SR Path Segment
& Bidirectional Path in PCEP

draft-li-pce-sr-path-segment-05
draft-li-pce-sr-bidir-path-05

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IETF#104
Motivation

• Use cases like end-2-end 1+1 path protection, bidirectional path correlation or performance measurement (PM) require the ability to implement “Path Segment” in SR networks:
  • [draft-cheng-spring-mpls-path-segment] introduces a new segment to uniquely identify an SR path in a specific context that is referred to as Path Segment.

• For configuring or allocating Path Segment to an SR path, extensions in PCEP are needed.
  • Path Segment allocation by PCEP
  • PCE controlled ID Space, where PCC informs the PCE the ID space range from which it should make allocations

• Bidirectional path correlation is required in some scenarios such as mobile backhaul transport network for Segment Routing.
  • Path Segment can be used for binding
Updated Drafts

• **draft-li-pce-sr-path-segment-03**
  • Specifies extensions to the PCEP to support path identifier allocation between PCEP speakers.
    • PATH-SEGMENT TLV in the LSP object
    • P-flag in LSP object
    • P-flag in SR/SRv6 Capabilities TLVs

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+----------------+------------------+
| Type         | Length           |
+----------------+------------------+
| ST            | Flag             |
+----------------+------------------+
| (Variable length) Path Segment | ~ |
```

• **draft-li-pce-sr-bidir-path-02**
  • Defines PCEP extensions for grouping two reverse unidirectional SR Paths into an Associated Bidirectional SR path
    • Defines "Double-sided Bidirectional SR Path Association Group" Object
PCEP Extension for Path Segment in SR
Updates: draft-li-pce-sr-path-segment-03

• Update
  • Path ID -> Path Segment in SRv6(draft-li-spring-srv6-path-segment)

• Delete
  • Ingress allocation mechanisms.(Sync up with draft-cheng-spring-mpls-path-segment-03
  • Two-labels solution

• Add
  • New authors and contributors: Weiqiang Cheng(CMCC), Rakesh, Zafar(Cisco),
  • IANA Considerations
  • Error Handling
  • Data plane Considerations

• Implementation Status:
  • Huawei: implementing in PCE and PCC products.
PCEP Extension for SR Bidirectional Associated Paths
Updates: draft-li-pce-sr-bidir-path-02

• Update
  • Path ID -> Path Segment in SRv6(draft-li-spring-srv6-path-segment)

• Delete
  • Stateless PCE

• Add
  • New authors and contributors: Weiqiang Cheng(CMCC), Rakesh(Cisco),
  • IANA Considerations
  • Security Considerations
  • Error Handling

• Implementation Status:
  • Huawei: implementing in PCE and PCC products.
Ready for WG Adoption

• The drafts are ready for WG adoption
  • Contents of drafts are stable
  • Commercial implementation is going on
  • Supported by operators and vendors
  • Request for early IANA allocation

• We would like to post WG adoption requests for drafts
  • draft-li-pce-sr-path-segment-03
  • draft-li-pce-sr-bidir-path-02

• Your comments and contributions are very welcome!
Thank you

CHENG LI
Path Segment/ID in PCEP

draft-li-pce-controlled-id-space-00
draft-li-pce-sr-path-segment-00
draft-li-pce-sr-bidir-path-00

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IETF#102
Motivation

- Use cases like end-2-end 1+1 path protection, bidirectional path correlation or performance measurement (PM) require the ability to implement path identification in SR networks:
  - draft-cheng-spring-mpls-path-segment introduces a new segment to uniquely identify an SR path in a specific context that is referred to as Path Segment.
  - draft-li-spring-passive-pm-for-srv6-np defines a Path ID to identify an SRv6 path.

- For configuring or allocating path ID to an SR path, extensions in PCEP are needed.
  - PCE controlled ID Space distribution.
  - Path Segment allocation.

- Bidirectional path correlation is required in some scenarios such as mobile backhaul transport network.
  - Bidirectional path correlation based on path Segment/ID.
Drafts

- draft-li-pce-controlled-id-space-00
  - specifies a mechanism for a PCC to inform the PCE of the identifier space under its control via PCEP.

- draft-li-pce-sr-path-segment-00
  - specifies extensions to the PCEP to support path identifier between PCEP speakers.

- draft-li-pce-sr-bidir-path-00
  - defines PCEP extensions for grouping two reverse unidirectional SR Paths into an Associated Bidirectional SR path
• I-D.zhao-pce-pcep-extension-for-pce-controller specifies the procedures and PCEP protocol extensions for using the PCE as the central controller, where label forwarding entries are downloaded through extending PCEP.

• I-D.zhao-pce-pcep-extension-for-pce-controller-sr specifies the procedures and PCEP protocol extensions for using the PCE as the central controller in SR networks.

However, these documents assume that label range to be used by a PCE is known and set on both PCEP peers.

• This document specify the extension to support advertisement of the various ID space to the PCE to control.
For delegating ID space, related ID Space TLV MUST be included in the Open message.

Each TLV (corresponding to each ID type) SHOULD be included only once in a Open Message.

The following ID-CONTROL-SPACE TLVs are defined in this document –

- LABEL-CONTROL-SPACE - for MPLS Labels
- SRv6-PATH-ID-CONTROL-SPACE - for SRv6 Path ID
LABEL-CONTROL-SPACE TLV

- **Flags:**
  - A: All space flag, set when all the label space is delegated to a PCE.

- **Blocks**
  - Start(i) (24 bits): indicates the beginning of the label block i.
  - Range(i) (24 bits): indicates the range of the label block i.

- **Labels:**
  - such as binding SID and path SID can be allocated directly from the PCE controlled space.
SRv6-PATH-ID-CONTROL-SPACE TLV

• Flags:
  • A: All space flag, set when all the ID space is delegated to a PCE.

• Blocks
  • Start(i) (32 bits): indicates the beginning of the SRv6 Path ID block i.
  • Range(i) (32 bits): indicates the range of the SRv6 Path ID block i.

• Path IDs
  • can be allocated directly from the PCE controlled space.
PCEP Extension for Path Identification in SR
specifies a mechanism to carry the SR path identification information in PCEP

- The path ID can be allocated by Ingress PCC itself and informed to the PCE. The PCE can then inform the egress PCC.

- The 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.

- For PCE can allocate a path ID on its own accord and inform the ingress/egress PCC, useful for PCE-initiated LSPs.

- (Next Version) The path ID can be allocated by Egress PCC. The PCE should request the Path ID from Egress PCC.
Capabilities Advertisement

• For advertising the capability of Path ID allocation, new flags are required:
  • SR-PCE-CAPABILITY TLV [I-D.ietf-pce-segment-routing] in OPEN message:
    • P-flag: Path Identification bit, set to indicate that it has the capability to encode SR path identification.

• SRv6-PCE-CAPABILITY TLV [I-D.negi-pce-segment-routing-ipv6]
  • P-flag: Path Identification bit, set to indicate that it has the capability to encode SRv6 path identification.

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

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

- P-flag: Indicating path ID allocation requirement and path ID allocation reply
  - LSP.P-flag: MUST be set in PCReq/PCRpt msg, when PCC requires the path ID allocation.
  - LSP.P-flag: MUST be set in PCRep/PCUpdate/PCInitiate, when PCE reply the path ID allocation requirement.

![Diagram of P-flag in LSP Object]

Figure 3: P-flag in LSP Object
Path ID TLV in LSP Object

- **IDT (ID type)** specifies the type of the Path ID field
  - 0: MPLS Path segment, which is an MPLS label as defined in [I-D.cheng-spring-mpls-path-segment].
  - 1: SRv6 Path ID, which is a 4-octet integer as defined in [I-D.li-spring-passive-pm-for-srv6-np].

- **Flags**
  - L: Local/Global bit: set when the path ID has the local significance.
  - C: PCC/PCE bit: set when the Path ID is allocated by the PCC.
  - E: Egress/Ingress bit: set when the Path ID is allocated from the Egress PCC’s ID space.

- **Path ID**:
  - 32bit value of path ID.
  - The path ID type is indicated by the ID Type field.
Inform the Egress PCC: Path FEC Object & CCI

- This document extends the procedures of [I-D.zhao-pce-pcep-extension-pce-controller-sr] by defining a new Path FEC object to inform the Path Identification information to the Egress PCC.

- One or more following TLV(s) are allowed in the Path FEC object:
  - SYMBOLIC-PATH-NAME TLV: a human readable string that identifies an LSP in the network [RFC8231].
  - LSP-IDENTIFIERS TLVs: optional for SR, but could be used to encode the source, destination and other identification information for the path [RFC8231].
  - SPEAKER-ENTITY-ID TLV: a unique identifier for the PCEP speaker, used to identify the Ingress PCC [RFC8232]. Can be used for two labels solution defined in [I-D.cheng-spring-mpls-path-segment].

- The Path ID information is encoded directly in the Central Control Instructions (CCI) SR object. The Path ID TLV MAY also be included in the CCI SR object.

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
| TLV(s) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

*Figure 2: The path FEC object Format*
The format of a PCInitiate message is as follows:

\[
\langle \text{PCInitiate Message} \rangle \ ::= \langle \text{Common Header} \rangle \\
\langle \text{PCE-initiated-lsp-list} \rangle
\]

Where:
\[
\langle \text{Common Header} \rangle \text{ is defined in RFC 5440}
\]

\[
\langle \text{PCE-initiated-lsp-list} \rangle \ ::= \langle \text{PCE-initiated-lsp-request} \rangle \\
\langle \text{PCE-initiated-lsp-list} \rangle
\]

\[
\langle \text{PCE-initiated-lsp-request} \rangle \ ::= (\langle \text{PCE-initiated-lsp-instantiation} \rangle | \langle \text{PCE-initiated-lsp-deletion} \rangle)
\]

\[
\langle \text{PCE-initiated-lsp-instantiation} \rangle \ ::= \langle \text{SRP} \rangle \\
\langle \text{LSP} \rangle \\
\langle \text{END-POINTS} \rangle \\
\langle \text{ERO} \rangle \\
\langle \text{attribute-list} \rangle
\]

\[
\langle \text{PCE-initiated-lsp-deletion} \rangle \ ::= \langle \text{SRP} \rangle \\
\langle \text{LSP} \rangle
\]

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Message Example: PCInitiate

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![Diagram of PCInitiate message structure]
Example: PCE allocated Path ID on its own

Figure 5: PCE allocated Path ID on its own
PCEP Extension for
SR Bidirectional Associated Paths
• For associating two SR paths, this document defines a new association group called 'Double-sided Bidirectional SR Path Association Group'
  • The paths belonging to this association is conveyed via PCEP messages to the PCEP peer.

  • A member of the Double-sided Bi-directional SR Path Association Group can take the role of a forward or reverse SR path.

  • The handling rules are set in the same way as [I-D.ietf-pce-association-bidir].

• B-flag in RP and SRP object MUST be set.

• The PATH-ID TLV [I-D.li-pce-sr-path-segment] MUST also be included in the LSP object for these SR paths.
Example: PCE-Initiated Bidir Path

• A stateful PCE:
  • Create/update the forward/reverse SR path independently
  • Establish/remove the association relationship on a per SR path basis.
  • Create/update the SR path and the association on a PCC via PCInitiate/PCUpd messages, respectively.

• The Path-ID TLV MUST be included for each SR path in the LSP object.

• The opposite direction SR SHOULD be informed via PCInitiate message with the matching association group.

Figure 1: PCE-Initiated Double-sided Bidirectional SR Path
Thank you