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C. Li
M. Chen
D. Dhody
Huawei Technologies
W. Cheng
China Mobile
J. Dong
Z. Li
Huawei Technologies
R. Gandhi
Cisco Systems, Inc.
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**Path Computation Element Communication Protocol (PCEP) Extension for
Path Identification in Segment Routing (SR)
draft-li-pce-sr-path-segment-02**

Abstract

The Path Computation Element (PCE) provides path computation functions in support of traffic engineering in Multiprotocol Label Switching (MPLS) and Generalized MPLS (GMPLS) networks.

The Source Packet Routing in Networking (SPRING) architecture describes how Segment Routing (SR) can be used to steer packets through an IPv6 or MPLS network using the source routing paradigm. A Segment Routed Path can be derived from a variety of mechanisms, including an IGP Shortest Path Tree (SPT), explicit configuration, or a Path Computation Element (PCE).

Path identification is needed for several use cases such as performance measurement in Segment Routing (SR) network. This document specifies extensions to the Path Computation Element Protocol (PCEP) to support requesting, replying, reporting and updating the path identifier between PCEP speakers.

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.

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[1.](#) Introduction

[RFC5440] describes the Path Computation Element (PCE) Communication Protocol (PCEP). PCEP enables the communication between a Path Computation Client (PCC) and a PCE, or between PCE and PCE, for the purpose of computation of Multiprotocol Label Switching (MPLS) as well as Generalized MPLS (GMPLS) Traffic Engineering Label Switched Path (TE LSP) characteristics.

[RFC8231] specifies a set of extensions to PCEP to enable stateful control of TE LSPs within and across PCEP sessions in compliance with [RFC4657]. It includes mechanisms to effect LSP State Synchronization between PCCs and PCEs, delegation of control over LSPs to PCEs, and PCE control of timing and sequence of path computations within and across PCEP sessions. The model of operation where LSPs are initiated from the PCE is described in [RFC8281].

[I-D.zhao-pce-pcep-extension-for-pce-controller] specify the procedures and PCEP protocol extensions for using the PCE as the central controller for static LSPs, where LSPs can be provisioned as explicit label instructions at each hop on the end-to-end path.

Segment routing (SR) [[RFC8402](#)] leverages the source routing and tunneling paradigms and supports steering packets into an explicit forwarding path at the ingress node.

An SR path needs to be identified in some use cases such as performance measurement. For identifying an SR path, [[I-D.cheng-spring-mpls-path-segment](#)] introduces a new segment that is referred to as Path Segment.

[[I-D.ietf-pce-segment-routing](#)] specifies extensions to the Path Computation Element Protocol (PCEP) [[RFC5440](#)] for SR networks, that allow a stateful PCE to compute and initiate SR-TE paths, as well as a PCC to request, report or delegate SR paths. [[I-D.negi-pce-segment-routing-ipv6](#)] extend PCEP to support SR for IPv6 data plane.

[[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)] specifies the procedures and PCEP protocol extensions when a PCE-based controller is also responsible for configuring the forwarding actions on the routers (SR SID distribution in this case), in addition to computing the paths for packet flows in a segment routing network and telling the edge routers what instructions to attach to packets as they enter the network.

This document specifies a mechanism to carry the SR path identification information in PCEP messages [[RFC5440](#)] [[RFC8231](#)] [[RFC8281](#)]. The path ID can be a path segment in SR-MPLS [[I-D.cheng-spring-mpls-path-segment](#)], or a path ID in SRv6 [[I-D.li-spring-passive-pm-for-srv6-np](#)], or other IDs that can identify the SR path. This document also extends the PCECC-SR mechanism to inform the path ID to the egress PCC.

2. Terminology

This memo makes use of the terms defined in [[RFC4655](#)], [[I-D.ietf-pce-segment-routing](#)], and [[RFC8402](#)].

3. Overview of Path ID Extensions in PCEP

This document specifies a mechanism of encoding (and allocating) path ID (path segment in case of MPLS, path ID in case of IPv6, etc) in PCEP extensions. For supporting path ID in PCEP, several TLVs and flags are defined. The formats of the objects and TLVs are described in [Section 4](#). The procedures of path ID allocation are described in [Section 5](#).

There are various modes of operations, such as -

- o The path ID can be allocated by Egress PCC. The PCE should request the Path ID from Egress PCC.
- o The path ID can be allocated by Ingress PCC itself and informed to the PCE. The PCE can then inform the egress PCC.
- o Ingress PCC can also request PCE to allocate the path ID, in this case, the PCE would allocate and inform the assigned path ID to the ingress/egress PCC using PCEP messages.
- o The PCE can allocate a path ID on its own accord and inform the ingress/egress PCC, useful for PCE-initiated LSPs.

The path information to the ingress PCC and PCE is exchanged via an extension to [[I-D.ietf-pce-segment-routing](#)] and [[I-D.negi-pce-segment-routing-ipv6](#)]. The path ID information to the egress PCC is informed via an extension to the PCECC-SR procedures [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)].

For the PCE to allocate a path ID, the PCE SHOULD be aware of the path ID space from the PCCs. This is done via mechanism as described in [[I-D.li-pce-controlled-id-space](#)]. Otherwise, the PCE should request the egress PCC of Path IDs.

[4. Objects and TLVs](#)

[4.1. The OPEN Object](#)

[4.1.1. The SR PCE Capability sub-TLV](#)

[[I-D.ietf-pce-segment-routing](#)] defined a new Path Setup Type (PST) and SR-PCE-CAPABILITY sub-TLV for SR. PCEP speakers use this sub-TLV to exchange information about their SR capability. The TLV includes a Flags field and one bit (L-flag) was allocated in [[I-D.ietf-pce-segment-routing](#)].

This document adds an additional flag for path ID allocation, as follows -

P (Path Identification bit): A PCEP speaker sets this flag to 1 to indicate that it has the capability to encode SR path identification (path segment, as per [[I-D.cheng-spring-mpls-path-segment](#)]).

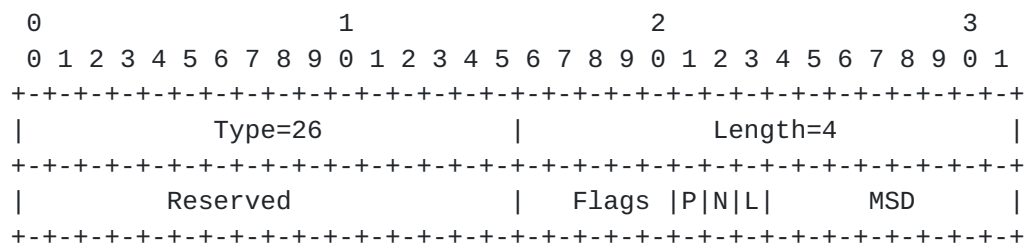


Figure 1: P-flag in SR-PCE-CAPABILITY TLV

The figure is included for the ease of the reader and can be removed at the time of publication.

4.1.2. The SRv6 PCE Capability sub-TLV

[I-D.negi-pce-segment-routing-ipv6] defined a new Path Setup Type (PST) and SRv6-PCE-CAPABILITY sub-TLV for SRv6. PCEP speakers use this sub-TLV to exchange information about their SRv6 capability. The TLV includes a Flags field and one bit (L-flag) was allocated in [I-D.negi-pce-segment-routing-ipv6].

This document adds an additional flag for path ID allocation, as follows -

P (Path Identification bit): A PCEP speaker sets this flag to 1 to indicate that it has the capability to encode SRv6 path identification.

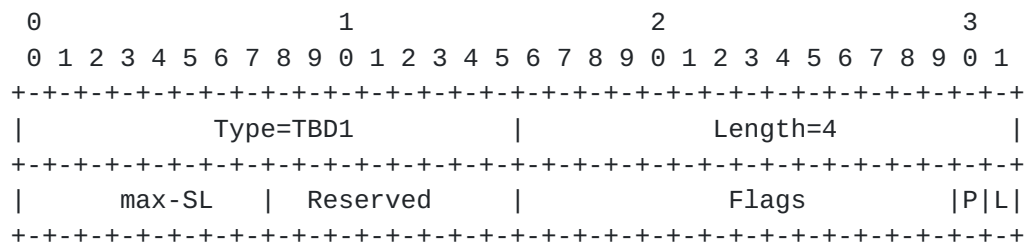


Figure 2: P-flag in SRv6-PCE-CAPABILITY TLV

The figure is included for the ease of the reader and can be removed at the time of publication.

4.1.3. PCECC-CAPABILITY sub-TLV

Along with the SR sub-TLVs, the PCECC Capability as per [I-D.zhao-pce-pcep-extension-pce-controller-sr] should be advertised if the PCE allocates the path identifier and acts as a Central Controller that manages the Label (Path ID) space.

The PCECC Capability should also be advertised on the egress PCEP session, along with the SR sub-TLVs. This is needed to ensure that the PCE can use the PCECC objects/mechanism to request/inform the egress PCC of the path ID as described in this document.

4.2. LSP Object

The LSP Object is defined in [Section 7.3 of \[RFC8231\]](#). This document adds the following flags to the LSP Object:

P (Path Identification Allocation bit): If the bit is set to 1, it indicates that the path identifier needs to be allocated by the PCE for this LSP. A PCC would set this bit to 1 to request for allocation of path identifier by the PCE in the PCReq or PCRpt message. A PCE would also set this bit to 1 to indicate that the path identifier is allocated by PCE and encoded in the PCRep, PCUpd or PCInitiate message (the PATH-ID TLV MUST be present in LSP object). Further, a PCE would set this bit to 0 to indicate that the path identifier should be allocated by the PCC as described in [Section 5.1.1](#).

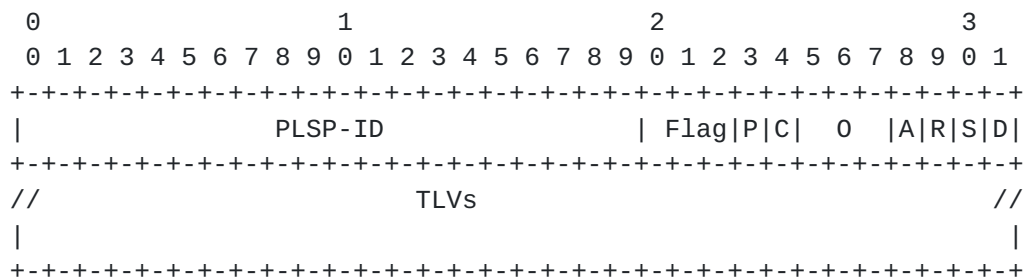


Figure 3: P-flag in LSP Object

The figure is included for the ease of the reader and can be removed at the time of publication.

4.2.1. Path ID TLV

The PATH-ID TLV is an optional TLV for use in the LSP Object for path ID allocation. The type of this TLV is to be allocated by IANA (TBA4). The format is shown below.

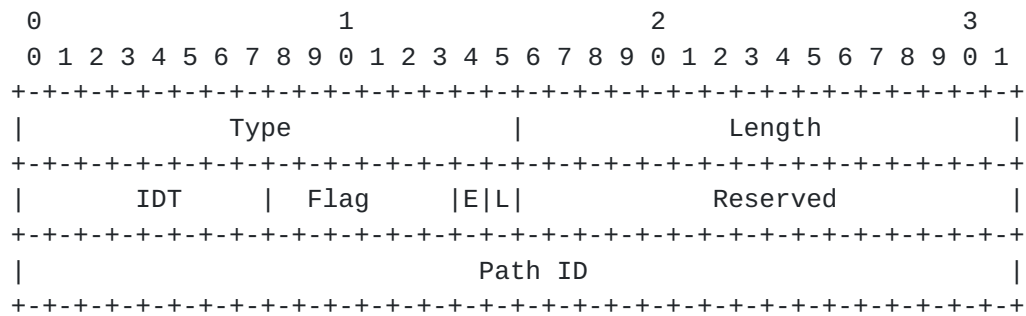


Figure 4: The PATH-ID TLV Format

The type (16-bit) of the TLV is TBA4 (to be allocated by IANA). The length (16-bit) has a fixed value of 8 octets. The value contains the following fields:

IDT (The ID type - 8 bits): The IDT field specifies the type of the Path ID field, which carries a Path ID corresponding to the SR path.

- * 0: MPLS Path Segment, which is an MPLS label as defined in [\[I-D.cheng-spring-mpls-path-segment\]](#). The PST type MUST be set to SR (MPLS).
- * 1: SRv6 Path ID, which is a 4-octet integer as defined in [\[I-D.li-spring-passive-pm-for-srv6-np\]](#). The PST type MUST be set to SRv6.

Flags (8 bits): Two flags are currently defined:

- * L-Bit (Local/Global - 1 bit): If set, then the Path ID carried by the PATH-ID TLV has local significance. If not set, then the Path ID carried by this TLV has global significance (i.e. Path ID is global within an SR domain).
- * E-bit (Egress/Ingress - 1 bit): If set, then the Path ID carried by the PATH-ID TLV is allocated from the Egress Path ID space. If not set, then the Path ID carried by this TLV is allocated from the Ingress Path ID space.
- * The unassigned bits MUST be set to 0 and MUST be ignored at receipt.

Reserved (16 bits): MUST be set to 0 and MUST be ignored at receipt.

Path ID (32 bits): The path ID of an SR path. The path ID type is indicated by the ID Type field. It can be a path segment [[I-D.cheng-spring-mpls-path-segment](#)] in MPLS label format. Or it can be a 4 octets integer ID as defined in [[I-D.li-spring-passive-pm-for-srv6-np](#)] or other IDs that can identify a path.

Only one instance of PATH-ID TLV is processed, if more than one PATH-ID TLV is included, the first one is processed and others MUST be ignored.

When the path ID allocation is enable, a PATH-ID TLV should be included in the LSP object.

If the label space is maintained by PCC itself, and the path ID is allocated by Egress PCC, then the PCE should request the Path ID from Egress PCC as described in [Section 5.1.1](#). In this case, the PCE should send a PCUpdate or PCInitiate message to the egress PCC to request the path ID. The P-flag in LSP should be unset in this case.

If the path ID is allocated by the ingress node, a PATH-ID TLV MUST be included in a LSP object (with E-bit unset) in the PCEP message from PCC. The L-flag is set if the path ID has local significance. In this case, the P flag in LSP object is set to 0.

If the PCC requests the path ID to be allocated by the PCE, P flag in LSP object is set to 1 and Path ID TLV MAY be skipped. After the PCE has allocated a path ID, it MUST include the PATH-ID TLV in a LSP object, the E-bit is set by PCE based on the path ID space from which the allocation is made.

If the PCE allocated the path ID on its own accord, a PATH-ID TLV MUST be included in a LSP object, the E-bit is set by PCE based on the path ID space from which the allocation is made.

If a PCEP node does not recognize the PATH-ID TLV, it would behave in accordance with [[RFC5440](#)] and ignore the TLV. If a PCEP node recognizes the TLV but does not support the TLV, it MUST send PCErr with Error-Type = 2 (Capability not supported).

[4.3.](#) FEC Object

The FEC Object [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)] is used to specify the FEC information and MAY be carried within PCInitiate or PCRpt message for the PCECC-SR operations. The PCE MUST inform the Path Identification information to the Egress PCC. To do this, this document extends the procedures of

[I-D.zhao-pce-pcep-extension-pce-controller-sr] by defining a new FEC object type for Path.

FEC Object-Type is TBA6 'Path'.

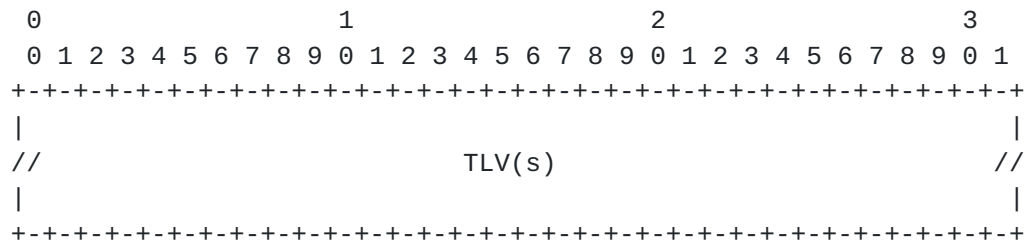


Figure 5: The path FEC object Format

One or more following TLV(s) are allowed in the 'path' FEC object -

- o SYMBOLIC-PATH-NAME TLV: As defined in [RFC8231], it is a human-readable string that identifies an LSP in the network.
- o LSP-IDENTIFIERS TLVs: As defined in [RFC8231], it is optional for SR, but could be used to encode the source, destination and other identification information for the path.
- o SPEAKER-ENTITY-ID TLV: As defined in [RFC8232], a unique identifier for the PCEP speaker, it is used to identify the Ingress PCC.

Either SYMBOLIC-PATH-NAME TLV or LSP-IDENTIFIERS TLV MUST be included. SPEAKER-ENTITY-ID TLV is optional. Only one instance of each TLV is processed, if more than one TLV of each type is included, the first one is processed and others MUST be ignored.

4.4. CCI Object

The Central Control Instructions (CCI) Object is used by the PCE to specify the forwarding instructions is defined in [I-D.zhao-pce-pcep-extension-for-pce-controller]. Further [I-D.zhao-pce-pcep-extension-pce-controller-sr] defined a CCI object type for SR.

The Path ID information is encoded directly in the CCI SR object. The Path ID TLV as described in the [Section 4.2.1](#), MUST also be included in the CCI SR object as the TLV includes additional information regarding the path identifier.

This document adds the following flags to the CCI Object:

- o C (PCC Allocation bit): If the bit is set to 1, it indicates that the allocation needs to be done by the PCC for this central controller instruction. A PCE set this bit to request the PCC to make an allocation from its SR label/ID space. A PCC would set this bit to indicate that it has allocated the CC-ID and report it to the PCE.

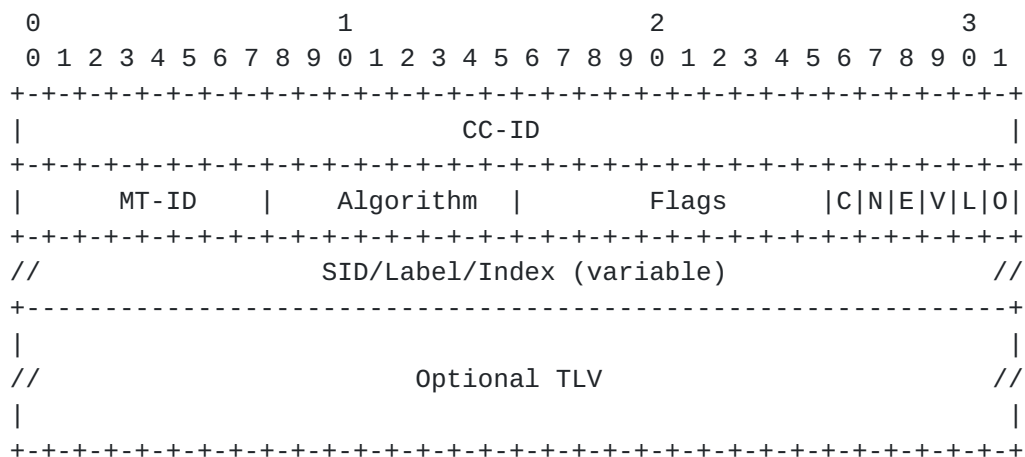


Figure 6: The CCI object for SR

(Editor's Note - An update is planned for [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#) in the next revision detailing this procedure, and the above text might move there.)

5. Operations

The path ID allocation and encoding is as per the stateful PCE operations for segment routing. The procedures are as per the corresponding extensions defined in [\[I-D.ietf-pce-segment-routing\]](#) and [\[I-D.negi-pce-segment-routing-ipv6\]](#) (which are further based on [\[RFC8231\]](#) and [\[RFC8281\]](#)). The additional operations for path identification are defined in this section.

To notify (or request) the path ID to the Egress PCC, the procedures are as per the PCECC-SR [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#) (which is based on [\[I-D.zhao-pce-pcep-extension-for-pce-controller\]](#)). The additional operations are defined in this section.

5.1. PCC Allocated Path ID

5.1.1. Egress PCC Allocated Path ID

As defined in [[I-D.cheng-spring-mpls-path-segment](#)], a path segment/ID can be allocated by the egress PCC. In this case, the ID/label space may be maintained on the PCC itself.

On receiving a stateful path computation request with path ID allocation request from an ingress PCC, or by initiating or updating an LSP with path ID actively, a PCE can request the egress PCC to allocate a path ID. This is needed if the PCE does not control the path IDs for the egress PCC or the ID/label space is maintained by the egress PCC itself.

The mechanism of Path ID request and reply may be achieved by using PCInitiate and PCUpd message as described in this section.

5.1.1.1. Using CCI and FEC objects (PCECC)

The PCE can request the egress to allocate the path ID using the PCInitiate message as described in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)]. The C flag in the CCI object is set to 1 and the CC-ID is set to a special value of 0x0000 to indicate that the allocation needs to be done by the PCC. The PATH-ID TLV is also included in CCI object along with the FEC object identifying the SR-Path. The egress PCC would allocate the path identification and would report to the PCE using the PCRpt message as described in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)] with the allocated path identification in the CC-ID field as well as in the PATH-ID TLV.

(Editor's Note - An update is planned for [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)] in the next revision detailing this procedure)

If the value of CC-ID/Path-ID is 0 and the C flag is set, it indicates that the PCE is requesting a path ID for this LSP. If the CC-ID/Path ID is set to a value 'n' and the C flag is set in the CCI object, it indicates that the PCE requests a specific value 'n' of path ID. If the path ID is allocated successfully, the egress PCC should report the path ID via PCRpt message with the CCI object along with the PATH-ID TLV. Else, it MUST send a PCErr message with Error-Type = TBA7 ("Path SID failure") and Error Value = 1 ("Invalid SID"). If the value of path ID in CCI object is valid, but the PCC is unable to allocate the path ID, it MUST send a PCErr message with Error-Type = TBA7 ("Path label/SID failure") and Error Value = 2 ("Unable to allocate the specified label/SID").

Once the PCE receives the PCRpt message with the CCI object, it can obtain the Path ID information from the egress PCC and then update the path with path ID or reply to the ingress PCC, the path information with path ID.

If the SR-Path is setup the ingress PCC will acknowledge with a PCRpt message to the PCE. In case of error, as described in [\[I-D.ietf-pce-segment-routing\]](#), an PCErr message will be sent back to the PCE. The PCE MUST request the withdraw of the path ID allocation by sending a PCInitiate message to remove the central controller instruction as per [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#). When the LSP is deleted or the path ID is removed, the PCE should synchronize with the egress PCC.

If the egress PCC wishes to withdraw or modify a previously reported path ID value, it MUST send a PCRpt message without any PATH-ID TLV or with the PATH-ID TLV containing the new path ID respectively in the CCI object. The PCE would further trigger the removal of the central controller instruction as per [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#).

If a PCE wishes to modify a previously requested path ID value, it MUST send a new PCInitiate message with an allocation request CC-ID/PATH-ID TLV containing the new path ID value and C flag is set. The PCE should trigger the removal of the older path ID next as per [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#).

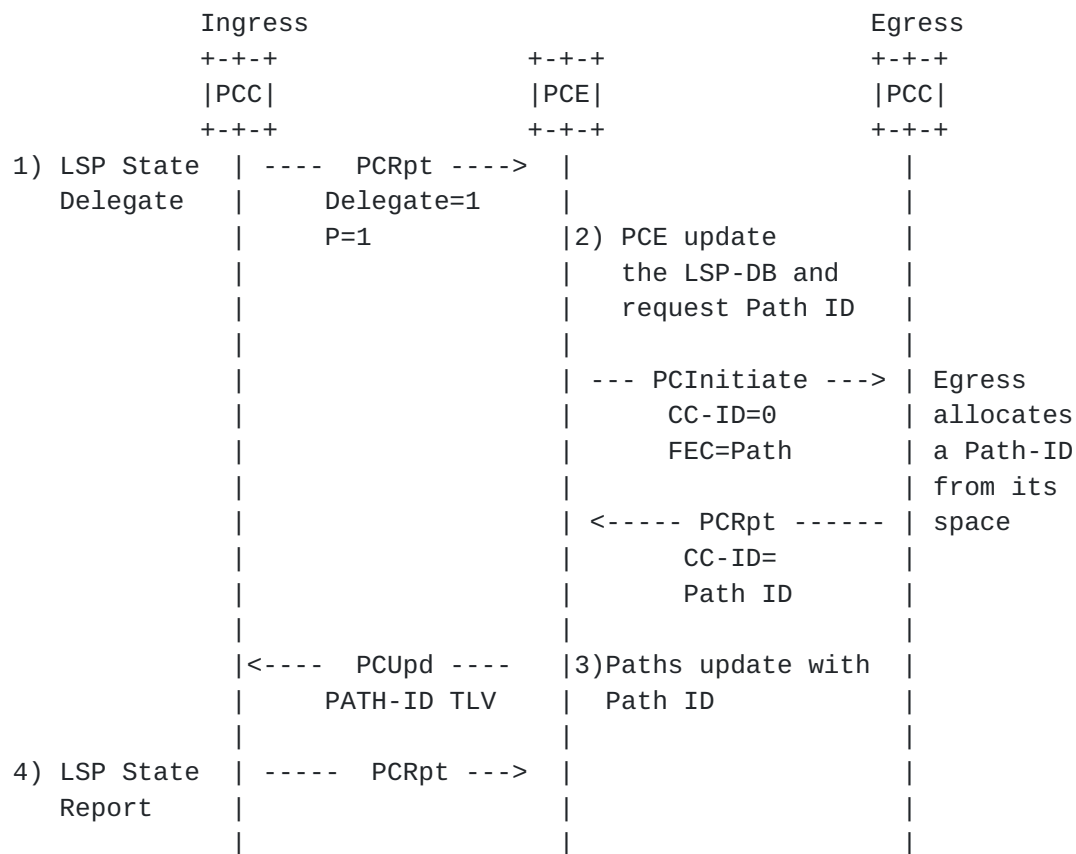


Figure 7: Egress PCC Allocated Path ID

5.1.1.2. Using LSP objects (PCEP-SR)

The PATH-ID TLV MUST be included in an LSP object in the PCInitiate message sent from the PCE to the egress to request path identification allocation by the egress PCC. The P flag in LSP object MUST be set to 0. This PCInitiate message to egress PCC would be the similar to the one sent to ingress PCC as per [\[I-D.ietf-pce-segment-routing\]](#), but the egress PCC would only allocate the path identification and would not trigger the initiation/update operation.

If the value of path ID is 0x0 it indicates that the PCE is requesting a path ID for this LSP. If the Path ID is set to a value 'n' and the P flag is unset in the LSP object, it indicates that the PCE requests a specific value 'n' of path ID. If the path ID is allocated successfully, the egress PCC should report the path ID via PCRpt message with PATH-ID TLV in LSP object. Else, it MUST send a PCErr message with Error-Type = TBA7 ("Path SID failure") and Error Value = 1 ("Invalid SID"). If the value of path ID is valid, but the PCC is unable to allocate the path ID, it MUST send a PCErr message

with Error-Type = TBA7 ("Path label/SID failure") and Error Value = 2 ("Unable to allocate the specified label/SID").

Once the PCE receives the PCRpt message, it can obtain the Path ID information from the egress PCC and then update the path with path ID or reply to the ingress PCC, the path information with path ID.

If the SR-Path is setup the ingress PCC will acknowledge with a PCRpt message to the PCE. In case of error, as described in [\[I-D.ietf-pce-segment-routing\]](#), an PCErr message will be sent back to the PCE. The PCE MUST request the withdraw of the path ID allocation by sending a PCUpd message to remove the LSP and associated path ID by setting the R flag in the SRP object. When the LSP is deleted or the path ID is removed, the PCE should send a PCUpd message to synchronize with the egress PCC.

If the egress PCC wishes to withdraw or modify a previously reported path ID value, it MUST send a PCRpt message without any PATH-ID TLV or with the PATH-ID TLV containing the new path ID respectively.

If a PCE wishes to modify a previously requested path ID value, it MUST send a PCUpd message with PATH-ID TLV containing the new path ID value and P flag in LSP object would be unset. Absence of the PATH-ID TLV in PCUpd message means that the PCE wishes to withdraw the path ID.

If a PCC receives a valid path ID value from a PCE which is different than the current path ID, it MUST try to allocate the new value. If the new path ID is successfully allocated, the PCC MUST report the new value to the PCE. Otherwise, it MUST send a PCErr message with Error-Type = TBA7 ("Path label/SID failure") and Error Value = 2 ("Unable to allocate the specified label/SID").

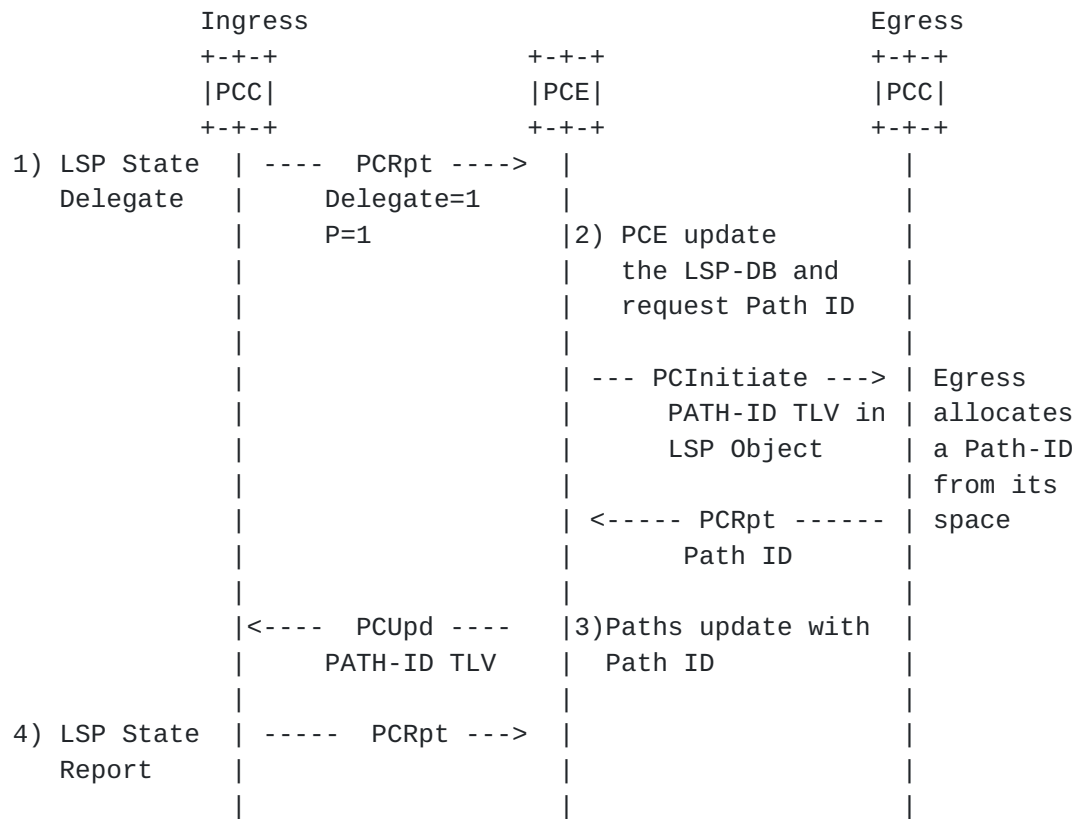


Figure 8: Egress PCC Allocated Path ID

5.1.2. Ingress PCC Allocated Path ID

The Ingress PCC could allocate the Path ID and inform the PCE via the PCRpt message as per [\[RFC8231\]](#). The PATH-ID TLV MUST be included in a LSP object in the PCEP message from PCC. The P flag in LSP object is set to 0. On receiving this report, the PCE updates the information in its database. The active PCE (where the LSP is delegated) further informs the egress about the path ID allocated by the PCC using the PCInitiate message as described in [\[I-D.zhao-pce-pcep-extension-pce-controller-sr\]](#).

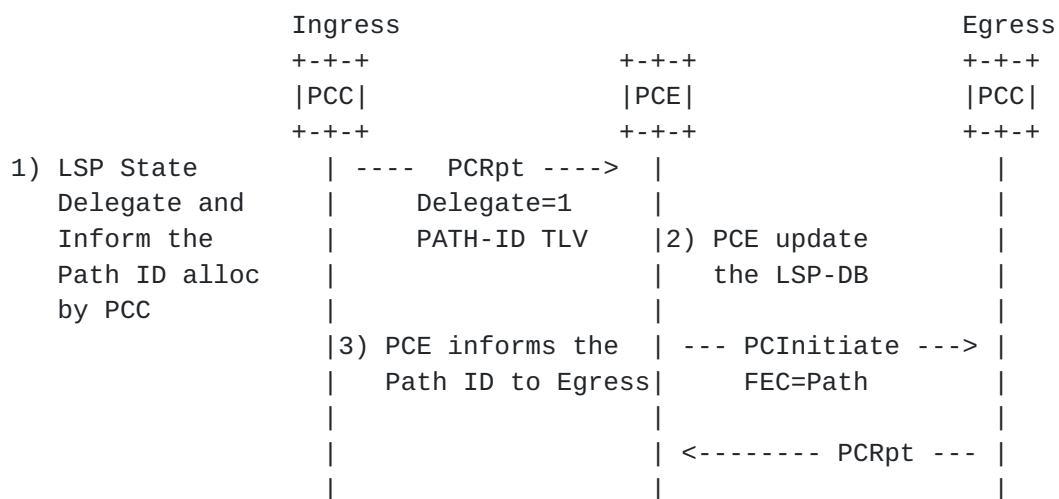


Figure 9: Ingress PCC Allocated Path ID

5.2. PCE Allocated Path ID

5.2.1. PCE Controlled ID Spaces Advertisement

For allocating the path IDs to SR paths by the PCEs, the PCE controlled ID Spaces MUST be known at PCEs via configurations or any other mechanism. The PCE controlled ID spaces MAY be advertised as described in [[I-D.li-pce-controlled-id-space](#)].

5.2.2. Ingress PCC request Path ID to PCE

The ingress PCC could request the path ID to be allocated by the PCE via PCRpt message as per [[RFC8231](#)]. The delegate flag (D-flag) MUST also be set for this LSP. Also, the P-flag in the LSP object MUST be set. The PATH-ID TLV MAY be included with Path ID set to 0x0000. If the Path ID is set to a value 'n' and the P flag is set in the LSP object, it indicates that the Ingress PCC requests a specific value 'n' of path ID.

If the path ID is allocated successfully, the PCE would further respond to Ingress PCC with PCUpd message as per [[RFC8231](#)] and MUST include the PATH-ID TLV in a LSP object. Else, it MUST send a PCErr message with Error-Type = TBA7 ("Path SID failure") and Error Value = 1 ("Invalid SID"). If the value of path ID is valid, but the PCC is unable to allocate the path ID, it MUST send a PCErr message with Error-Type = TBA7 ("Path label/SID failure") and Error Value = 2 ("Unable to allocate the specified label/SID").

The active PCE would allocated the path ID as per the PATH-ID flags and in case PATH-ID is not included, the PCE MUST act based on the local policy.

The PCE would further inform the egress PCC about the path ID allocated by the PCE using the PCInitiate message as described in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)].

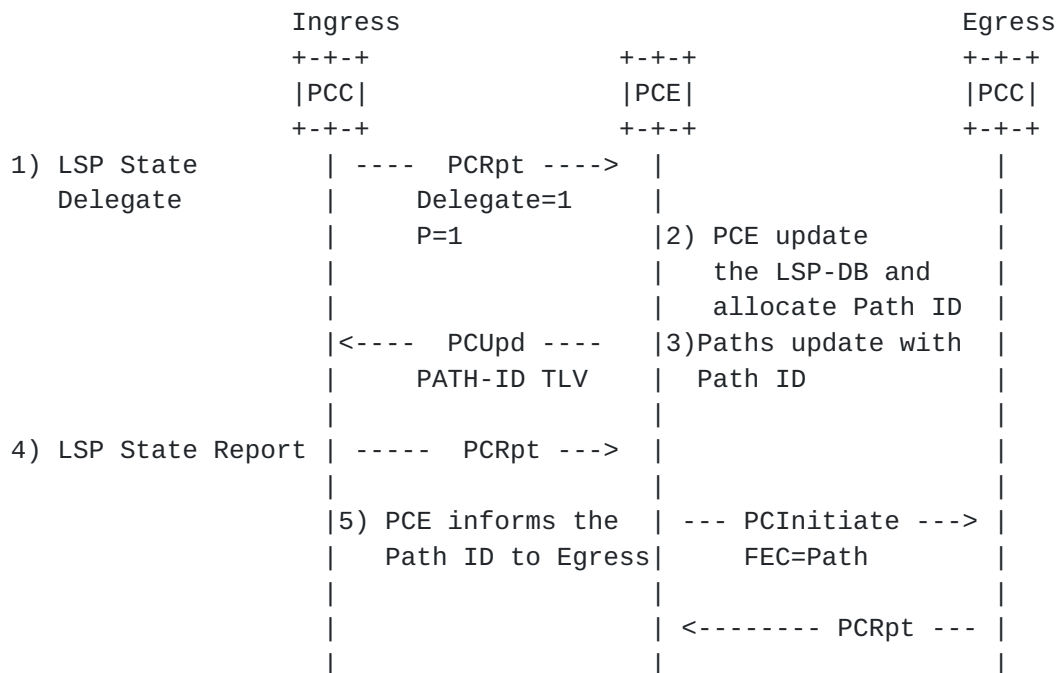


Figure 10: Ingress PCC request Path ID to PCE

5.2.3. PCE allocated Path ID on its own

The PCE could allocate the path ID on its own accord for a PCE-Initiated (or delegated LSP). The allocated path ID needs to be informed to the Ingress and Egress PCC. The PCE would use the PCInitiate message [[RFC8281](#)] or PCUpd message [[RFC8231](#)] towards the Ingress PCC and MUST include the PATH-ID TLV in the LSP object. The PCE would further inform the egress PCC about the path ID allocated by the PCE using the PCInitiate message as described in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)].

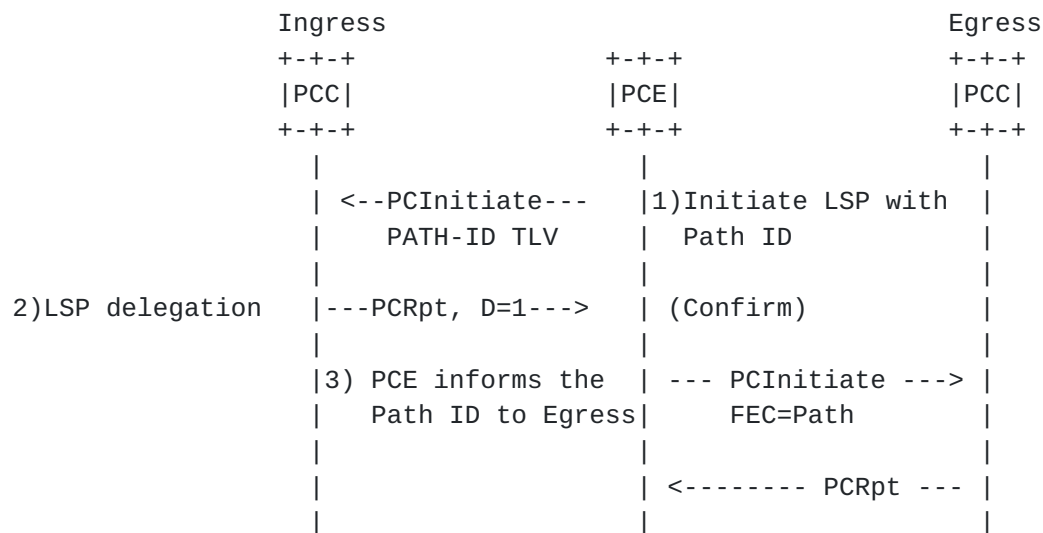


Figure 11: PCE allocated Path ID on its own

5.3. Two Label Solution

[I-D.cheng-spring-mpls-path-segment] describe a Path Segment to uniquely identify an SR path in a specific context. (e.g., in the context of the egress node or ingress node of an SR path, or within an SR domain). It further describes two solution based on 'one label' or 'two labels' solution. For the latter, two segments (Source segment and Path segment) are used to identify an SR path where the source segment is a global node segment which can uniquely identify a node within the SR domain (it is NOT used for forwarding and indicates that a Path segment immediately follows). The combination of Source segment and Path segment uniquely identify an SR Path with an SR domain.

The procedure described in this document allocates and encode the Path Segment only. It is expected that the Egress PCC is aware of the Source segment by some other procedures. These procedures could be IGP, PCECC-SR, or some other mechanisms.

6. Dataplane Considerations

As described in [I-D.cheng-spring-mpls-path-segment], in an SR-MPLS network, when a packet is transmitted along an SR path, the labels in the MPLS label stack will be swapped or popped. So that no label or only the last label may be left in the MPLS label stack when the packet reaches the egress node. Thus, the egress node cannot determine from which SR path the packet comes. For this reason it introduces the Path Segment (or Path Identifier).

Apart from allocation and encoding of the Path Identifier (described in this document) for the LSP, it would also be included in the SID/Label stack of the LSP (usually for processing by the egress). To support this, the path segment MAY also be a part of SR-ERO as prepared by the PCE as per [\[I-D.ietf-pce-segment-routing\]](#). The PCC MAY also include the path segment while preparing the label stack based on the local policy and use-case.

[7.](#) IANA Considerations

[7.1.](#) SR PCE Capability Flags

SR PCE Capability TLV is defined in [\[I-D.ietf-pce-segment-routing\]](#), and the registry to manage the Flag field of the SR PCE Capability TLV is requested in [\[I-D.ietf-pce-segment-routing\]](#). IANA is requested to make the following allocation in the aforementioned registry.

Bit	Description	Reference
TBA1	Path Identifier Allocation is supported(P)	This document

[7.2.](#) SRv6 PCE Capability Flags

SRv6 PCE Capability TLV is defined in defined in [\[I-D.negi-pce-segment-routing-ipv6\]](#), and the registry to manage the Flag field of the SRv6 PCE Capability Flags is requested in [\[I-D.negi-pce-segment-routing-ipv6\]](#). IANA is requested to make the following allocation in the aforementioned registry.

Bit	Description	Reference
TBA2	Path Identifier Allocation is supported(P)	This document

[7.3.](#) New LSP Flag Registry

[RFC8231] defines the LSP object; per that RFC, IANA created a registry to manage the value of the LSP object's Flag field. IANA has allocated a new bit in the "LSP Object Flag Field" subregistry, as follows:

Bit	Description	Reference
TBA3	Request for Path Identifier Allocation(P)	This document

7.4. New PCEP TLV

IANA is requested to add the assignment of a new allocation in the existing "PCEP TLV Type Indicators" subregistry as follows:

Value	Description	Reference
TBA4	PATH-ID TLV	This document

7.4.1. Path ID TLV

This document requests that a new subregistry named "PATH-ID TLV ID Type Field" to be created to manage the value of the ID type field in the PATH-ID TLV.

Value	Description	Reference
0	MPLS Label	This document
1	SRv6 Path Segment	This document

Further, this document also requests that a new subregistry named "PATH-ID TLV ID Flag Field" to be created to manage the Flag field in the PATH-ID TLV. New values are assigned by Standards Action [[RFC8126](#)]. Each bit should be tracked with the following qualities:

- o Bit number (counting from bit 0 as the most significant bit)
- o Capability description
- o Defining RFC

Bit	Description	Reference
6	Allocated by Egress Node(E)	This document
7	Local Signification(L)	This document

7.5. New CCI Flag Registry

CCI object is defined in defined in [[I-D.zhao-pce-pcep-extension-for-pce-controller](#)], further [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)] defined a CCI object type for SR. and the subregistry to manage the Flag field of the CCI object for SR is requested in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)]. IANA is requested to make the following allocation in the aforementioned subregistry.

Bit	Description	Reference
TBA5	PCC is requested to allocate resource(C)	This document

7.6. New FEC Type Registry

A new PCEP object called FEC is defined in [[I-D.zhao-pce-pcep-extension-pce-controller-sr](#)]. IANA is requested to allocate a new Object-Type for FEC object in the "PCEP Objects" subregistry.

Value	Description	Reference
TBA6	SR path	This document

7.7. PCEP Error Type and Value

IANA is requested to allocate code-points in the "PCEP-ERROR Object Error Types and Values" subregistry for the following new error-types and error-values:

Error-Type	Meaning	Reference
TBA7	Path SID failure: Error-value = 1 Invalid SID Error-value = 2 Unable to allocate Path SID	This document

8. Security Considerations

TBA

9. Acknowledgments

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Authors' Addresses

Cheng Li
Huawei Technologies
Huawei Campus, No. 156 Beiqing Rd.
Beijing 100095
China

Email: chengli13@huawei.com

Mach(Guoyi) Chen
Huawei Technologies
Huawei Campus, No. 156 Beiqing Rd.
Beijing 100095
China

Email: Mach.chen@huawei.com

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

Email: dhruv.ietf@gmail.com

Weiqiang Cheng
China Mobile
China

Email: chengweiqiang@chinamobile.com

Jie Dong
Huawei Technologies
Huawei Campus, No. 156 Beiqing Rd.
Beijing 100095
China

Email: jie.dong@huawei.com

Zhenbin Li
Huawei Technologies
Huawei Campus, No. 156 Beiqing Rd.
Beijing 100095
China

Email: lizhenbin@huawei.com

Rakesh Gandhi
Cisco Systems, Inc.
Canada

Email: rgandhi@cisco.com

