Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: April 19, 2014

S. Sivabalan
J. Medved
C. Filsfils
Cisco Systems, Inc.
E. Crabbe
Google, Inc.
R. Raszuk
NTT I3

October 16, 2013

PCEP Extensions for Segment Routing
draft-sivabalan-pce-segment-routing-02.txt

Abstract

Segment Routing (SR) enables any head-end node to select any path without relying on a hop-by-hop signaling technique (e.g., LDP or RSVP-TE). It depends only on "segments" that are advertised by Link-State Interior Gateway Protocols (IGPs). 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). This document specifies extensions to the Path Computation Element Protocol (PCEP) that allow a stateful PCE to compute and instantiate Traffic Engineering paths, as well as a PCC to request a path subject to certain constraint(s) and optimization criteria in SR networks.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

Status of This Memo

This Internet-Draft will expire on April 19, 2014.

Copyright Notice

Table of Contents

1. Introduction

SR technology leverages the source routing and tunneling paradigms. A source node can choose a path without relying on hop-by-hop signaling protocols such as LDP or RSVP-TE. Each path is specified as a set of "segments" advertised by link-state routing protocols (IS-IS or OSPF). [I-D.filsfils-rtgwg-segment-routing] provides an introduction to SR technology. The corresponding IS-IS and OSPF extensions are specified in [I-D.previdi-isis-segment-routing-extensions] and [I-D.psenak-ospf-segment-routing-extensions], respectively. Two types of segments have been defined; nodal and adjacency segments. A nodal segment represents a path to a node, whereas an adjacency segment represents a specific adjacency to a node. The SR architecture can be applied to the MPLS forwarding plane without any change, as well as to the IPv6 forwarding plane with a new type of routing extension header. A Segment Identifier (SID) is a 32-bit value. In the case of the MPLS data plane, an SR path corresponds to an MPLS Label Switching Path (LSP)

A Segment Routed path (SR path) can be derived from an IGP Shortest Path Tree (SPT). Segment Routed Traffic Engineering paths (SR-TE paths) may not follow IGP SPT. Such paths may be chosen by a suitable network planning tool and provisioned on the source node of the SR-TE path.

[RFC5440] describes Path Computation Element Protocol (PCEP) for communication between a Path Computation Client (PCC) and a Path Control Element (PCE) or between one a pair of PCEs. A PCE computes paths for MPLS Traffic Engineering LSPs (MPLS-TE LSPs) based on various constraints and optimization criteria.

[I-D.ietf-pce-stateful-pce] specifies extensions to PCEP that allow a stateful PCE to compute and recommend network paths in compliance with [RFC4657] and defines objects and TLVs for MPLS-TE LSPs. Stateful PCEP extensions provide synchronization of LSP state between a PCC and a PCE or between a pair of PCEs, delegation of LSP control, reporting of LSP state from a PCC to a PCE, controlling the setup and path routing of an LSP from a PCE to a PCC. Stateful PCEP extensions are intended for an operational model in which LSPs are configured on the PCC, and control over them is delegated to the PCE.

A mechanism to dynamically instantiate LSPs on a PCC based on the requests from a stateful PCE or a controller using stateful PCE is

specified in [I-D.crabbe-pce-pce-initiated-lsp]. Such mechanism is useful in Software Driven Networks (SDN) applications, such as demand engineering, or bandwidth calendaring.

It is possible to use a stateful PCE for computing one or more SR-TE paths taking into account various constraints and objective functions. Once a path is chosen, the stateful PCE can instantiate an SR-TE path on a PCC using PCEP extensions specified in [I-D.crabbe-pce-pce-initiated-lsp] using the SR specific PCEP extensions described in this document. Additionally, using procedures described in this document, a PCC can request an SR path from either stateful or a stateless PCE. This specification uses the PATH-SETUP-TYPE TLV and procedures specified in [I-D.sivabalan-pce-lsp-setup-type].

2. Terminology

The following terminologies are used in this document:

ERO: Explicit Route Object

IGP: Interior Gateway Protocol

IS-IS: Intermediate System to Intermediate System

LSR: Label Switching Router

MSD: Maximum SID Depth

NAI: Node or Adjacency Identifier

OSPF: Open Shortest Path First

PCC: Path Computation Client

PCE: Path Computation Element

PCEP: Path Computation Element Protocol

RRO: Record Route Object

SID: Segment Identifier

SR: Segment Routing

SR-ERO: Segment Routed Explicit Route Object

SR Path: Segment Routed Path

SR-RRO: Segment Routed Record Route Object

SR-TE: Segment Routed Traffic Engineering

3. Overview of PCEP Operation in SR Networks

In SR networks, an ingress node of an SR path appends all outgoing packets with an SR header consisting of a list of Segment IDs (SIDs). The header has all necessary information to guide the packets from the ingress node to the egress node of the path, and hence there is no need for any signaling protocol. A SID can represent a nodal segment representing a path to a node or adjacency segment representing path over a specific adjacency.

In a PCEP session, path information is carried in the Explicit Route Object (ERO), which consists of a sequence of subobjects. Various types of ERO subobjects have been specified in [RFC3209], [RFC3473], and [RFC3477]. In SR networks, a PCE needs to specify EROs containing SIDs (denoted as SR-EROs in this document), and a PCC needs to be capable of processing such EROs. An SR-ERO can be included in the Path Computation LSP Initiate Request message (PCInitiate) defined in [I-D.crabbe-pce-pce-initiated-lsp], as well

as in the Path Computation LSP Update Request (PCUpd) and Path Computation LSP State Report (PCRpt) messages defined in Report (PCRpt) messages defined in [I-D.ietf-pce-stateful-pce].

When a PCEP session between a PCC and a PCE is established, both PCEP Speakers exchange information to indicate their ability to support SR-specific functionality. This document does not preclude a PCEP message from containing different ERO types. However, each subobject within an SR-ERO MUST represent an SID. Furthermore, an LSP initially established using RSVP-TE can be updated using SR-ERO. This capability is useful when a network is migrated from RSVP-TE to SR technology. Similarly, an LSP initially established using SR-ERO can updated to signal the LSP using RSVP-TE if necessary.

A PCC MAY include an ERO object in a PCRpt message. In SR networks, a PCC MAY learn the SR path actually taken by data packets and report that path to a PCE. Methods used by a PCC to learn SR-TE paths are outside the scope of this document.

In summary, this document:

o Defines a new PCEP capability, new subobjects, a new TLV, and new PCEP error codes.

o Specifies how two PCEP Speakers can establish a PCEP session that can carry SR-TE paths.

o Defines the formats of SR-specific PCEP messages in Backus-Naur Format (BNF).

This document specifies SR extensions for the stateless PCE model defined in [RFC5440], as well as for the active stateful and passive stateful PCE models defined in [I-D.ietf-pce-stateful-pce].

4. SR-Specific PCEP Message Extensions

As defined in [RFC5440], a PCEP message consists of a common header followed by a variable length body made up of mandatory and/or optional objects. PCEP messages an their formats for stateless PCE are defined in [RFC5440]. PCEP messages and their formats for stateful PCE are defined in [I-D.ietf-pce-stateful-pce]. PCEP messages and their formats for PCE-initiated LSP instantiation are

defined in [I-D.crabbe-pce-pce-initiated-lsp].

This document defines changes to PCEP messages and their formats required to carry SR-specific information.

4.1. The PCReq Message

This document does not specify any changes to the PCReq message format. This document requires the PATH-SETUP-TYPE TLV to be carried in the RP Object in order for a PCC to request SR-TE paths.

4.2. The PCRep Message

This document defines the format of the PCRep message carrying SR-TE paths. The message is sent by a PCE to a PCC in response to a previously received PCReq message, where the PCC requested SR TE path. The format of the SR-specific PCRep message is as follows:

```
   <PCRep Message> ::= <Common Header>
                       <response-list>
Where:

   <response-list>::=<response>[<response-list>]

   <response> ::= <RP>
                  [<NO-PATH>]
                  [<path-list>]

Where:
    <path-list>::=<SR-ERO>[<path-list>]
```


The RP and NO-PATH Objects are defined in [RFC5440]. The <SR-ERO> object contains the SR-TE path and is defined in Section 5.3.

4.3. The PCInitiate Message

The format of the PCInitiate message is as follows:

```
   <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> ::= <SRP>
                                   <LSP>
                                   [<SR-ERO>]
```

The <LSP> object in the Common Header MUST include the SYMBOLIC-PATH-NAME TLV. The message MAY contain an <SR-ERO> object containing subobjects defining the SR-TE path as defined in Section 5.3.

4.4. The PCRpt Message

An SR-specific PCRpt message is sent by a PCC to a PCE to report the current state of an SR-TE Path. A PCRpt message can carry more than one LSP State Report, but all LSP State reports in the SR-Specific PCRpt message MUST be for SR TE Paths. A PCC can send an LSP State Report either in response to an LSP Update Request from a PCE, or asynchronously when the state of an SR-TE Path changes.

The format of the SR-specific PCRpt message is as follows:

```
   <PCRpt Message> ::= <Common Header>
                       <state-report-list>
Where:

   <state-report-list> ::= <state-report>[<state-report-list>]

   <state-report> ::= <SRP>
                      <LSP>
                      <sr-te-path>

Where:
    <sr-te-path> ::= <SR-ERO>
```


The <SR-ERO> object contains the actual SR-TE path used by the PCC

and is defined in Section 5.3. The actual SR-TE Path may be different from the programmed SR-TE Path, for example, when the latter contains loose hops and the PCC must compute the path between loose hops locally.

The <SRP> and <LSP> objects are defined in [I-D.ietf-pce-stateful-pce]. The <LSP> object MUST include the SYMBOLIC-PATH-NAME TLV.

4.5. The PCUpd Message

An SR-Specific PCUpd message is sent by a PCE to a PCC to update an SR-TE Path. A PCUpd message can carry more than one LSP Update Request.

The format of the SR-specific PCUpd message is as follows:

```
   <PCUpd Message> ::= <Common Header>
                       <udpate-request-list>
Where:

   <update-request-list> ::= <update-request>[<update-request-list>]

   <update-request> ::= <SRP>
                        <LSP>
                        <sr-te-path>
Where:
   <sr-te-path>::= <SR-ERO>
```

The <SR-ERO> object contains the SR-TE path computed by the PCE, and is defined in Section 5.3. The <SRP> and <LSP> objects are defined in [I-D.ietf-pce-stateful-pce]. The LSP object MUST include the SYMBOLIC-PATH-NAME TLV. Note that unlike the RSVP-TE specific PCUpd message defined in [I-D.ietf-pce-stateful-pce], the path in the SR-specific PCUpd message does not have attributes - only hops specified in the <SR-ERO> object.

5. Object Formats

5.1. The OPEN Object

This document defines a new optional TLV for use in the OPEN Object.

5.1.1. The SR PCE Capability TLV

The SR-PCE-CAPABILITY TLV is an optional TLV for use in the OPEN Object to negotiate Segment Routing capability on the PCEP session. The format of the SR-PCE-CAPABILITY TLV is shown in the following figure:

```
 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=TBD          |            Length=4           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Reserved              |     Flags     |      MSD      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: SR-PCE-CAPABILITY TLV format

The code point for the TLV type is to be defined by IANA. The TLV length is 4 octets.

The 32-bit value is formatted as follows. The "Maximum SID Depth" (1 octet) field (MSD) specifies the maximum number of SIDs that a PCC is capable of imposing on a packet. The "Flags" (1 octet) and "Reserved" (2 octets) fields are currently unused, and MUST be set to zero and ignored on receipt.

5.1.1.1. Negotiating SR Capability

The SR capability TLV is contained in the OPEN object. By including the TLV in the OPEN message to a PCE, a PCC indicates its support for SR-TE Paths. By including the TLV in the OPEN message to a PCC, a PCE indicates that it is capable of computing SR-TE paths.

The number of SIDs that can be imposed on a packet depends on PCC's data plane's capability. The default value of MSD is 0 meaning that a PCC does not impose any limitation on the number of SIDs included in any SR-TE path coming from PCE. Once an SR-capable PCEP session is established with a non-default MSD value, the corresponding PCE cannot send SR-TE paths with SIDs exceeding the MSD value. If a PCC needs to modify the MSD value, the PCEP session must be closed and re-established with the new MSD value. If a PCEP session is established with a non-default MSD value, and the PCC receives an SR-TE path containing more SIDs than specified in the MSD value, the PCC MUST send out a PCErr message with Error-Type 10 (Reception of an invalid object) and Error-value 3 (Unsupported number of Segment ERO).

The SR Capability TLV is meaningful only in the OPEN message sent from a PCC to a PCE. As such, a PCE does not need to set MSD value

in outbound message to a PCC. Similarly, an MSD value received by a PCC is ignored. If there are multiple SR capability TLVs, only the first TLV is processed.

All bits in the Reserved and Flags fields SHOULD be set to 0 on outbound OPEN messages, and MUST be ignored on inbound OPEN messages.

5.2. The RP/SRP Object

In order to setup an LSP using SR, RP or SRP object may carry PATH-SETUP-TYPE TLV specified in [I-D.sivabalan-pce-lsp-setup-type]. This document defines a new Path Setup Type (PST) for SR as follows:

o PST = 1: Path is setup using Segment Routing technique.

5.3. The SR-ERO Object

An SR-TE path consists of one or more SID(s) where each SID is associated with the identifier that represents the node or adjacency corresponding to the SID. This identifier is referred to as the 'Node or Adjacency Identifier' (NAI). As described later, a NAI can be represented in various formats (e.g., IPv4 address, IPv6 address, etc). Furthermore, a NAI is used only for troubleshooting purposes, and MUST not be used to replace or modify any fields in a data packet header. An SR-ERO object consists of one or more ERO subobjects described in the following section. Also, all subobjects within an SR-ERO MUST be of the SR-ERO subobject type.

5.3.1. The SR-ERO Subobject

An SR-ERO subobject consists of a 32-bit header followed by the SID and the NAI associated with the SID. The SID is a 32-bit number. The size of the NAI depends on its respective type, as described in the following sections.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|    Type     |     Length    |  ST   |     Flags     |F|S|C|M|
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             SID                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//                        NAI (variable)                       //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: SR-ERO Subobject format

The fields in the ERO Subobject are as follows:

The 'L' Flag indicates whether the subobject represents a loose-hop in the explicit route [RFC3209]. If this flag is unset, a PCC MUST not overwrite the SID value present in the SR-ERO subobject. Otherwise, a PCC MAY expand or replace one or more SID value(s) in the received SR-ERO based on its local policy.

Type is the type of the SR-ERO Subobject. This document defines the SR-ERO Subobject type. A new code point will be requested for the SR-ERO Subobject from IANA.

Length contains the total length of the subobject in octets, including the L, Type and Length fields. Length MUST be at least 4, and MUST be a multiple of 4.

SID Type (ST) indicates the type of information associated with the SID contained in the object body. The SID-Type values are described later in this document.

Flags is used to carry any additional information pertaining to SID. Currently, the following flag bits are defined:

* M: When this bit is set, the SID value represents an MPLS label stack entry as specified in [RFC5462] where only the label value is specified by the PCE. Other fields (TC, S, and TTL) fields MUST be considered invalid, and PCC MUST set these fields according to its local policy and MPLS forwarding rules.

* C: When this bit as well as the M bit are set, then the SID value represents an MPLS label stack entry as specified in [RFC5462], where all the entry's fields (Label, TC, S, and TTL) are specified by the PCE. However, a PCC MAY choose to override TC, S, and TTL values according its local policy and MPLS forwarding rules.

* S: When this bit is set, the SID value in the subobject body is null. In this case, the PCC is responsible for choosing the SID value, e.g., by looking up its Traffic Engineering Database (TED) using node/adjacency identifier in the subobject body.

* F: When this bit is set, the NAI value in the subobject body is null.

SID is the Segment Identifier.

NAI contains the NAI associated with the SID. Depending on the value of ST, the NAI can have different format as described in the following section.

5.3.2. NAI Associated with SID

This document defines the following NAIs:

'IPv4 Node ID' is specified as an IPv4 address. In this case, ST and Length are 1 and 12 respectively.

'IPv6 Node ID' is specified as an IPv6 address. In this case, ST and Length are 2 and 24 respectively.

'IPv4 Adjacency' is specified as a pair of IPv4 addresses. In this case, ST and Length are 3 and 16, respectively, and the format of

the NAI is shown in the following figure:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Local IPv4 address                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Remote IPv4 address                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: NAI for IPv4 Adjacency

'IPv6 Adjacency' is specified as a pair of IPv6 addresses. In this case, ST and Length are 4 and 40 respectively, and the format of the NAI is shown in the following figure:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//               Local IPv6 address (16 bytes)                 //
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//               Remote IPv6 address (16 bytes)                //
```



```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: NAI for IPv6 adjacency

'Unnumbered Adjacency with IPv4 NodeIDs' is specified as a pair of Node ID / Interface ID tuples. In this case, ST and Length are 5 and 24 respectively, and the format of the NAI is shown in the following figure:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Local Node-ID                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Local Interface ID                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Remote Node-ID                           |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Remote Interface ID                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: NAI for Unnumbered adjacency with IPv4 Node IDs

We are yet to decide if another SID subobject is required for unnumbered adjacency with 128 bit node ID.

5.3.3. SR-ERO Processing

A PCEP Speaker that does not recognize the new ERO subobject in the PCCreate, PCUpd or PCRpt message MUST reject the entire PCEP message and MUST send a PCE error message with Error-Type=3 ("Unknown Object") and Error-Value=2 ("Unrecognized object Type") or Error-Type=4 ("Not supported object") and Error-Value=2 ("Not supported object Type"), defined in [RFC5440].

When the SID represents an MPLS label (i.e. the M bit is set), its value (20 most significant bits) MUST be larger than 15, unless it is special purpose label, such as an Entropy Label Indicator (ELI) or an Entropy Label (EL). If a PCEP Speaker receives a label ERO subobject with an invalid value, it MUST send the PCE error message with Error-Type = "Reception of an invalid object" and Error-Value = "Bad label value". If both M and C bits of an ERO subobject are set, and if a PCEP Speaker finds erroneous setting in one or more of TC, S, and TTL fields, it MUST send a PCE error with Error-Type = "Reception of an invalid object" and Error-Value = "Bad label format".

If a PCC receives a stack of SR-ERO subobjects, and the number of stack exceeds the maximum number of SIDs that the PCC can impose on the packet, it MAY send a PCE error with Error-Type = "Reception of an invalid object" and Error-Value = "Unsupported number of Segment ERO subobjects".

When a PCEP speaker detects that all subobjects of SR-ERO are not identical, it MUST send PCE error with Error-Type = "Reception of an invalid object" and Error-Value = "Non-identical ERO subobjects" and close the PCEP session.

6. Backward Compatibility

An LSR that does not support the SR PCEP capability negotiation cannot recognize the SR-ERO subobjects. As such, it shall send a PCEP error with Error-Type = 4 (Not supported object) and Error-Value = 2 (Not supported object Type) as per [RFC5440].

7. Management Considerations

7.1. Policy

PCEP implementation:

- o Can enable SR-PCEP capability either by default or via explicit configuration.

- o May generate PCEP error due to unsupported number of SR-ERO subobjects either by default or via explicit configuration.

7.2. The PCEP Data Model

A PCEP MIB module is defined in [I-D.ietf-pce-pcep-mib] needs be extended to cover additional functionality provided by [RFC5440] and [I-D.crabbe-pce-pce-initiated-lsp]. Such extension will cover the new functionality specified in this document.

8. Security Considerations

The security considerations described in [RFC5440] and [I-D.crabbe-pce-pce-initiated-lsp] are applicable to this specification. No additional security measure is required.

9. IANA Considerations

9.1. PCEP Objects

IANA is requested to allocate a ERO subobject type (recommended value = 5) for the SR-ERO subobject.

9.2. PCEP-Error Object

This document defines new Error-Type and Error-Value for the following new conditions:

Error-Type	Meaning
10	Reception of an invalid object
	Error-value=2: Bad label value
	Error-value=3: Unsupported number of Segment ERO subobjects
	Error-value=4: Bad label format
	Error-value=5: Non-identical ERO subobjects

9.3. PCEP TLV Type Indicators

This document defines the following new PCEP TLVs:

Value	Meaning	Reference
26	SR-PCE-CAPABILITY	This document

Table 1

9.4. New Path Setup Type

This document defines a new setup type for the PATH-SETUP-TYPE TLV as follows:

Value	Description	Reference
1	Traffic engineering path is setup using Segment Routing technique.	This document

Table 2

10. Contributors

The following people contributed to this document:

- Lakshmi Sharma (Cisco Systems)

11. Acknowledgements

We like to thank Ina Minei, George Swallow, and Marek Zavodsky for the valuable comments.

12. References

12.1. Normative References

[I-D.crabbe-pce-pce-initiated-lsp]
Crabbe, E., Minei, I., Sivabalan, S., and R. Varga, "PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model", draft-crabbe-pce-pce-initiated-lsp-01 (work in progress), April 2013.

[I-D.filsfils-rtgwg-segment-routing]
Filsfils, C., Previdi, S., Bashandy, A., Decraene, B., Litkowski, S., Horneffer, M., Milojevic, I., Shakir, R., Ytti, S., Henderickx, W., Tantsura, J., and E. Crabbe, "Segment Routing Architecture", draft-filsfils-rtgwg-segment-routing-00 (work in progress), June 2013.

[I-D.ietf-pce-pcep-mib]
Koushik, K., Stephan, E., Zhao, Q., King, D., and J. Hardwick, "PCE communication protocol (PCEP) Management Information Base", draft-ietf-pce-pcep-mib-04 (work in progress), February 2013.

[I-D.ietf-pce-stateful-pce]
Crabbe, E., Medved, J., Minei, I., and R. Varga, "PCEP Extensions for Stateful PCE", draft-ietf-pce-stateful-pce-05 (work in progress), July 2013.

[I-D.previdi-isis-segment-routing-extensions]
Previdi, S., Filsfils, C., Bashandy, A., Gredler, H., Decraene, B., Litkowski, S., Geib, R., Milojevic, I., Shakir, R., Ytti, S., Henderickx, W., and J. Tantsura, "IS-IS Extensions for Segment Routing", draft-previdi-isis-segment-routing-extensions-01 (work in progress), July 2013.

[I-D.psenak-ospf-segment-routing-extensions]
Psenak, P., Previdi, S., Filsfils, C., Gredler, H., and R. Shakir, "OSPF Extensions for Segment Routing", draft-psenak-ospf-segment-routing-extensions-01 (work in

progress), July 2013.

[I-D.sivabalan-pce-lsp-setup-type]
Sivabalan, S., Medved, J., Minei, I., Varga, R., and E. Crabbe, "LSP setup method in PCEP messages", draft-sivabalan-pce-lsp-setup-type-00 (work in progress), October 2013.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC5440] Vasseur, JP. and JL. Le Roux, "Path Computation Element (PCE) Communication Protocol (PCEP)", RFC 5440, March 2009.

[RFC5462] Andersson, L. and R. Asati, "Multiprotocol Label Switching (MPLS) Label Stack Entry: "EXP" Field Renamed to "Traffic Class" Field", RFC 5462, February 2009.

12.2. Informative References

[RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, December 2001.

[RFC3473] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC 3473, January 2003.

[RFC3477] Kompella, K. and Y. Rekhter, "Signalling Unnumbered Links in Resource ReSerVation Protocol - Traffic Engineering (RSVP-TE)", RFC 3477, January 2003.

[RFC4657] Ash, J. and J. Le Roux, "Path Computation Element (PCE) Communication Protocol Generic Requirements", RFC 4657, September 2006.

Authors' Addresses

Siva Sivabalan
Cisco Systems, Inc.
2000 Innovation Drive

Kanata, Ontario K2K 3E8
Canada

Email: msiva@cisco.com

Jan Medved
Cisco Systems, Inc.
170 West Tasman Dr.
San Jose, CA 95134
US

Email: jmedved@cisco.com

Clarence Filsfils
Cisco Systems, Inc.
Pegasus Parc
De kleetlaan 6a, DIEGEM BRABANT 1831
BELGIUM

Email: cfilsfil@cisco.com

Edward Crabbe
Google, Inc.
1600 Amphitheatre Parkway
Mountain View, CA 94043
US

Email: edward.crabbe@gmail.com

Robert Raszuk
NTT I3
101 S. Ellsworth Ave
San Mateo, CA 94401
US

Email: robert@raszuk.net