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**PCEP Extension for SRv6 Unified SIDs
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Abstract

This document proposes PCEP extensions for SRv6 Path which applied to the use of SRv6 Unified SIDs.

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[1.](#) Introduction

[RFC5440] describes the Path Computation Element Protocol (PCEP) which is used between a Path Computation Element (PCE) and a Path Computation Client (PCC) (or other PCE) to enable computation of Multi-protocol Label Switching (MPLS) for Traffic Engineering Label Switched Path (TE LSP). PCEP Extensions for the Stateful PCE Model [[RFC8231](#)] describes a set of extensions to PCEP to enable active control of MPLS-TE and Generalized MPLS (GMPLS) tunnels. [[RFC8281](#)] describes the setup and teardown of PCE-initiated LSPs under the active stateful PCE model, without the need for local configuration on the PCC, thus allowing for dynamic centralized control of a network.

Segment Routing (SR) leverages the source routing paradigm. Segment Routing can be instantiated on MPLS data plane which is referred to as SR-MPLS [[RFC8660](#)]. SR-MPLS leverages the MPLS label stack to construct the SR path. PCEP Extensions for Segment Routing [[RFC8664](#)] specifies extensions to the PCEP that allow a stateful PCE to compute and initiate TE paths in SR networks. Segment Routing can be applied to the IPv6 architecture which is called SRv6 with the Segment Routing Header (SRH) [[RFC8754](#)]. [[I-D.ietf-pce-segment-routing-ipv6](#)] extends the PCEP to support SRv6.

[[I-D.ietf-spring-srv6-network-programming](#)] proposes the SRv6 Network Programming to specify a packet processing program by encoding a sequence of instructions in the IPv6 packet header. It defined the

SID as two parts, LOC:FUNCT or a complete structure is BLOCK:NODE:FUNCT:ARGS. However, the size of SRv6 SID faces a scaling challenge to use topological instructions.

[[I-D.mirsky-6man-unified-id-sr](#)] proposed an extension of SRH that enables the use of unified segment identifiers which is referred to as unified SID, such as MPLS label or IPv4 address, to compress the SRH. So the controller (i.e. PCE) should indicate the SRv6 path with SRv6 unified SIDs in a 128-bit classic SRv6 SID.

[[I-D.liu-idr-segment-routing-te-policy-complement](#)] defined the BGP extensions to advertise Unified SIDs in SR-TE policies.

This document proposes PCEP extensions for SRv6 Path which applied to the use of SRv6 Unified SIDs.

2. Conventions used in this document

2.1. Terminology

The terminology is defined as [[RFC5440](#)], [[RFC8660](#)], [[I-D.ietf-spring-srv6-network-programming](#)] and [[I-D.ietf-pce-segment-routing-ipv6](#)].

2.2. 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.

3. PCEP Extensions for SRv6 Unified SIDs

As defined in [[I-D.mirsky-6man-unified-id-sr](#)], the unified SID is used to compress the SRH, and a new field Size (two-bits) in the SRH Flags field is defined as UET (U-SID Encapsulation Type) which is used to indicate which UET domain the packet is currently in.

Especially for UET 0b01 domain, the SIDs which allocated by SRv6 nodes are in the same SRv6 SID Locator Block, SRH only needs to store the difference between SIDs, such as NODE:FUNCT:ARGS. The 128-bits SRv6 SID can be compressed and truncated and does not need to contain the SRv6 SID Locator Block information but the truncated information. The length of SRv6 SID Locator Block (BL) and the length of truncated SRv6 SID (TL) in a 128-bits classic SRv6 SID should be advertised with each SID from PCE to PCC.

An SR path that can be optimized by short U-SIDs and the 128-bit SID can be compressed to a truncated SID. To verify the TL of the SID, a PCE may collect U-SID encapsulation capability (UEC) information and

SID allocation per UET flavor of all SRv6 nodes. Each node can support one or more UEC in SRv6 networks. A border node may belong to multiple UET domains, so it may support more than one UEC. If a node support an UEC, it should also allocate related SIDs for this UET flavor. For a SID with specific UET flavor allocated by a node, from the perspective of this node, it starts a specific UET domain. When a PCE computes an SRv6 path, it can check the UEC of each node along this path and outline which UET domain the SRv6 path crosses. The UET flavor attribute may be advertised with each SID by PCE to indicate the type of UET domain which the next segment node belongs to. The PCC should optimize each original 128-bits SID to a short one (e.g, 32-bits) along the path and verify the result according to the UET flavor of previous SID.

The UET flavor attribute and BL and TL information of each SID can be directly obtained from the link-state database that is used for path computation by PCE. So when a PCE is used to support path computation in SRv6 networks, the capability of SRv6 path with unified SIDs should be advertised between the PCE and PCC. The information of BL, TL and UET with a 128-bit classic SRv6 SID should be configured from PCE to PCC.

3.1. The OPEN Object

When the PCEP is used to support path computation in SRv6 networks, the capability of SRv6 path with unified SIDs should be advertised between the PCE and PCC.

As defined in [[I-D.ietf-pce-segment-routing-ipv6](#)], PCEP speakers use SRv6 PCE Capability sub-TLV to exchange information about their SRv6 capability carried in Open object. This document defined a new flag (U-flag) for SRv6 PCE Capability sub-TLV as shown in Figure 1.

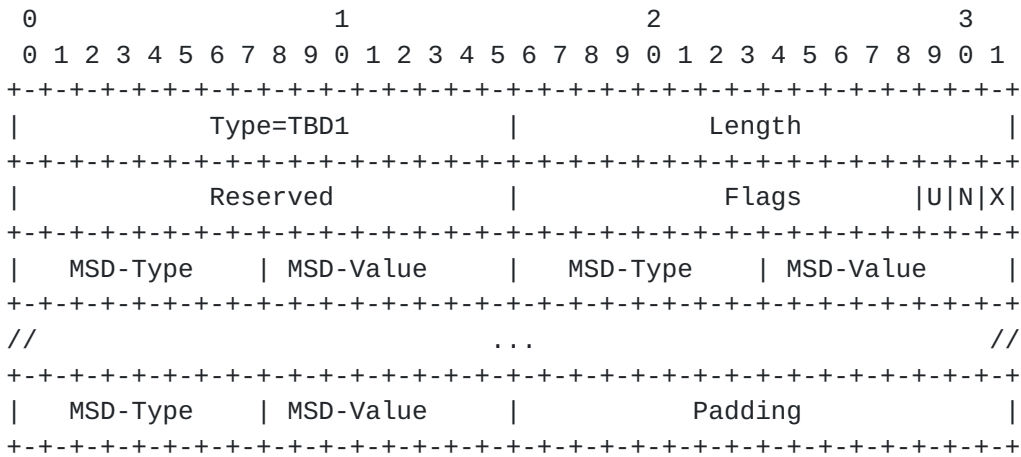


Figure 1: U-flag in SRV6-PCE-CAPABILITY sub-TLV

U (SRv6 unified SIDs is supported) : A PCE sets this flag bit to 1 carried in Open message to indicate that it supports the configuration of SRv6 path with unified SIDs. A PCC sets this flag to 1 to indicate that it supports the capability of processing the unified SIDs and and supports the results of SRv6 path with unified SIDs.

3.2. The LSP Object

The LSP Object is defined in [Section 7.3 of \[RFC8231\]](#). This document defiend a new flag (U-flag) for the LSP Object as Figure 2 shown:

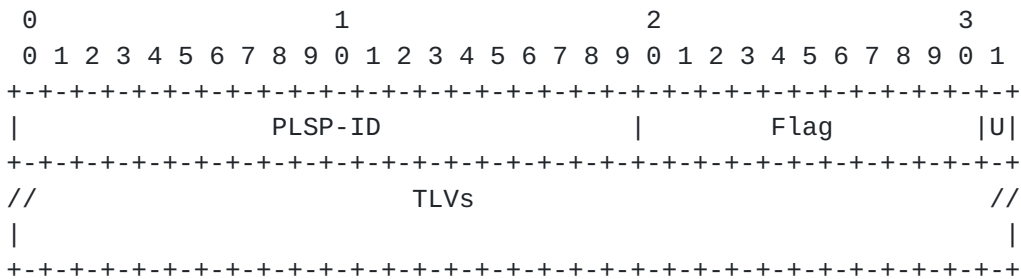


Figure 2: U-flag in LSP Object

U (SRv6 Unified SIDs bit) : If the bit is set to 1, it indicates that the PCC requests PCE to compute the SRv6 path with the unified SIDs information. A PCE would set this bit to 1 and include a UNIFIED-SID-INFO TLV in the LSP object to configure the SRv6 unified SIDs information in the PCEP message.

3.2.1. The UNIFIED-SID-INFO TLV

The UNIFIED-SID-INFO TLV is an optional TLV for use in the LSP Object for SRv6 path computation. The type of this TLV is to be allocated by IANA. The format is as shown below.

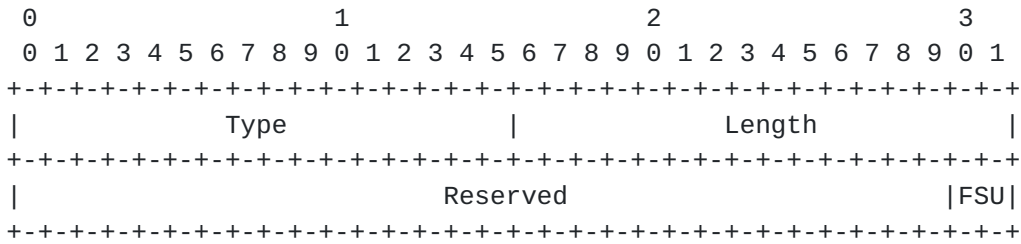


Figure 3: The UNIFIED-SID-INFO TLV Format

FSU (First SID UET-domain flag, 2bits), indicates the first UET domain constructed by the headend and the first segment node. The value as per [I-D.mirsky-6man-unified-id-sr].

3.3. The ERO Object

SRv6-ERO subobject is used for SRv6 path which consists of one or more SRv6 SIDs as defined in [I-D.ietf-pce-segment-routing-ipv6]. This document extends the SRv6-ERO for supporting the SRv6 unified SIDs as Figure 2 shown:

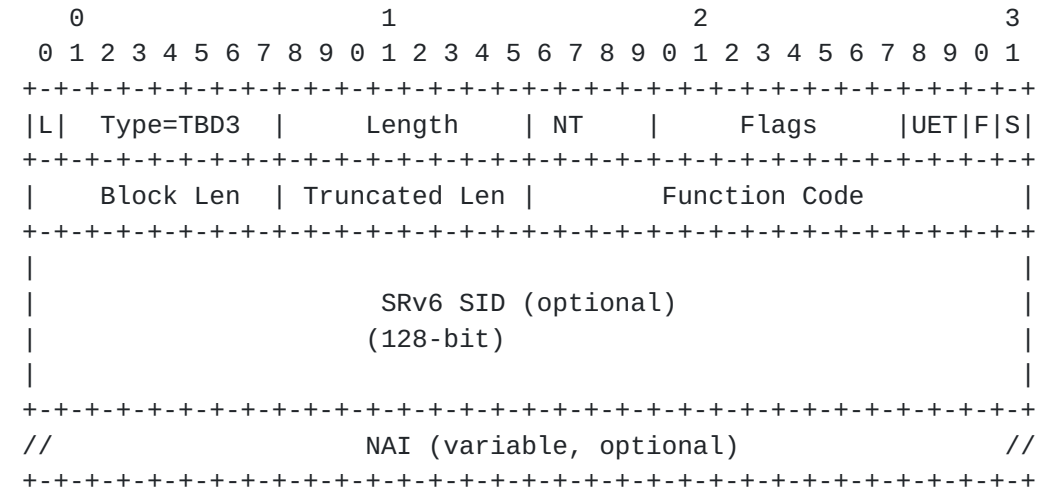


Figure 4: Extension for SRv6-ERO Subobject

UET (U-SID Encapsulation Type, 2bits), indicates the UET domain constructed by the current segment node and the next segment node. The value as per [[I-D.mirsky-6man-unified-id-sr](#)]. Especially, the UET-flag of the last SID will determine whether the overlay VPN SID can be optimized or not in SRH.

Block Len (BL, 8bits), indicates the bit length of SRv6 SID Locator Block information of a 128-bit SID. The value range is [1~128]. If the SID is MPLS label, the value of BL is set to 0.

Truncated Len (TL, 8bits), indicates the bit length of SRv6 SID Locator Truncated SID information of a 128-bit SID. The value range is [1~128]. It is the length of the Node:Func:ARGs which is immediately followed the SRv6 SID Locator Block. For example, if the 128-bit SID is truncated to 32 bits, the TL is set to 32. And if it is 128-bit SID and not be truncated, the TL is set to 128. If the SID is MPLS label, the value of TL is set to 32.

4. Operations

The PCC and PCE exchanges the capability of supporting SRv6 compresses SIDs with U bit set to 1 with in SRv6 PCE Capability sub-TLV carried in Open message. The SRv6 path is initiated by PCE or PCC with PCReq, PCInitiated or PCUpd messages.

When PCC received the SRv6 path, if the U-Flag in the LSP object is set to 1, the SRv6 path could be optimized to an SID list that contains short U-SIDs.

For each original SID in SRv6-ERO subobject, it will be optimized to an U-SID with the help of BL and TL field and verified according to the UET of prev SID. Especially, the original first SID could be verified with a short U-SID according the FSU flag within UNIFIED-SID-INFO TLV.

The SRH will contain the optimized U-SIDs, and the initial UET of SRH will be set as FSU. Other procedures refer to [[I-D.mirsky-6man-unified-id-sr](#)].

5. Security Considerations

TBA

6. Acknowledgements

TBA

7. IANA Considerations

7.1. New SR PCE Capability Flag Registry

SR PCE Capability TLV is defined in [\[I-D.ietf-pce-segment-routing-ipv6\]](#), and the registry to manage the Flag field of the SRv6 PCE Capability TLV is requested in [\[I-D.ietf-pce-segment-routing-ipv6\]](#). IANA is requested to make allocations from the registry, as follows:

Value	Name	Reference
TBD1	SRv6 unified SIDs is supported is supported (U)	[this document]

Table 1

7.2. 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 is requested to make allocations from the registry, as follows:

Value	Name	Reference
TBD2	SRv6 Unified SIDs bit (U)	[this document]
TBD3	UNIFIED-SID-INFO TLV	[this document]

Table 2

7.3. Extension for SRv6-ERO Registry

SRv6-ERO subobject is defined in [\[I-D.ietf-pce-segment-routing-ipv6\]](#), and the registry to manage the Flag field of SR-ERO is requested in [\[I-D.ietf-pce-segment-routing-ipv6\]](#). IANA is requested to make allocations from the registry, as follows:

Value	Name	Reference
TBD4	Extension for SRv6-ERO Subobject	[this document]

Table 3

8. Normative References

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