Path Computation Element (PCE) WG Status

IETF 109 - Online

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Definitive information is in the documents listed below and other IETF BCPs. For advice, please talk to WG chairs or ADs:

• BCP 9 (Internet Standards Process)
• BCP 25 (Working Group processes)
• BCP 25 (Anti-Harassment Procedures)
• BCP 54 (Code of Conduct)
• BCP 78 (Copyright)
• BCP 79 (Patents, Participation)
• https://www.ietf.org/privacy-policy/ (Privacy Policy)
Administrivia

• Minute taker(s), jabber scribe(s)
• Meetecho Etiquette
  – Join the queue if you would like to speak/present
    • Do not send audio directly
  – Please state your name before speaking
  – Be mindful of the agenda time
    • Longer discussion on mailing list (or jabber)
• Collaborative minutes
  • https://codimd.ietf.org/notes-ietf-109-pce?both
Using the Mailing List

• Please use the mailing list actively to discuss all working group business
• Open issues with drafts should be discussed on the list, and conclusions reported to the list
• New drafts should be introduced to the working group first on the mailing list, to gauge interest
• Working group consensus is determined from the mailing list
• Priority in meetings is given to drafts that have been discussed on the list
Please be Vocal

- During WG Adoption and WG LC calls, the response is less.
- Please be vocal on the list to help us gauge the consensus better.
- The working group mailing lists are looked at by the IESG, IAB, and others (internal and external to IETF) to determine interest/participation level in our standards process.
- Please review ideas from your peers, these are community outputs of the working group as a whole.
Using the Wiki

• A way to give you visibility as the document progress through the WG
  – adoption queue
  – WG LC queue
  – balancing work between chairs
  – shepherding responsibilities
  – pending actions
  – IPR polls

• Use this wiki
  – make sure this is up to date!

• https://trac.ietf.org/trac/pce/wiki/WikiStart
Early Codepoint Allocation

• If you have an implementation of a WG I-D
  – that requires inter-operation with other implementations
    • Please request for early IANA codepoint allocation
  – Make sure to include an Implementation Status section in your I-D
  – Make sure the IANA section is correct and complete
    • And meets the condition set out in RFC 7120

• Maintained at
  – https://trac.ietf.org/trac/pce/wiki/WikiStart#CandidateforearlyIANAAllocations
    • Currently empty!
      – Please make your request!
Agenda Bashing

Introduction
1.1 Administrivia, Agenda Bashing (chairs, 5 min)
1.2 WG Status (chairs, 10 min) [15/120]
1.3 State of WG I-Ds and next steps (chairs, 15 min) [30/120]

Segment Routing
2.1 Binding SID (Mike Koldychev, 10 min) [40/120]
draft-ietf-pce-binding-label-sid-05

2.2 PCEP for SRv6 (Cheng Li, 10 min) [50/120]
draft-ietf-pce-segment-routing-ipv6-07

2.3 Algorithm in SID (Samuel Sidor, 10 min) [60/120]
draft-tokar-pce-sid-algo-02

2.4 P2MP SR Policy (Hooman Bidgoli, 10 min) [70/120]
draft-hsd-pce-sr-p2mp-policy-02

Stateful PCE & PCECC
3.1 PCECC Drafts (Shuping Peng, 10 mins) [80/120]
draft-zhao-pce-pcep-extension-pce-controller-sr-08
draft-dhody-pce-pcep-extension-pce-controller-srv6-05
draft-dhody-pce-pcep-extension-pce-controller-p2mp-05

3.2 IFIT (Giuseppe Fioccola, 10 min) [90/120]
draft-chen-pce-pcep-ifit-01

3.3 Path MTU (Luc-Fabrice Ndifor, 10 mins) [100/120]
draft-li-pce-pcep-pmtu-03

3.4 Updates to Stateful PCE drafts (Haomian Zheng, 15 mins) [115/120]
draft-litkowski-pce-state-sync-09
draft-dhody-pce-stateful-pceoptional-07
draft-dhody-pce-stateful-pce-vendor-11
WG Status
Beyond the WG

• 2 new RFC since IETF 108 (Singapore)
  – RFC 8800 - draft-ietf-pce-association-diversity
  – RFC 8934 - draft-ietf-pce-stateful-pce-lsp-scheduling

• Documents in RFC editor queue
  – draft-ietf-pce-pcep-flowspec (MISREF)

• Drafts with the IESG
  – draft-ietf-pce-association-policy
    • Waiting for RTGDIR/AD review
Beyond the WG

• Errata
  – 6231 for RFC 8231 - Technical Errata by Dhruv Dhody (Verified)
    • a “companion” errata for LSP state synchronization
  – 6289 for RFC 8231 - Technical Errata by Dhruv Dhody (Verified)
    • Incorrect use of “total” for TLV length
  – 6301 for RFC8281 - Technical Errata by Samuel Sidor (Verified)
    • Change in RBNF

• Existing Early IANA codepoint allocation
  – draft-ietf-pce-association-policy (Expires 2021-05)

PCE WG @ IETF 109
Liaisons and Communications

• ITU-T-SG-15 – LS
  – To CCAMP, MPLS, PALS, PCE, TEAS
  – Scott Mansfield is coordinating across WGs
  – Reply to LS on OTNT Standardization Work Plan
    • Sent on 2020-08-24, in response to SG15-LS245
    • [https://datatracker.ietf.org/liaison/1693/](https://datatracker.ietf.org/liaison/1693/)

  – LS on OTNT Standardization Work Plan Issue 28
    • Received on 2020-10-05
    • [https://datatracker.ietf.org/liaison/1698/](https://datatracker.ietf.org/liaison/1698/)
    • Reply by 2021-05-01
Status of WG I-Ds & Next Steps
Post WG LC Queue

• draft-ietf-pce-pcep-extension-for-pce-controller-08
  – Shepherd review done by Julien
  – An update (-08) posted by the authors
  – Almost ready now!

• draft-ietf-pce-association-bidir-08
  – Shepherd review done by Dhruv
  – Awaiting an update/response from authors
WG documents “nearing” WG LC

• draft-ietf-pce-pcep-yang-15
  – Two Open Issue listed in the draft
    • PCE-Initiated LSP in the TE YANG Model
    • LSP-ID as a key, reference to TE YANG Model
  – No reference to SR Policy YANG
    • Perhaps better to handle it in another I-D
  – TE yang dependencies are progressing
  – Dependency on draft-ietf-netconf-tls-client-server (used for PCEPS/TLS) is also making progress
  – Very early YANG Doctor review was done
    • should get it done again...
  – Last updated on 2020-10-31
WG documents

- draft-ietf-pce-pcep-stateful-pce-gmpls
  - No Update & Expired!
  - Was merged with draft-ietf-pce-remote-initiated-gmpls-lsp
  - Implementation Status is missing
  - Last updated on 2020-04-24 (version -13)

- draft-ietf-pce-pcep-extension-native-ip
  - Update (-09) on 2020-10-20
    - Multiple versions and major rework
    - Please keep WG in loop and explain the changes
    - Discussion in TEAS WG about document status of the related TEAS I-D
      - We need to have a discussion on document status for this I-D as well
      - Coordinate with IDR for BGP considerations!

- draft-ietf-pce-enhanced-errors
  - Update (-08) on 2020-08-17
    - Moved scenarios to appendix
    - Updated guidelines
WG documents

• draft-ietf-pce-flexible-grid
  – Update (-04) on 2020-08-27
    • Added implementation status

• draft-ietf-pce-segment-routing-ipv6
  – Update (-07) on 2020-11-02
    • On Agenda

• draft-ietf-pce-binding-label-sid
  – Update (-05) on 2020-10-31
    • On Agenda

• draft-ietf-pce-vn-association
  – Update (-03) on 2020-10-19
    • Keepalive update :)
WG documents

• draft-ietf-pce-sr-path-segment
  – Update (-02) on 2020-11-02
    • Keepalive update :)

• draft-ietf-pce-sr-bidir-path
  – Update (-03) on 2020-09-15
    • Added scope clarifications
    • Updated figures and notations for clarity

• draft-ietf-pce-segment-routing-policy-cp
  – Update (-01) on 2020-10-27
    • Changed in reserved value of association ID
  – Discussion on the Mailing List regarding the new procedure to mandate the PCC’s allocation of association parameters
Recent WG documents

• draft-ietf-pce-path-protection-enforcement
  – Suggestion to make it generic either in this I-D or in future
    • Please discuss on the list
Adoption Poll Queue

• draft-zhao-pce-pcep-extension-pce-controller-sr
• draft-dugeon-pce-stateful-interdomain

• Other adoption request’s are maintained at -
  – https://trac.ietf.org/trac/pce/wiki#IndividualdocumentsthatauthorsconsiderreadyforWGAdoption
Thanks & Stay Safe!
Carrying Binding Label/Segment-ID in PCE-based Networks

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TE-PATH-BINDING TLV

Carries the Binding SID of a Policy/Tunnel:

Binding Type (BT) is a numeric field that controls the format of the Binding Value.
For BT=0 and BT=1, the Binding Value is an MPLS label.
For BT=2, the Binding Value is an SRv6 SID.
For BT=3, the Binding Value is an SRv6 SID + some extra information.
Extend TE-PATH-BINDING TLV to carry an SRv6 BSID, as well as its **Endpoint Behavior** and **SID Structure**, as specified in [draft-ietf-spring-srv6-network-programming].

For this, we define a new “Binding Type” BT=3, with a Binding Value that has room for Endpoint Behavior and SID Structure:

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-------------------------------+-------------------------------+
<table>
<thead>
<tr>
<th>SRv6 Binding SID (16 octets)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserved</td>
<td>Endpoint Behavior</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>LB Length</td>
<td>LN Length</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
</tbody>
</table>
```
S-flag and I-flag

Extend TE-PATH-BINDING TLV to carry S-flag “Specified-BSID-only” and I-flag “Drop Upon Invalid”:

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----------------------------------------------+
|                                        Type    |
|                                        Length  |
+-----------------------------------------------+
|                                +-----+-----+|
|                                | BT  | Flags|
|                                +-----+-----+|
|                                        Reserved |
+-----------------------------------------------+
~           Binding Value (variable length)   ~
+-----------------------------------------------------------------------------------+
```

“Specified-BSID-only”: if the specified BSID cannot be provisioned, then the given Policy/Tunnel MUST not carry traffic.

“Drop Upon Invalid”: if there is no path for the Policy/Tunnel, the traffic that would normally be steered there is dropped.
Next steps

• Discuss
PCEP Extensions for SRv6

From
draft-ietf-pce-segment-routing-ipv6-00
to
draft-ietf-pce-segment-routing-ipv6-07

Presenter: Cheng Li

Cheng Li/Mahendra Singh Negi/Mike Koldychev/Prejeeth Kaladharan/Yongqing Zhu

IETF#109
Overview (00-06)

This document mainly defines the following extensions for SRv6 in PCEP.

- Open Object
  - PATH-SETUP-TYPE-CAPABILITY TLV: Adding a new PST=SRv6
  - SRv6 PCE Capability sub-TLV
- New PST for SRv6 in RP/SRP object
- SRv6-ERO Subobject
  - Renamed NAI-Type (NT) (from SID-Type (ST))
- SRv6-RRO Subobject

- It also defines the processing including error handling of the extensions.
Update from 06 to 07

Adding SID Structure TLV to align with the extensions in IS-IS, BGP-LS and BGP SR policy.

- **T**: The T bit indicates the presence of an optional 8-byte SID Structure when SRv6 SID is included.
- **V**: The "SID verification" bit usage is as per Section 5.1 of [I-D.ietf-spring-segment-routing-policy].
- Do we need the A-flag (Algorithm flag)?

---

![SID Structure TLV Diagram](image_url)
Update from 06 to 07: SID Structure

SID Structure

- Indicating the length of the four parts of an SRv6 SID.
- 8-bit flag for future usage.
- 24-bits reserved for future usage, like defining extra parts of an SRv6 SID.
Next Step

• Comments are welcome!
• Refine document to specify the details.
Thank you
Carrying SID Algorithm information in PCE-based Networks

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Motivation

• A PCE can compute SR-TE paths using prefix SIDs with different Algorithms depending on the use-case, constraints, etc. While this information is available on the PCE, there is no method of conveying this information to the headend router

• The headend can also compute SR-TE paths using different Algorithms, and this information also needs to be conveyed to the PCE for collection or troubleshooting purposes

• An operator may also want to constrain the path computed by the PCE to a specific SID Algorithm. For example, in order to only use SID Algorithms for a low-latency path
Prefix-SID Algorithm

• Described in Segment Routing Architecture RFC
  • RFC 8402 - Section 3.1.1
  • Two algorithms defined
    • Shortest Path First (SPF)
    • Strict Shortest Path First (Strict-SPF)

• IGP Algorithm Types in IANA registry
  • Two existing algorithms and Flexible Algorithms range
New NAI types for SR-ERO subobject

• SR-ERO subobject encoding is extended with additional NAI types

NAI for IPv4 Node SID with Algorithm

+--------------------------------------------------------------------------------------------------------------+
| Node IPv4 address                                                   | |
+--------------------------------------------------------------------------------------------------------------+
| Reserved                                                             |  Algorithm    |
+--------------------------------------------------------------------------------------------------------------+

NAI for IPv6 Node SID with Algorithm

+--------------------------------------------------------------------------------------------------------------+
| Node IPv6 address (16 octets) //                                                                                 |
+--------------------------------------------------------------------------------------------------------------+
| Reserved                                                             |  Algorithm    |
+--------------------------------------------------------------------------------------------------------------+
**TLV for the LSPA Object**

- Introduced new TLV to carry the SID Algorithm constraint

```
+-----------------------------------------------+----------------+
| Type=TBD                                      | Length=4       |
+-----------------------------------------------+----------------+
```

- **F (Fallback):** If set to 1 and the PCE is unable to compute a path using only prefix SIDs with the specified Algorithm, the PCE MAY compute an alternate fallback path without constraining to the specified Algorithm.

- **L (Loose):** If set to 1, the PCE MAY insert prefix SIDs with a different Algorithm, but it MUST prefer the specified Algorithm whenever possible.
Next steps

• Comments and discussion are welcome
• Request WG adoption
P2MP Policy
draft-hsd-pce-sr-p2mp-policy

Authors:
Hooman Bidgoli, Nokia
Daniel Voyer, Bell Canada
Ehsan Hemmati, Cisco
Saranya Rajarathinam, Nokia
Tarek Saad, Juniper
Siva Sivabalan, Ciena
Update/Relevant Drafts

Multiple Vendors are implementing/finished implementing this draft.

draft-spring-sr-replication-segment (adopted)

draft-ietf-pim-sr-p2mp-policy (adopted)

draft-hb-spring-sr-p2mp-policy-yang-01 (should we move it to PIM WG?)

draft-Parekh-bess-mvpn-evpn-sr-p2mp-00 (Next for adaptation)

draft-hsd-pce-sr-p2mp-policy-01 (Will ask for adaptation call for IETF 109)

draft-hb-idr-sr-p2mp-policy-00 (Will ask for adaptation call for IETF 110)

draft-hb-pim-p2mp-policy-ping-00 (New)
Multicast Evolution

• There is a desire to simplify Next generation complex networks (i.e. 5G transport) from administration and protocol point of view.

• The controller provides an end-to-end view of the network and simplifies traffic engineering, slicing and monitoring of the end-to-end SLAs for each slice.

• Protocols like SR simplify the underlay by removing the need of LDP/RSVP-TE protocols and use IGP/BGP to signal segments.

• Multicast needs to follow suite

• SR P2MP Policy removes legacy P2MP MPLS protocols like mLDP/RSVP-TE while providing traffic engineering via SR Policy attributes.
SR P2MP Segment

- A Point-to-Multipoint (P2MP) segment connects a Root node to a set of Leaf nodes in segment routing domain.

- A Point-to-Multipoint Policy contains
  - Is identified via ROOT-ID and TREE-ID
  - A set of Leaves
  - Candidate paths used for P2MP Tree redundancy
  - Candidate paths contain Path-Instances used for Global Optimization

- PCC Initiated: Root and Leaves can be discovered via multicast procedures like NG-MVPN (RFC 6514, 6513) or PIM (Protocol Independent Multicast) on PCC and the relevant information send to the PCE

- PCE Initiated: Root and Leaves can be configured explicitly on the PCE or controller and programmed on the PCC
Replication Segment

• Is the forwarding instructions for the P2MP LSP
  • Label instructions
  • Fast Reroute instructions

• A Replication segment can be defined via following
  • Root: The root of the P2MP segment that the replication segment is for;
  • Tree-ID: Tree that the replication segment is part of;
  • LSP-ID: LSP-ID is unique per <root and p2mp policy>
    OR
  • node-address
  • Replicatoin-id

  • Replication-SID: Segment ID for this Replication Segment.
  • Replication-SIDs can’t be stacked as each replication segment can be a egress or transit.

• Two Replication Segments can be connected directly via adjacent nodes or they can be non-adjacent and connected via a SID List (Unicast)
Shared Replication Segment

- Shared Replication segment is defined via following
  - Two or more P2MP trees may share a replication segment.
  - Replication segment may be identified with Zero ROOT-ID, a unique Replication-ID (for the Tree-ID) and the Node-ID.
  - As an example, it can be used for Facility FRR when the by-pass tunnel is made of only Replication Segments to protect a nexthop. i.e. LFA or TI-LFA is not sued.
**PCC Init Example**

1. **BGP**
   - MC AD Routes

2. **Root**: Learn about the leaves via the AD routes

3. **Update Controller**: RootID Leaves

4. **Calculate the Tree and its Replication Segments**

5. **Program PCCs with Replication Segments and forwarding information, including SID-LISTS**

- **ROOT**
  - None SR-P2MP nodes

- **LEAVES**
SR P2MP Objects

Non-SR-P2MP nodes

SR P2MP Policy
- ROOT Node, key
- Leaf Node
- Tree-ID, key

Candidate path 1
- Preference
- PLSP-ID = 1
- TE-Info

Path-Instance-1
LSP ID (tree-1)

Path-Instance-2
LSP ID (tree-2)

SR P2MP Policy
- Root Node, key
- Leaf Node
- Tree-ID
- Instance ID
- Inc Rep SID
- Rep SID Action

Candidate path N
- Preference
- PLSP-ID = N
- TE-Info

Path-Instance-1
LDP-ID

Path-Instance-2
LDP-ID

Replication segment
- Node-ID
- Tree-ID
- Root
- Instance ID
- Inc Rep SID
- Rep SID Action

Unicast SR Policy
- Node-ID
- Tree-ID
- Root
- Instance ID
- Inc Rep SID
- Rep SID Action

Forwarding Info
- Next-hop-group-id [nh-id] //array of nh
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]

Forwarding Info
- Next-hop-group-id [nh-id] //array of nh
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]

Forwarding Info
- Next-hop-group-id [nh-id] //array of nh
  - Next-hop-id <id>
  - Next-hop-add
  - Next-hop-int
  - Protect-nh <id>
  - Sid-list [list of outgoing labels]
SR P2MP YANG Model

```
+-rw p2mp-traffic-engineering!
  | |     +-rw p2mp-policy* [root-address tree-id]
  | |     | |     | +--rw root-address inet:ip-address
  | |     | +--rw tree-id uint32
  | |     | +--rw p2mp-policy-name? string
  | |     | +--rw admin-state? enumeration
  | |     | +--rw oper-state? enumeration
  | |     | |     | |     | +--rw leaf-list* [leaf-address]
  | |     | |     | +--rw leaf-address inet:ip-address
  | |     | | +--rw admin-state? enumeration
  | |     | +--rw candidate-path* [protocol-id originator discriminator]
  | |     | | +--rw protocol-id enumeration
  | |     | | +--rw originator inet:ip-address
  | |     | | +--rw discriminator uint32
  | |     | | +--rw candidate-path-name? string
  | |     | | +--rw admin-state? enumeration
  | |     | | +--rw oper-state? enumeration
  | |     | | +--rw preference? uint32
  | |     | +--rw constraints* [index]
  | |     | | +--rw index uint32
  | |     | | +--rw attributes? uint32
  | |     | +--rw explicit-routing* [index]
  | |     | | +--rw index uint32
  | |     | | +--rw attributes? uint32
  | |     | +--rw path-instances* [index]
  | |     | | +--rw index uint32
  | |     | | +--rw instance-id?
  | |     | |   -> ../../replication-segment/replication-id
  | |     | | +--rw oper-state? enumeration
  | +--rw replication-segment* [node-address replication-id]
      | |     | +--rw node-address inet:ipv4-address
      | |     | +--rw replication-id uint32
      | |     | +--rw admin-state? enumeration
      | |     | +--ro oper-state? enumeration
      | |     | +--rw root-address? inet:ipv4-address
      | |     | +--rw tree-id? uint32
      | |     | +--rw instance-id? uint32
      | +--rw replication-sid? uint32
      | +--rw downstream-nodes* [downstream-index]
      | | +--rw downstream-index uint32
      | | +--rw next-hop-address? inet:ip-address
      | | +--rw next-hop-interface-name? if:interface-ref
      | +--rw protecting-next-hop? boolean
      | +--rw protect-nexthop? uint32
      | +--rw (label)?
      |     +--(sid-list)
      |     | |     | +--rw sid-list* [index]
      |     | | | +--rw index uint32
      |     | | | +--rw sid-segment-type? uint32
      |     | +--(sr-policy)
      |     | | +--rw sr-policy* [replication-sid]
      |     | | | +--rw replication-sid uint32
      |     | | | +--rw sr-policy? string
      |     | +--(rsvp-te)
      |     | | +--rw rsvp-te* [replication-sid]
      |     | | | +--rw replication-sid uint32
      |     | | | +--rw rsvp-te-tunnel-id? uint32
```

...
Example 1
Single Candidate Path

1. The primary path (candidate path 1) is A to C to LEAF D and LEAF E with C being a BUD node
2. B does not support Replication Segment
1. Ingress Replication from A to D and A to E
2. Root and Leaves need to support Replication Policy.
3. B, C, G don’t support P2MP Policy and are part of the unicast SR.
4. All SR resiliency functionality can be used in unicast SR domain.

**SR P2MP Policy**
- ROOT Node = A
- Leaf Node = D, E
- Tree-ID = 1

**Replication Policy A**
- Tree-ID = 1
- Root = A
- Instance ID = 1
- Inc Rep SID

**Candidate path 1**
- Preference = 1000
- Instance-1
- LSP ID = 1

**Forwarding Info**
- Next-hop-group-id 0
  - Next-hop-add = B
  - Sid-list B,C,D <D is bottom of Stack>
- Next-hop-group-id 1
  - Next-hop-add = B
  - Sid-list B,G,E <E is bottom of Stack>

**Replication Policy D**
- Tree-ID = 1
- Root = A
- Instance ID = 1
- Inc Rep SID = D

**Forwarding Info**
- Next-hop-group-id 0
  - Next-hop-add = na

**Replication Policy E**
- Tree-ID = 1
- Root = A
- Instance ID = 1
- Inc Rep SID = E

**Forwarding Info**
- Next-hop-group-id 0
  - Next-hop-add = na
Example 3
FRR via Shared Replication Segment

1. The primary path is A to C to LEAF D
2. Link between C and D is cut, FRR Nexthop Protection via G
3. G can use a Shared RS to act as a facility bypass for multiple trees.
Next Steps

• Asking for adaptation of this draft

Thank you!
PCECC Drafts

draft-zhao-pce-pcep-extension-pce-controller-sr-08
draft-dhody-pce-pcep-extension-pce-controller-srv6-05
draft-dhody-pce-pcep-extension-pce-controller-p2mp-05

Mahendra Singh Negi, Zhenbin Li, Shuping Peng, Quintin Zhao, Chao Zhou, and Xuesong Geng

IETF 109
Quick Recap

- RFC 8283 defines the PCE as a Central Controller architecture. It examines the motivation and applicability of PCEP as a SDN SBI.
- [I-D.ietf-pce-pcep-extension-for-pce-controller] specify the basic PCEP extension for static LSP
  - Post WG-LC, reworked after shepherd’s review
  - Recent Changes
    - Re-ordering of sections with PCE-Initiated described first, as the common case in the case of PCECC
    - An explicit flag in the PCECC capability sub-TLV
    - Excellent comments from Julien to clean up the I-D
Further PCECC Extensions

- Segment Routing
  - SR-MPLS: draft-zhao-pce-pcep-extension-pce-controller-sr
  - P2MP: draft-dhody-pce-pcep-extension-pce-controller-p2mp

Last discussed during IETF 106, added in the WG adoption queue!
PCECC for SR-MPLS

- draft-zhao-pce-pcep-extension-pce-controller-sr
- Use of PCEP to allocate SR-MPLS Label/SID on all nodes in the SR domain
  - A new CCI Object-Type for SR-MPLS
  - A new FEC Object
- Recent Changes
  - Alignment and sync with the changes in the other draft
  - Reuse PST=1 for SR
  - New flags for Adj-SID added
  - Editorial Cleanup
- It’s been on the WG adoption queue for a while now :)
  - Being overtaken by other draft, request to issue adoption call.
PCECC for SRv6

- draft-dhody-pce-pcep-extension-pce-controller-srv6
- Use of PCEP to allocate SRv6 SID on all nodes in the SR domain
  - A new CCI Object-Type for SRv6
- Recent Changes
  - Alignment and sync with the changes in the other draft
  - Reuse PST=TBD for SRv6 (I-D.ietf-pce-segment-routing-ipv6)
  - New flags for Adj-SID added
  - Editorial Cleanup
- No other open issue
PCECC for P2MP

- draft-dhody-pce-pcep-extension-pce-controller-p2mp
- Use of PCEP to allocate label instruction on the branch node for static P2MP LSP
  - Allow multiple CCI object for the replication at branch node
- Recent Changes
  - Alignment and sync with the changes in the other draft
    - Re-ordering of sections with PCE-Initiated described first, as the common case in the case of PCECC
  - Editorial Cleanup
- No other open issue
Questions?
Request for issuing the adoption call.....
Thank You!
Path Computation Element Communication Protocol (PCEP) Extensions to Enable IFIT

draft-chen-pce-pcep-ifit-01

Online, Nov 2020, IETF 109

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Hang Yuan (UnionPay)
Tianran Zhou (Huawei)
Weidong Li (Huawei)
Giuseppe Fioccola (Huawei)
Yali Wang (Huawei)
Background and Motivation

- In-situ Flow Information Telemetry (IFIT) refers to dataplane on-path telemetry techniques, including In-situ OAM (IOAM) (draft-ietf-ippm-ioam-data) and Alternate Marking (RFC8321, RFC8889)

- The PCEP extension defined in this document allows to signal the IFIT capabilities. In this way IFIT methods are automatically activated and running.

The IFIT attributes can be generalized and included as TLVs carried inside the LSPA (LSP Attributes) object in order to be applied for all path types, as long as they support the relevant data plane telemetry method.
Changes after IETF108

We got some feedback during IETF 108 and later on the mailing list

- The draft has deeply changed because the PCEP extension is now applied as TLVs to the LSP Attributes and not to the Association Groups

- The PCEP extension for IFIT is now general and the LSPA TLVs are applicable for all path types, if the IFIT methods are supported (input from Dhruv Dhody)
  - The application to SR policy is now mentioned as use case

- Addition of different IFIT-CAPABILITY TLV Flags for IOAM and Alternate Marking, in this way each capability can be advertised separately (comment from Fengwei Qin)

- A new section about the PCEP messages and the procedures of handling the TLV (comment from Huaimo Chen)

- Revised the section on the Example of application to SR Policy (comment from Huaimo Chen)
PCEP Extensions for IFIT Attributes

IFIT attribute TLVs are carried inside the LSPA (LSP Attributes) object and applicable to all path types

- IFIT TLVs are optional and can be taken into account by the PCE during path computation and by the PCC during path setup.

- In general, the LSPA object can be carried within a PCInitiate message, a PCUpd message, or a PCRpt message in the stateful PCE model.

- IFIT for SR Policies: IFIT attributes also complement draft-ietf-pce-segment-routing-policy-cp
IFIT capability advertisement
TLV

A new **IFIT-CAPABILITY TLV**, that is an optional TLV for use in the OPEN Object for IFIT attributes via PCEP capability advertisement

| +---------------------------------+ | +-------------------------------+ |
| | Type |           Length=4           |
| | +---------------------------------+ | |
| | Flags |
| +---------------------------------+ | |

- **P**: IOAM Pre-allocated Trace Option Type-enabled flag (draft-ietf-ippm-ioam-data)
- **I**: IOAM Incremental Trace Option Type-enabled flag (draft-ietf-ippm-ioam-data)
- **D**: IOAM DEX Option Type-enabled flag (draft-ietf-ippm-ioam-data)
- **E**: IOAM E2E Option Type-enabled flag (draft-ietf-ippm-ioam-data)
- **M**: Alternate Marking enabled flag (RFC8321)

• If set to 1 by a PCC, the flag indicates that the PCC allows instantiation of the feature by a PCE
• If set to 1 by a PCE, the flag indicates that the PCE supports the feature instantiation
• The flag MUST be set by both PCC and PCE in order to support the instantiation
IFIT Attributes TLV

The **IFIT-ATTRIBUTES TLV** provides the configurable knobs of the IFIT feature, and it can be included as an optional TLV in the **LSPA object**

```
+---------------------------------+---------------------------------+
| Type                           | Length                          |
+---------------------------------+---------------------------------+
| +---------------------------------+---------------------------------+ //
| sub-TLVs                        | sub-TLVs                        |
+---------------------------------+---------------------------------+ //
```
# IOAM Sub-TLVs

- **IOAM Pre-allocated Trace Option Sub-TLV**
  
<table>
<thead>
<tr>
<th>Type=1</th>
<th>Length=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namespace ID</td>
<td>Rsvd1</td>
</tr>
<tr>
<td>IOAM Trace Type</td>
<td>Flags</td>
</tr>
</tbody>
</table>

- **IOAM Incremental Trace Option Sub-TLV**
  
<table>
<thead>
<tr>
<th>Type=2</th>
<th>Length=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namespace ID</td>
<td>Rsvd1</td>
</tr>
<tr>
<td>IOAM Trace Type</td>
<td>Flags</td>
</tr>
</tbody>
</table>

- **IOAM Directly Export Option Sub-TLV**
  
<table>
<thead>
<tr>
<th>Type=3</th>
<th>Length=12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namespace ID</td>
<td>Flags</td>
</tr>
<tr>
<td>IOAM Trace Type</td>
<td>Rsvd</td>
</tr>
<tr>
<td>Flow ID</td>
<td></td>
</tr>
</tbody>
</table>

- **IOAM Edge-to-Edge Option Sub-TLV**
  
<table>
<thead>
<tr>
<th>Type=4</th>
<th>Length=4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namespace ID</td>
<td>IOAM E2E Type</td>
</tr>
</tbody>
</table>
Enhanced Alternate Marking Sub-TLV

- Enhanced Alternate Marking Sub-TLV

  +---+---+---+---+
  | Type=5 | Length=4 |
  +---+---+---+---+
  | FlowMonID | Period | Rsvd |
  +---+---+---+---+
PCEP Messages and Example of application to SR Policy

The Examples of PCC Initiated SR Policy and PCE Initiated SR Policy are reported in draft-ietf-pce-segment-routing-policy-cp and this draft describes the addition of IFIT TLVs through LSPA object:

- For the **PCE-initiated LSP** with the IFIT feature enabled, IFIT-ATTRIBUTES TLV MUST be included in the LSPA object with the **PCInitiate message**

- The PCC creates the LSP using the attributes communicated by the PCE and the local values for the unspecified parameters

- After the successful instantiation of the LSP, the PCC automatically delegates the LSP to the PCE and generates a **PCRpt message** to provide the status report for the LSP

- When the LSP is instantiated the IFIT methods are applied as specified for the corresponding data plane, e.g. draft-ietf-ippm-ioam-ipv6-options and draft-ietf-6man-ipv6-alt-mark

- To enabling/disabling some features, the IFIT-ATTRIBUTES TLV MUST be included in the LSPA object with the **PCUpd message**
Discussion & Next Steps

• Collect feedbacks
  – Comment from Mike Koldychev about multiple SLs signaling (draft-koldychev-pce-multipath-04)

• Evaluate WG adoption

• Welcome questions, comments

Thank you
Support for Path MTU (PMTU) in the Path Computation Element (PCE) communication Protocol (PCEP)

draft-li-pce-pcep-pmtu-03

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Motivation

• In traditional MPLS, the Path MTU can be signaled via signaling protocols like RSVP-TE[3209] and LDP[RFC3988].

• However, there is no additional signaling to establish Segment Routing (SR) paths, so the SR tunnel cannot currently support the negotiation mechanism of the Path MTU.  
  • SR information is reported by BGP-LS, and the PCE can calculate the SR Paths based on this info.

• When SIDs (Label or IPv6 address) are pushed in a packet, the packet will be dropped (in IPv6) or fragmented in forwarding since the packet size may exceed the Path MTU.

• From Operator:
  • When using leased line over multi-domains, MTU should be learned to avoid dropping packets.

• This draft is to specify the extensions to PCEP to carry Path MTU in PCEP messages.
METRIC Object for Path MTU

- This document defines a new type for the existing METRIC object for Path MTU.
  - \( T = \text{TBD by IANA} \)
  - \( B \) (Bound - 1 bit): Bound
  - metric-value = PMTU
- The Path MTU metric type of the METRIC object in PCEP represents the minimum of the Link MTU of all the links along the path.

The format of the METRIC object body is as follows:

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---------------------------------------------+
| Reserved | Flags | C|B| T | +---------------------------------------------+
| metric-value | +---------------------------------------------+
| +---------------------------------------------+
```
PMTU for Segment Routing

• PCE can be used for computing one or more SR-TE paths taking into account various constraints and objective functions.
  • Path MTU could be another metric for PCE to consider

• Once a path is chosen, the PCE can inform an SR-TE path on a PCC using PCEP extensions specified in [RFC8664].
  • PCE could also inform the Path MTU to the PCC

• [I-D.ietch-segment-routing-ipv6] adds the support for IPv6 data plane in SR.

• The new metric type for path MTU is applicable for the SR-TE path and does not require any additional extensions.
What we have updated?

• Thank you for the comments we have received during the presentation @IETF108
• We have updated the draft and addressed all the comments
  • A Terminology session has been added to clarify the often confusing terms including MTU, Link MTU, Path MTU
  • A Path MTU Adjustment session has been added to include the case of protection such as TI-LFA.
  • Some editorial changes.
Next Step

• We would like to ask for WG adoption of this draft since PMTU is a very important feature to have for Network Operators.
Thank you for your attention!
State Synchronization Between Stateful PCE

PCE WG, IETF109

draft-litkowski-pce-state-sync-09

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Draft Re-Cap

• Procedure for Inter-Stateful PCE sync up
  ➢ Making PCE deployments more resilient
  ➢ Solve computation loop/optimality issues for dependent path computations (for e.g. diversity)

• Key Concept:
  ➢ Initiate sync up PCEP sessions among stateful PCEs;
  ➢ Sync incremental LSP states during the session;
  ➢ Setting Primary/Secondary PCE for different responsibilities;

• Scenarios include:
  ➢ Redundant PCEs (backup or load-balance)
  ➢ Inter-domain PCEs / H-PCEs

• Discussed previously in IETF 105 with good support for adoption
Sync-up Example

Latest LSP State (V=100)

Latest LSP State (V=101)

V=100, ignored

V=101, ignored
Status & Next Step

- Editorial changes made to align with recent RFCs after IETF 105, especially terminologies;
- Added security consideration;
- Request WG adoption;
Extension For Stateful PCE to allow Optional Processing of PCEP Objects

PCE WG, IETF109

draft-dhody-pce-stateful-pce-optional-07

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Draft Summary and Changes

• Clarified how the P and I flag usage:
  – Identify the optional objects;
  – Applicable to PCRpt/PCUpd/PCInitiate message;
• Updated the handling of unknown objects based on these flags!
• Described the processing rule in the delegation mode;
Background

- RFC 5440 has specified P and I flags
  - P flag for: must **Processing** or optional
  - I flag for: whether to **Ignore** for optional;
- RFC 8231 has specified the stateful PCE
  - The P and I flags of the PCEP objects defined in the current document MUST be set to 0 on transmission and SHOULD be ignored on receipt since they are exclusively related to path computation requests.
  - The behavior for P and I flag in **OTHER objects** was not specified.

![Figure 8: PCEP Common Object Header](image)
P/I Flag Usage

- **P Flag**
  - Indicate whether the object is mandatory (1) or just optional (0);
  - Indicated by PCE in PCUpd/PCInitiate, and by PCC in PCRpt;
  - P=1, means the object MUST be taken into account;
  - P=0, means PCC can be free to ignore;

- **I Flag**
  - PCUpd, whether (1) or not (0) an optional object was processed, indicated by PCE;
  - PCRpt, whether (1) or not (0) an optional object was processed, indicated by PCC;
  - Meaningless in PCInitiate;
Processing of Unknown Objects

• Checking P flag and process as follow:

- **P flag set?**
  - **Y**
    - **Unknown Objects?**
      - **Y**
        - PCEP must be rejected with ERROR message (PCErr);
      - **N**
        - Normal Processing
  - **N**
    - PCEP Speaker is free to ignore the objects

• LSP Error Code TLV defined in RFC8231 is used here.
Status & Next Step

• Problem statement confirmed on the list;
  – To be useful;
• Editorial changes made to align with recent RFCs after IETF 105;
• Request WG adoption.
Conveying Vendor-Specific Information in PCEP extensions for Stateful PCE

PCE WG, IETF109

draft-dhody-pce-stateful-pce-vendor-11

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Draft Re-Cap

• A Continuation of RFC7150/7470 about the vendor-specific information;
  – This I-D works on the stateful PCEP, i.e., the vendor information in PCRep, PCUpd and PCInitiate;

• Presented in IETF 105 with good support;
RBNF for Stateful PCEP Messages

PCRpt Message ::= <Common Header> <state-report-list>
Where:
  <state-report-list> ::= <state-report>[<state-report-list>]
  <state-report> ::= [SRP]
    <LSP>
    <path>
      [vendor-info-list]
Where:
  vendor-info-list ::= <VENDOR-INFORMATION>
    [vendor-info-list]
<path> is defined in [RFC8231].

PCInitiate Message ::= <Common Header> <PCE-initiated-lsp-list>
Where:
  PCE-initiated-lsp-list ::= <PCE-initiated-lsp-request>
    [PCE-initiated-lsp-list]
  PCE-initiated-lsp-request ::= 
    (PCE-initiated-lsp-instantiation | PCE-initiated-lsp-deletion)
  PCE-initiated-lsp-instantiation ::= <SRP>
    <LSP>
    [END-POINTS]
    <ERO>
    [attribute-list]
    [vendor-info-list]
Where:
  vendor-info-list ::= <VENDOR-INFORMATION>
    [vendor-info-list]
PCE-initiated-lsp-deletion and attribute-list is as per [RFC8281].

PC_upd Message ::= <Common Header> <update-request-list>
Where:
  update-request-list ::= <update-request>[update-request-list]
  update-request ::= <SRP>
    <LSP>
    <path>
      [vendor-info-list]
Where:
  vendor-info-list ::= <VENDOR-INFORMATION>
    [vendor-info-list]
<path> is defined in [RFC8231].
Changes & Next Step

• Editorial changes made to align with recent RFCs after IETF 105;
• Added the implementation case (from Cisco);
  – Two more co-authors joined;
• Request WG adoption.
THANK YOU!