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PCEP extensions for SR MPLS-TP
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Abstract

This document proposes a set of extensions to PCEP for Segment Routing in MPLS Transport Profile (MPLS-TP) networks and defines a mechanism to create the bi-directional SR tunnel in SR networks with PCE.

Status of This Memo

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1. Introduction

The Path Computation Element Communication Protocol (PCEP) defined in [RFC5440] provides mechanisms for Path Computation Elements (PCEs) to perform path computations in response to Path Computation Clients (PCCs) requests.

[I-D.ietf-pce-segment-routing] proposes extensions to PCEP that allow a stateful PCE to compute Traffic Engineering (TE) paths in segment routing (SR) networks. But it is applicable to Multi-protocol Label Switching (MPLS) networks. [I-D.hu-spring-sr-tp-use-case] describes the use case of SR tunnel to be deployed in MPLS Transport Profile (MPLS-TP) network. It is required to extend the PCEP protocol to meet the new requirements for SR MPLS-TP services. One of the requirements is the bidirectional SR tunnel described in [I-D.cheng-spring-mpls-path-segment].

This document proposes a set of extensions to PCEP for Segment Routing in MPLS Transport Profile networks and defines a mechanism to create the bidirectional SR tunnel in SR networks with PCE.

1.1. 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].

1.2. Terminology

The terminology is defined as [RFC5440], [I-D.ietf-pce-segment-routing] , [I-D.cheng-spring-mpls-path-segment] and [I-D.hu-spring-sr-tp-use-case].

2. The SR MPLS-TP Architecture with PCE

As described in [I-D.hu-spring-sr-tp-use-case], in MPLS-TP networks, the centralized controller may calculate the end to end SR paths, and creates the ordered segment list. The centralized controller may be replaced to PCE as the Figure 1 shown. The PCE can calculate the SR paths and a SR path can be initiated by PCE or PCC.

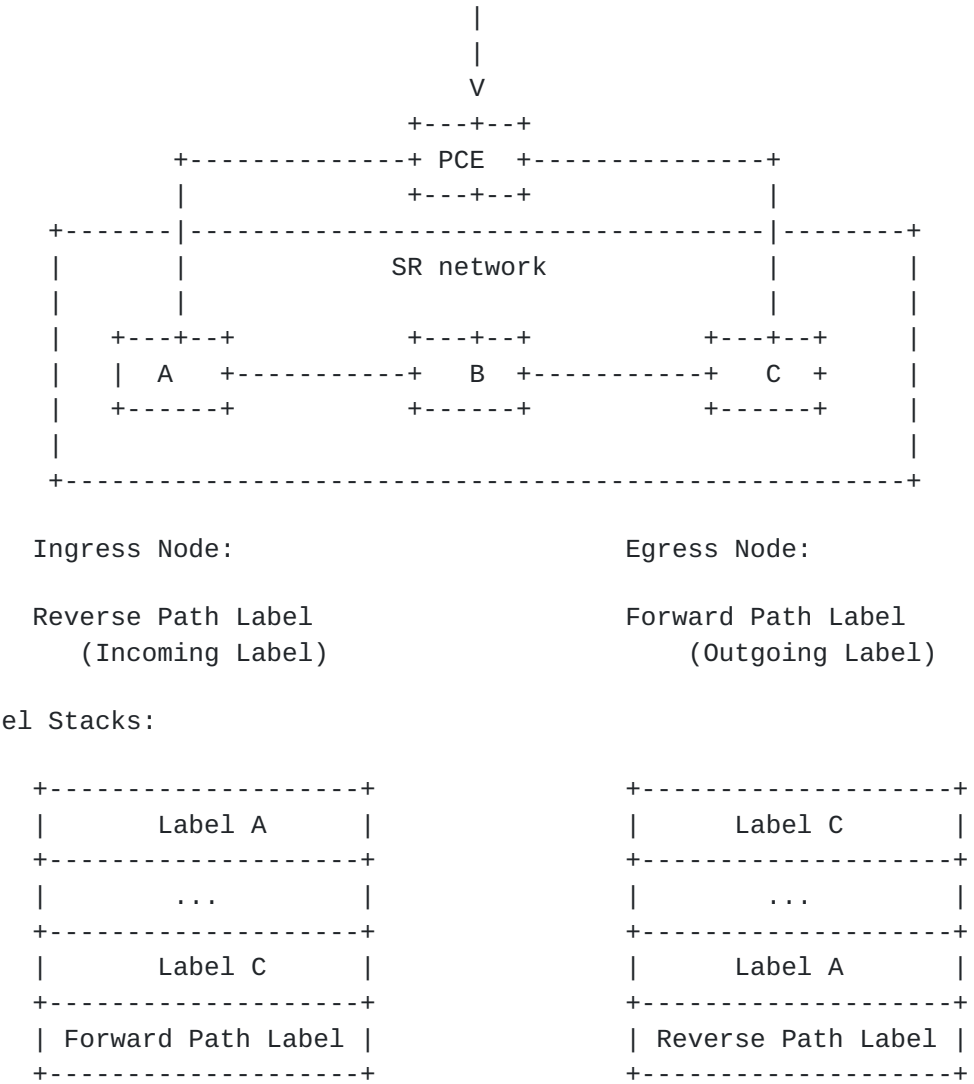

Figure 1 The SR MPLS-TP Architecture with PCE

It is required to support bidirectional SR tunnel to meet the requirement of MPLS-TP networks. A label named path segment at both ends of the paths was defined to identify the direction of the SR paths as defined in [I-D.cheng-spring-mpls-path-segment]. It mainly aims to bind two unidirectional SR paths to a single bidirectional tunnel.

As the Figure 1 shown, the forward and backward directions of the bidirectional SR tunnel are identified by the forward and reverse path label respectively. For the ingress node, the forward path label shall be added to the bottom of the label stack and the reverse path label shall be configured to the data plane as incoming label for the SR LSP. And for the egress node, the reverse path label need to be the last one label of the label stack and the forward path label shall be used as outgoing label.

2.1. SR Path SID Allocation

[RFC8402] defined the IGP, BGP, and Binding segments for the SR-MPLS and SRv6 data planes which can be referred to by Segment Identifier (SID). And [I-D.cheng-spring-mpls-path-segment] defined a new type of segment named path segment. So the path segment can also be identified by SID called SR path SID. The path segment may be associated with a unidirectional path.

The path SID allocation includes ingress PCC allocated, egress PCC allocated and PCE allocated in the domain. In case of egress PCC allocated, the ingress PCC needs to comunicate with PCE to send path segment request to egress PCC as the Figure 2 shown. When the ingress PCC requests PCE to compute the SR path with PCReq message, the PCE needs to request egress PCC to allocate the path SID with the PCUpd or PCInit message carrying the Tunnel 1 and LSP 1. The egress PCC needs to identify the allocation function from the initiation message and should not return back PCErr message when checking the local address is not equal with the source address of Tunnel 1. This document defines E bit in section 3.2 carried in LSP object to indicate the egress PCC operation which may not trigger the LSP initiation.

When the path SID is allocated by ingress PCC, it need to inform PCE with the PCRpt message and the latter one sends the notification to egress PCC with PCUpd or PCInit message carried LSP object which set the E bit to 1.

When the path SID is allocated by PCE, it need to inform ingress and egress PCC with PCUpd or PCInit message carrying the Tunnel 1 and LSP 1. But the message sent to egress PCC MUST set the E bit to 1 to avoid triggering the LSP initiation.

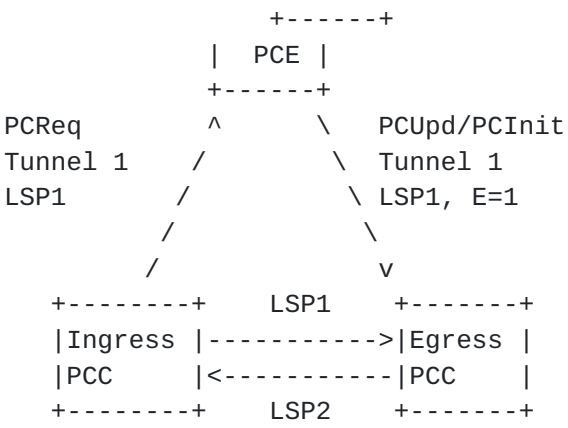

Figure 2 The path SID allocation with PCE

2.2. Associated Bi-directional SR tunnel

As [RFC5654] defined, MPLS-TP MUST support unidirectional, co-routed bidirectional, and associated bidirectional point-to-point transport paths. Based on the defination of co-routed bidirectional path, the forward and backward directions follow the same route (links and nodes) across the network and must be setup, monitored and protected as a single entity.

However, as [RFC8402] defined, segment routing leverages the source routing paradigm and the sourse node steers a packet through an ordered segment list along a unidirectional path. So for bidirectional SR tunnel, the forward and backward directional paths may be setup by the source node and destination node seperately. So the co-routed birectional SR paths can not be provisioned by PCE.

As described in [I-D.ietf-pce-association-bidir], two reverse unidirectional LSPs can be associated as an associated bidirectional tunnel which can be initialed by single-sided and double-sided methods. Based on the discussion above, the associated bidirectional SR tunnel can only be provisioned on both ingress and egress node (PCCs).

The Double-sided initiation can be initiated by PCCs or PCE.The forward and reverse directional paths can be co-routed or non-corouted. The SR bidirectional tunnel may follow the same path in the forward and reverse directions and initialed as a co-routed associated bidirectional LSP.

3. PCEP extensions for SR MPLS-TP

3.1. ERO extension

As described in [I-D.hu-spring-sr-tp-use-case], it is required to support bi-directional tunnel to meet the requirement of SR networks. But it is the uni-directional tunnel for SR and engineering traffic network as discussed in [I-D.ietf-pce-segment-routing]. The SR path is carried in the Segment Routing Explicit Route Object (SR-ERO), which consists of a sequence of SR subobjects. This document proposes the extension of the SR-ERO Subobject to carry the bi-directional tunnel information as the Figure 3 shown. The subobjects with path SIDs need to be added to the list of the SR-ERO subobjects.

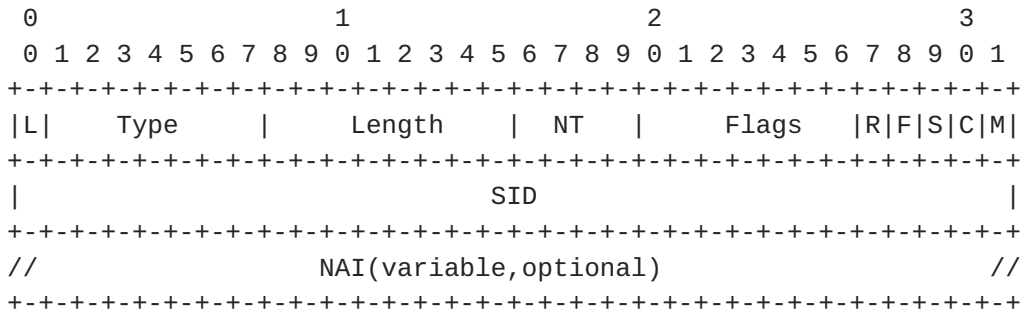

Figure 3 Extension of SR-ERO Subobject format

NAI Type (NT) : A new type of NT = 6 is added in this document and it indicates the type and format of the NAI associated with the path SID contained in the object body. When NT is set to 6, the format of NAI field is shown as figure 4.

R (Reverse Flag -- 1 bit): indicates the SR path direction, when it is clear, it indicates the forward direction and when it is set, it indicates the reverse direction.

The definition of other fields is the same with [I-D.ietf-pce-segment-routing].

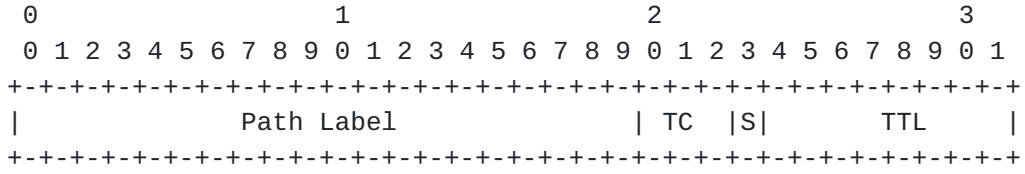

Figure 4 NAI for Path Label information

The format of Path Label information is specified as [I-D.cheng-spring-mpls-path-segment].

3.2. E bit in LSP object

The LSP object is defined in [RFC8231]. This document proposes the E bit in flag field of the LSP object:

E (Egress PCC Operation bit): If the bit is set to 1, it indicates that the egress PCC operation with PCUpd or PCInit message and no need to trigger the LSP initiation. A PCE would set the bit to 1 in SR network to request or inform the path SID information.

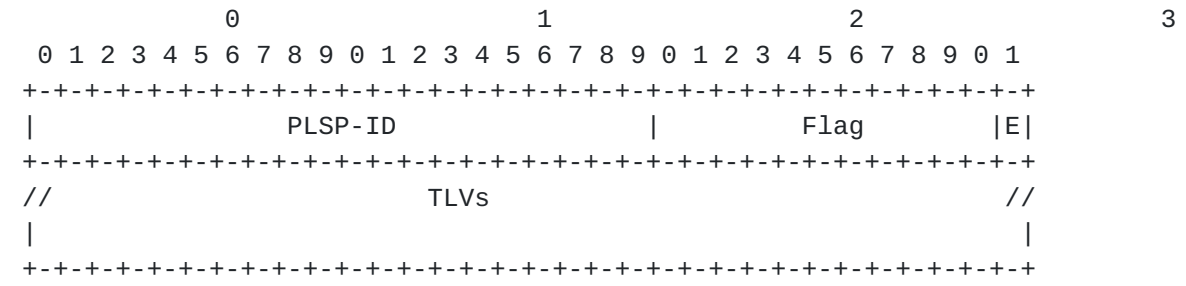

Figure 5 The extension of LSP object

3.3. Processing Rules

As discussed in [I-D.cheng-spring-mpls-path-segment], the bi-directional SR tunnel is created from two binding unidirectional SR paths. As defined in [RFC8281], the stateful PCE calculates the SR paths and initiates the bi-directional LSP with PCUpd or PCInit message.

The B bit in SRP Object MUST be set and the two unidirectional SR paths may be computed from the forward and reverse direction and sent to the source and destination PCC respectively in SR-ERO object. The path labels which binding the paths may be generated in PCE and sent to the related PCC carried in the bottom of the SR-ERO. When the PCCs at both ends receiving the PCInit message with the labels in SR-ERO subobjects, they may forward the packets from bi-directional tunnel in MPLS-TP networks.

4. Security Considerations

TBD.

5. IANA Considerations

TBD.

6. Acknowledgements

TBD.

7. References

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