sent to the PCC. If the delegation of such LSP is transferred to another PCE, the new PCE will not know whether the path of the LSP was computed dynamically or explicitly specified by the operator.

Even if a similar problem does not exist for LSPs originated on the PCC, information about the type of path may be valuable for other purposes, such as debuggability.

For LSPs initiated by PCC, the X flag value is initially set by the PCC in the PCRpt message and the PCE MUST set the flag value in PCUpd messages for such LSP based on the last reported state.

For PCE-initiated LSPs, the X flag value is initially set by the PCE in PCInitiate message but MAY be modified in the PCUpd messages. The PCC MUST set the flag value in PCRpt messages for such LSP based on the value received from the last PCInitiate or PCUpd message.

Both explicitly specified and dynamically computed paths, can contain a mix of strict and loose subobjects:

* For an Explicitly Specified Path (X flag set): An operator might define a path that explicitly specifies certain hops (strict) but allows the forwarding to select the exact route for other nodes (loose). For example, "go strictly through Router A, then loosely to Network B, then strictly through Router C."

* For a Dynamically Computed Path (X flag not set): A PCE, when computing a path, might generate an ERO that includes strict hops (e.g., to satisfy specific constraints like avoiding certain links) and loose hops (e.g., where flexibility is allowed to optimize for metrics like shortest path).

4.2. LSP Transit Eligibility

The T flag in the LSP-EXTENDED-FLAG TLV MUST NOT be set unless the TRANSIT-ELIGIBLE-CAPABILITY is supported by both PCEP peers.

If the TRANSIT-ELIGIBLE-CAPABILITY is not advertised, the PCE implementation MAY use a local policy to determine the value of the Transit Eligible flag.

For PCC-initiated LSPs, the T flag value is initially set by the PCC in the PCRpt message. The PCE MUST set the flag value in PCUpd messages for these LSPs based on the last reported state.

For PCE-initiated LSPs, the T flag value is initially set by the PCE in the PCInitiate message but MAY be modified in subsequent PCUpd messages. The PCC MUST set the flag value in PCRpt messages for these LSPs based on the value received from the latest PCInitiate or PCUpd message.

5. Manageability Considerations

All manageability requirements and considerations listed in [RFC5440] and [RFC8231] apply to PCEP protocol extensions defined in this document. In addition, requirements and considerations listed in this section apply.

5.1. Control of Function and Policy

A PCE or PCC implementation MAY allow the capability of supporting PCEP extensions introduced in this document to be enabled or disabled as part of the global configuration.

5.2. Information and Data Models

An implementation SHOULD allow the operator to view the capability defined in this document. Sections 4.1 and 4.1.1 of [I-D.ietf-pce-pcep-yang] should be extended to include the capability introduced in Section 3.1 for the PCEP peer.

5.3. Verify Correct Operations

Operation verification requirements already listed in [RFC5440] and [RFC8231] are applicable to mechanisms defined in this document.

5.4. Impact On Network Operations

The mechanisms defined in [RFC5440] and [RFC8231] also apply to the PCEP extensions defined in this document.

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".

7. Security Considerations

The security considerations described in [RFC8231] and [RFC5440] are applicable to this document. No additional security measures are required.

8. IANA Considerations

8.1. STATEFUL-PCE-CAPABILITY TLV Flag

IANA maintains a registry, named "STATEFUL-PCE-CAPABILITY TLV Flag Field", within the "Path Computation Element Protocol (PCEP) Numbers" registry group to manage the Flags field of the STATEFUL-PCE-CAPABILITY TLV. IANA is requested to make the following assignments:

Bit	Description	Reference
TBA1	T (TRANSIT-ELIGIBLE-CAPABILITY)	This document

Table 1

8.2. LSP-EXTENDED-FLAG TLV Flags

IANA maintains a registry, named "LSP-EXTENDED-FLAG TLV Flag Field", within the "Path Computation Element Protocol (PCEP) Numbers" registry group to manage the Flags field of the LSP-EXTENDED-FLAG TLV. IANA is requested to make the following assignments:

Bit	Description	Reference
TBA2	X (Explicit)	This document
TBA3	T (Transit Eligible)	This document

Table 2

9. References

9.1. Normative References

[I-D.ietf-pce-pcep-yang]
Dhody, D., Beeram, V. P., Hardwick, J., and J. Tantsura, "A YANG Data Model for Path Computation Element Communications Protocol (PCEP)", Work in Progress, Internet-Draft, draft-ietf-pce-pcep-yang-30, 26 January 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-pce-pcep-yang-30>.

[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>.

[RFC9357] Xiong, Q., "Label Switched Path (LSP) Object Flag Extension for Stateful PCE", RFC 9357, DOI 10.17487/RFC9357, February 2023, <https://www.rfc-editor.org/info/rfc9357>.

9.2. Informative References

[I-D.ietf-pce-stateful-interdomain] Dugeon, O., Meuric, J., Lee, Y., and D. Ceccarelli, "PCEP Extension for Stateful Inter-Domain Tunnels", Work in Progress, Internet-Draft, draft-ietf-pce-stateful-interdomain-07, 3 March 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-pce-stateful-interdomain-07>.

[RFC7942] Sheffer, Y. and A. Farrel, "Improving Awareness of Running Code: The Implementation Status Section", BCP 205, RFC 7942, DOI 10.17487/RFC7942, July 2016, <https://www.rfc-editor.org/info/rfc7942>.

Appendix A. Acknowledgements

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