

PCE Working Group
Internet-Draft
Intended status: Standards Track
Expires: November 5, 2018

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May 4, 2018

Conveying path setup type in PCEP messages
draft-ietf-pce-lsp-setup-type-10

Abstract

A Path Computation Element (PCE) can compute Traffic Engineering (TE) paths through a network that are subject to various constraints. Currently, TE paths are Label Switched Paths (LSPs) which are set up using the RSVP-TE signaling protocol. However, other TE path setup methods are possible within the PCE architecture. This document proposes an extension to the PCE communication protocol (PCEP) to allow support for different path setup methods over a given PCEP session.

Status of This Memo

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[1. Introduction](#)

[RFC5440] describes the Path Computation Element communication Protocol (PCEP) for communication between a Path Computation Client (PCC) and a Path Computation Element (PCE), or between a PCE and a PCE. A PCC requests a path subject to various constraints and optimization criteria from a PCE. The PCE responds to the PCC with a hop-by-hop path in an Explicit Route Object (ERO). The PCC uses the ERO to set up the path in the network.

[RFC8231] specifies extensions to PCEP that allow a PCC to delegate its LSPs to a PCE. The PCE can then update the state of LSPs

delegated to it. In particular, the PCE may modify the path of an LSP by sending a new ERO. The PCC uses this ERO to re-route the LSP in a make-before-break fashion. [RFC8281] specifies a mechanism allowing a PCE to dynamically instantiate an LSP on a PCC by sending the ERO and the characteristics of the LSP. The PCC creates the LSP using the ERO and other attributes sent by the PCE.

So far, PCEP and its extensions have assumed that the TE paths are label switched and are established via the RSVP-TE protocol. However, other methods of LSP setup are possible in the PCE architecture (see [RFC4655] and [RFC4657]). This document generalizes PCEP to allow other LSP setup methods to be used. It defines two new TLVs and specifies the base procedures to facilitate this, as follows.

- o The PATH-SETUP-TYPE-CAPABILITY TLV, which allows a PCEP speaker to announce which LSP setup methods it supports when the PCEP session is established.
- o The PATH-SETUP-TYPE TLV, which allows a PCEP speaker to specify which setup method should be used for a given LSP. When multiple path setup types are deployed in a network, a given PCEP session may have to simultaneously support more than one path setup type. A PCEP speaker uses the PATH-SETUP-TYPE TLV to explicitly indicate the intended path setup type in the appropriate PCEP messages, unless the path setup type is RSVP-TE (which is assumed to be the path setup type if no other setup type is indicated). This is so that both the PCC and the PCE can take the necessary steps to set up the path.

This document defines a path setup type code for RSVP-TE. When a new path setup type (other than RSVP-TE) is introduced for setting up a path, a path setup type code and, optionally, a sub-TLV pertaining to the new path setup type will be defined by the document that specifies the new path setup type.

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.

LSR: Label Switching Router.

PCC: Path Computation Client.

PCE: Path Computation Element.

PCEP: Path Computation Element Protocol.

PST: Path Setup Type.

TLV: Type, Length, and Value.

3. Path Setup Type Capability TLV

A PCEP speaker indicates which PSTs it supports during the PCEP initialization phase, as follows. When the PCEP session is created, it sends an Open message with an OPEN object containing the PATH-SETUP-TYPE-CAPABILITY TLV. The format of this TLV is as follows.

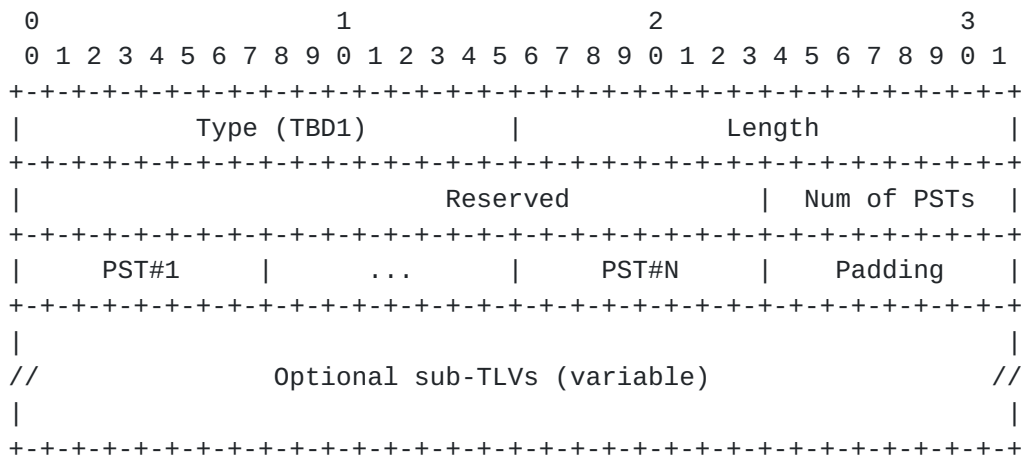


Figure 1: PATH-SETUP-TYPE-CAPABILITY TLV

The TLV type is TBD1 (to be assigned by IANA). Its reserved field MUST be set to zero by the sender and MUST be ignored by the receiver. The other fields in the TLV are as follows.

Length: The total length in bytes of the remainder of the TLV, that is, excluding the Type and Length fields.

Number of PSTs: The number of PSTs in the following list, excluding padding.

List of PSTs: A list of the PSTs that the PCEP speaker supports. Each PST is a single byte in length. Duplicate entries in this list MUST be ignored. The PCEP speaker MUST pad the list with zeros so that it is a multiple of four bytes in length. This document defines the following PST value:

- * PST = 0: Path is setup using the RSVP-TE signaling protocol.

Optional sub-TLVs: A list of sub-TLVs associated with the supported PSTs. Each PST has zero or one sub-TLVs associated with it, and each sub-TLV is associated with exactly one PST. Each sub-TLV MUST obey the rules for TLV formatting defined in ([RFC5440](#)). That is, each sub-TLV is padded to a four byte alignment, and the length field of each sub-TLV does not include the padding bytes. This document does not define any sub-TLVs; an example can be found in [[I-D.ietf-pce-segment-routing](#)].

A PCEP speaker MUST check that this TLV is correctly formatted, as follows.

- o If there are no sub-TLVs, then the TLV length field MUST be equal to four bytes plus the size of the PST list, excluding any padding bytes.
- o If there are sub-TLVs then the TLV Length field MUST be equal to four bytes plus the size of the PST list (rounded up to the nearest multiple of four) plus the size of the appended sub-TLVs excluding any padding bytes in the final sub-TLV.
- o The Number of PSTs field MUST be greater than zero.

If a PCEP speaker receives a PATH-SETUP-TYPE-CAPABILITY TLV which violates these rules, then the PCEP speaker MUST send a PCErr message with Error-Type = 10 (Reception of an invalid object) and Error-Value = 11 (Malformed object) and MUST close the PCEP session. The PCEP speaker MAY include the malformed OPEN object in the PCErr message as well.

If a PCEP speaker receives an OPEN object with more than one PATH-SETUP-TYPE-CAPABILITY TLV then it MUST ignore all but the first instance of this TLV.

The absence of the PATH-SETUP-TYPE-CAPABILITY TLV from the OPEN object is equivalent to a PATH-SETUP-TYPE-CAPABILITY TLV containing a single PST of 0 (RSVP-TE signaling protocol) and no sub-TLVs. A PCEP

speaker MAY omit the PATH-SETUP-TYPE-CAPABILITY TLV if the only PST it supports is RSVP-TE. If a PCEP speaker supports other PSTs besides RSVP-TE, then it SHOULD include the PATH-SETUP-TYPE-CAPABILITY TLV in its OPEN object.

If a PCEP speaker does not recognize the PATH-SETUP-TYPE-CAPABILITY TLV, it will ignore the TLV in accordance with [\[RFC5440\]](#).

4. Path Setup Type TLV

When a PCEP session is used to set up TE paths using different methods, the corresponding PCE and PCC must be aware of the path setup method used. That means, a PCE must be able to specify paths in the correct format and a PCC must be able to take control plane and forwarding plane actions appropriate to the PST.

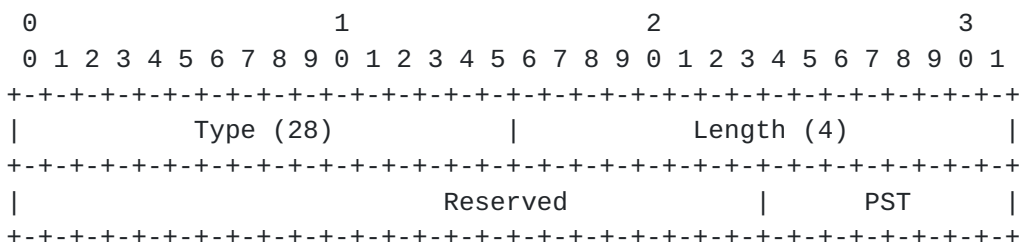


Figure 2: PATH-SETUP-TYPE TLV

PATH-SETUP-TYPE TLV is an optional TLV associated with the RP ([\[RFC5440\]](#)) and the SRP ([\[RFC8231\]](#)) objects. Its format is shown in the above figure. The TLV type is 28. Its reserved field MUST be set to zero. The one byte value contains the PST as defined for the PATH-SETUP-TYPE-CAPABILITY TLV.

The absence of the PATH-SETUP-TYPE TLV is equivalent to a PATH-SETUP-TYPE TLV with a PST value of 0 (RSVP-TE). A PCEP speaker MAY omit the TLV if the PST is RSVP-TE. If the RP or SRP object contains more than one PATH-SETUP-TYPE TLV, only the first TLV MUST be processed and the rest MUST be ignored.

If a PCEP speaker does not recognize the PATH-SETUP-TYPE TLV, it will ignore the TLV in accordance with [\[RFC5440\]](#), and will use RSVP-TE to set up the path.

5. Operation

During the PCEP initialization phase, if a PCEP speaker receives a PATH-SETUP-TYPE-CAPABILITY TLV from its peer, it MUST assume that the peer supports only the PSTs listed in the TLV. If the PCEP speaker and its peer have no PSTs in common, then the PCEP speaker MUST send

a PCErr message with Error-Type = 21 (Invalid traffic engineering path setup type) and Error-Value = 2 (Mismatched path setup type) and close the PCEP session.

If the peer has sent no PATH-SETUP-TYPE-CAPABILITY TLV, then the PCEP speaker MUST infer that the peer supports path setup using at least RSVP-TE. The PCEP speaker MAY also infer that the peer supports other path setup types, but the means of inference are outside the scope of this document.

When a PCC sends a PCReq message to a PCE ([\[RFC5440\]](#)), it MUST include the PATH-SETUP-TYPE TLV in the RP object, unless the intended PST is RSVP-TE, in which case it MAY omit the PATH-SETUP-TYPE TLV. If the PCE is capable of expressing the path in a format appropriate to the intended PST, it MUST use the appropriate ERO format in the PCRep message.

When a PCE sends a PCRep message to a PCC ([\[RFC5440\]](#)), it MUST include the PATH-SETUP-TYPE TLV in the RP object, unless the PST is RSVP-TE, in which case it MAY omit the PATH-SETUP-TYPE TLV. If the PCE does not support the intended PST, it MUST send a PCErr message with Error-Type = 21 (Invalid traffic engineering path setup type) and Error-Value = 1 (Unsupported path setup type) and close the PCEP session. If the PSTs corresponding to the PCReq and PCRep messages do not match, the PCC MUST send a PCErr message with Error-Type = 21 (Invalid traffic engineering path setup type) and Error-Value = 2 (Mismatched path setup type) and close the PCEP session.

When a stateful PCE sends a PCUpd message ([\[RFC8231\]](#)) or a PCInitiate message ([\[RFC8281\]](#)) to a PCC, it MUST include the PATH-SETUP-TYPE TLV in the SRP object, unless the intended PST is RSVP-TE, in which case it MAY omit the PATH-SETUP-TYPE TLV. If the PCC does not support the PST associated with the PCUpd or PCInitiate message, it MUST send a PCErr message with Error-Type = 21 (Invalid traffic engineering path setup type) and Error-Value = 1 (Unsupported path setup type) and close the PCEP session.

When a PCC sends a PCRpt message to a stateful PCE ([\[RFC8231\]](#)), it MUST include the PATH-SETUP-TYPE TLV in the SRP object, unless the PST is RSVP-TE, in which case it MAY omit the PATH-SETUP-TYPE TLV. The PCC MUST include the SRP object in the PCRpt message if the PST is not RSVP-TE, even when the SRP-ID-number is the reserved value of 0x00000000. If the PCRpt message is triggered by a PCUpd or PCInitiate message, then the PST that the PCC indicates in the PCRpt MUST match the PST that the stateful PCE intended in the PCUpd or PCInitiate. If it does not, then the PCE MUST send a PCErr message with Error-Type = 21 (Invalid traffic engineering path setup type)

and Error-Value = 2 (Mismatched path setup type) and close the PCEP session.

6. Manageability Considerations

This document generalises PCEP to allow path setup methods other than RSVP-TE to be used by the network (but does not define any new path setup types, besides RSVP-TE). It is possible that, in a given network, multiple path setup methods will be used. It is also possible that not all devices will support the same set of path setup methods. Managing networks that combine multiple path setup methods may therefore raise some challenges from a configuration and observability point of view.

Each document that defines a new Path Setup Type in the Path Setup Type Registry ([Section 8.2](#)) must include a manageability section. The manageability section must explain how operators can manage PCEP with the new path setup type. It must address the following questions, which are generally applicable when working with multiple path setup types in PCEP.

- o What are the criteria for when devices will use the new path setup type in PCEP, and how can the operator control this?
- o How can the network be migrated to the new path setup type, and are there any backwards compatibility issues that operators need to be aware of?
- o Are paths set up using the new path setup type intended to coexist with other paths over the long term and, if so, how is this situation managed with PCEP?
- o How can operators verify the correct operation of PCEP in the network with respect to the new path setup type? Which fault conditions must be reported to the operators?
- o Are there any existing management interfaces (such as YANG models) that must be extended to model the operation of PCEP in the network with respect to the new path setup type?

See [[RFC5706](#)] for further guidance on how to write manageability sections in standards-track documents.

7. Security Considerations

The security considerations described in [[RFC5440](#)] and [[RFC8281](#)] are applicable to this specification. No additional security measure is required.

Note that, if the security mechanisms of [\[RFC5440\]](#) and [\[RFC8281\]](#) are not used, then the protocol described by this draft could be attacked in the following new way. An attacker, using a TCP man-in-the-middle attack, could inject error messages into the PCEP session when a particular PST is (or is not) used. By doing so, the attacker could potentially force the use of a specific PST, which may allow them to subsequently attack a weakness in that PST.

8. IANA Considerations

8.1. PCEP TLV Type Indicators

IANA is requested to confirm the early allocation of the following code point in the PCEP TLV Type Indicators registry.

Value	Description	Reference
28	PATH-SETUP-TYPE	This document

IANA is requested to allocate a new code point for the following TLV in the PCEP TLV Type Indicators registry.

Value	Description	Reference
TBD1	PATH-SETUP-TYPE-CAPABILITY	This document

Note to IANA: The above TLV type was not part of the early code point allocation that was done for this draft. It was added to the draft after the early code point allocation had taken place. Please assign a code point from the indicated registry and replace each instance of "TBD1" in this document with the allocated code point.

8.2. New Path Setup Type Registry

IANA is requested to create a new sub-registry within the "Path Computation Element Protocol (PCEP) Numbers" registry called "PCEP Path Setup Types". The allocation policy for this new registry should be by IETF Review. The new registry should contain the following value:

Value	Description	Reference
0	Path is setup using the RSVP-TE signaling protocol.	This document

8.3. PCEP-Error Object

IANA is requested to confirm the early allocation of the following code-points in the PCEP-ERROR Object Error Types and Values registry.

Error-Type	Meaning
10	Reception of an invalid object Error-value=11: Malformed object
21	Invalid traffic engineering path setup type Error-value=0: Unassigned Error-value=1: Unsupported path setup type Error-value=2: Mismatched path setup type

Note to IANA: the early allocation for Error-Type=10, Error-value=11 was originally done by [draft-ietf-pce-segment-routing](#). However, we have since moved its definition into this document. Therefore, please update the reference for this Error-value in the indicated registry to point to RFC.ietf-pce-lsp-setup-type.

9. Contributors

The following people contributed to this document:

- Jan Medved
- Edward Crabbe

10. Acknowledgements

We like to thank Marek Zavodsky for valuable comments.

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