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Carrying Binding Label/Segment Identifier in PCE-based Networks.
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Abstract

In order to provide greater scalability, network confidentiality, and service independence, Segment Routing (SR) utilizes a Binding Segment Identifier (BSID). It is possible to associate a BSID to an RSVP-TE-signaled Traffic Engineering Label Switched Path or an SR Traffic Engineering path. The BSID can be used by an upstream node for steering traffic into the appropriate TE path to enforce SR policies. This document specifies the binding value as an MPLS label or Segment Identifier. It further specify an approach for reporting binding label/SID by a Path Computation Client (PCC) to the Path Computation Element (PCE) to support PCE-based Traffic Engineering policies.

Status of This Memo

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Table of Contents

1. Introduction 3
2. Requirements Language 5
3. Terminology 5
4. Path Binding TLV 5
  4.1. SRv6 Endpoint Behavior and SID Structure 7
5. Operation 8
6. Binding SID in SR-ERO 10
7. Binding SID in SRv6-ERO 11
8. PCE Allocation of Binding label/SID 11
9. Implementation Status 13
  9.1. Huawei 13
  9.2. Cisco 13
10. Security Considerations 14
11. Manageability Considerations 14
  11.1. Control of Function and Policy 14
  11.2. Information and Data Models 14
  11.3. Liveness Detection and Monitoring 15
  11.4. Verify Correct Operations 15
  11.5. Requirements On Other Protocols 15
  11.6. Impact On Network Operations 15
12. IANA Considerations 15
  12.1. PCEP TLV Type Indicators 15
    12.1.1. TE-PATH-BINDING TLV 15
  12.2. LSP Object 16
  12.3. PCEP Error Type and Value 16
13. Acknowledgements 17
14. References 17
  14.1. Normative References 17
  14.2. Informative References 19
Appendix A. Contributor Addresses 20
Authors' Addresses 20

1. Introduction

A Path Computation Element (PCE) can compute Traffic Engineering paths (TE paths) through a network where those paths are subject to various constraints. Currently, TE paths are set up either using the RSVP-TE signaling protocol or Segment Routing (SR). We refer to such paths as RSVP-TE paths and SR-TE paths respectively in this document.

As per [RFC8402] SR allows a head-end node to steer a packet flow along any path. The head-end node is said to steer a flow into a Segment Routing Policy (SR Policy). Further, as per [I-D.ietf-spring-segment-routing-policy], an SR Policy is a framework that enables the instantiation of an ordered list of segments on a node for implementing a source routing policy with a specific intent for traffic steering from that node.

As described in [RFC8402], a Binding Segment Identifier (BSID) is bound to a Segment Routed (SR) Policy, instantiation of which may involve a list of SIDs. Any packets received with an active segment equal to a BSID are steered onto the bound SR Policy. A BSID may be either a local (SR Local Block (SRLB)) or a global (SR Global Block (SRGB)) SID. As per Section 6.4 of [I-D.ietf-spring-segment-routing-policy] a BSID can also be associated with any type of interface or tunnel to enable the use of a non-SR interface or tunnel as a segment in a SID list. In this document, binding label/SID is used to generalize the allocation of binding value for both SR and non-SR paths.

[RFC5440] describes the PCE communication Protocol(PCEP) for communication between a Path Computation Client (PCC) and a PCE or between a pair of PCEs as per [RFC4655]. [RFC8231] specifies extensions to PCEP that allow a PCC to delegate its Label Switched Paths (LSPs) to a stateful PCE. A stateful PCE can then update the state of LSPs delegated to it. [RFC8281] specifies a mechanism allowing a PCE to dynamically instantiate an LSP on a PCC by sending the path and characteristics.

[RFC8664] provides a mechanism for a PCE (acting as a network controller) to instantiate SR-TE paths (candidate paths) for an SR Policy onto a head-end node (acting as a PCC) using PCEP. For more information on the SR Policy Architecture, see [I-D.ietf-spring-segment-routing-policy].

A binding label/SID has local significance to the ingress node of the corresponding TE path. When a stateful PCE is deployed for setting up TE paths, it may be desirable for PCC to report the binding label/SID to the stateful PCE for the purpose of enforcing end-to-end TE/SR policy. A sample Data Center (DC) use-case is illustrated in the

Figure 1. In the MPLS DC network, an SR LSP (without traffic engineering) is established using a prefix SID advertised by BGP (see [RFC8669]). In the IP/MPLS WAN, an SR-TE LSP is set up using the PCE. The list of SIDs of the SR-TE LSP is {A, B, C, D}. The gateway node 1 (which is the PCC) allocates a binding SID X and reports it to the PCE. In order for the access node to steer the traffic over the SR-TE LSP, the PCE passes the SID stack {Y, X} where Y is the prefix SID of the gateway node-1 to the access node. In the absence of the binding SID X, the PCE should pass the SID stack {Y, A, B, C, D} to the access node. This example also illustrates the additional benefit of using the binding SID to reduce the number of SIDs imposed on the access nodes with a limited forwarding capacity.

```
           SID stack
           {Y, X}              +-----+
    _ _ _ _ _ _ _ _ _ _ _ _ _ _| PCE |
   |                           +-----+
   |                              ^
   |                              | Binding
   |           .-----.            | SID (X)     .-----.
   |          (       )           |            (       )
   V       .--(         )--.      |        .--(         )--.
+------+  (                 )  +-------+  (                 )  +-------+
|Access|_(  MPLS DC Network  )_|Gateway|_(    IP/MPLS WAN    )_|Gateway|
| Node | (  ==============>  ) |Node-1 | ( ================> ) |Node-2 |
+------+  (     SR path     )  +-------+  (    SR-TE path   )  +-------+
           '--(         )--'    Prefix     '--(         )--'
               (       )        SID of         (       )
                '-----'         Node-1          '-----'
                                is Y            SIDs for SR-TE LSP:
                                                {A, B, C, D}
```

Figure 1: A sample Use-case of Binding SID

A PCC could report to the stateful PCE the binding label/SID it allocated via a Path Computation LSP State Report (PCRpt) message. It is also possible for a stateful PCE to request a PCC to allocate a specific binding label/SID by sending aPath Computation LSP Update Request (PCUpd) message. If the PCC can successfully allocate the specified binding value, it reports the binding value to the PCE. Otherwise, the PCC sends an error message to the PCE indicating the cause of the failure. A local policy or configuration at the PCC SHOULD dictate if the binding label/SID needs to be assigned.

In this document, we introduce a new OPTIONAL TLV that a PCC can use in order to report the binding label/SID associated with a TE LSP, or a PCE to request a PCC to allocate a specific binding label/SID value. This TLV is intended for TE LSPs established using RSVP-TE, SR, or any other future method. Also, in the case of SR-TE LSPs, the TLV can carry a binding label (for SR-TE path with MPLS data-plane) or a binding IPv6 SID (e.g., IPv6 address for SR-TE paths with IPv6 data-plane). Throughout this document, the term "binding value" means either an MPLS label or a SID.

Additionally, to support the PCE-based central controller [RFC8283] operation where the PCE would take responsibility for managing some part of the MPLS label space for each of the routers that it controls, the PCE could directly make the binding label/SID allocation and inform the PCC. See Section 8 for details.

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. Terminology

The following terminologies are used in this document:

BSID: Binding Segment Identifier.

LSP: Label Switched Path.

PCC: Path Computation Client.

PCEP: Path Computation Element communication Protocol.

RSVP-TE: Resource ReserVation Protocol-Traffic Engineering.

SID: Segment Identifier.

SR: Segment Routing.

4. Path Binding TLV

The new optional TLV called "TE-PATH-BINDING TLV" (whose format is shown in the Figure 2) is defined to carry the binding label/SID for a TE path. This TLV is associated with the LSP object specified in [RFC8231]. This TLV can also be carried in the PCEP-ERROR object

[RFC5440] in case of error. Multiple instance of TE-PATH-BINDING TLVs MAY be present in the LSP and PCEP-ERROR object. The type of this TLV is 55 (early allocated by IANA). The length is variable.

```
     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 = 55         |             Length            |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |      BT       |    Flags      |            Reserved           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    ~             Binding Value (variable length)                   ~
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: TE-PATH-BINDING TLV

TE-PATH-BINDING TLV is a generic TLV such that it is able to carry binding label/SID (i.e. MPLS label or SRv6 SID). It is formatted according to the rules specified in [RFC5440]. The value portion of the TLV comprises:

Binding Type (BT): A one-octet field identifies the type of binding included in the TLV. This document specifies the following BT values:

o BT = 0: The binding value is a 20-bit MPLS label value. The TLV is padded to 4-bytes alignment. The Length MUST be set to 7 and the first 20 bits are used to encode the MPLS label value.

o BT = 1: The binding value is a 32-bit MPLS label stack entry as per [RFC3032] with Label, TC [RFC5462], S, and TTL values encoded. Note that the receiver MAY choose to override TC, S, and TTL values according to its local policy. The Length MUST be set to 8.

o BT = 2: The binding value is an SRv6 SID with a format of a 16-octet IPv6 address, representing the binding SID for SRv6. The Length MUST be set to 20.

o BT = 3: The binding value is a 24 octet field, defined in Section 4.1, that contains the SRv6 SID as well as its Behavior and Structure. The Length MUST be set to 28.

Section 12.1.1 defines the IANA registry used to maintain all these binding types as well as any future ones. Note that multiple TE-PATH-BINDING TLVs with different Binding Types MAY be present for the same LSP.

Flags: 1 octet of flags. The following flag is defined in the new registry "TE-PATH-BINDING TLV Flag field" as described in Section 12.1.1:

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|R|             |
+-+-+-+-+-+-+-+-+
```

Figure 3: Flags

where:

- o R (Removal - 1 bit): When set, the requesting PCEP peer requires the removal of the binding value for the LSP. When unset, the PCEP peer indicates that the binding value is added or retained for the LSP. This flag is used in the PCRpt and PCUpd messages. It is ignored in other PCEP messages.

- o The unassigned flags MUST be set to 0 while sending and ignored on receipt.

Reserved: MUST be set to 0 while sending and ignored on receipt.

Binding Value: A variable-length field, padded with trailing zeros to a 4-octet boundary. When the BT is 0, the 20 bits represent the MPLS label. When the BT is 1, the 32 bits represent the MPLS label stack entry as per [RFC3032]. When the BT is 2, the 128 bits represent the SRv6 SID. When the BT is 3, the Binding Value also contains the SRv6 Endpoint Behavior and SID Structure, defined in Section 4.1.

4.1. SRv6 Endpoint Behavior and SID Structure

This section specifies the format of the Binding Value in the TE-PATH-BINDING TLV when the BT is set to 3 for the SRv6 Binding SIDs [RFC8986], as shown in Figure 4.

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                 SRv6 Binding SID (16 octets)                  |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |          Reserved             |      Endpoint Behavior        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |    LB Length  |    LN Length  | Fun. Length   |  Arg. Length  |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: SRv6 Endpoint Behavior and SID Structure

The Binding Value consists of:

- o SRv6 Binding SID: 16 octets. The 128-bit IPv6 address, representing the binding SID for SRv6.

- o Reserved: 2 octets. It MUST be set to 0 on transmit and ignored on receipt.

- o Endpoint Behavior: 2 octets. The Endpoint Behavior code point for this SRv6 SID as per the IANA subregistry called "SRv6 Endpoint Behaviors", created by [RFC8986]. When the field is set with the value 0, the endpoint behavior is considered unknown.

- o The following fields are used to advertise the length of each individual part of the SRv6 SID as defined in [RFC8986]:

  * LB Length: 1 octet. SRv6 SID Locator Block length in bits.

  * LN Length: 1 octet. SRv6 SID Locator Node length in bits.

  * Function Length: 1 octet. SRv6 SID Function length in bits.

  * Argument Length: 1 octet. SRv6 SID Arguments length in bits.

5. Operation

The binding value is allocated by the PCC and reported to a PCE via a PCRpt message. If a PCE does not recognize the TE-PATH-BINDING TLV, it would ignore the TLV in accordance with [RFC5440]. If a PCE recognizes the TLV but does not support the TLV, it MUST send a PCErr with Error-Type = 2 (Capability not supported).

Multiple TE-PATH-BINDING TLVs are allowed to be present in the same LSP object. This signifies the presence of multiple binding SIDs for the given LSP. In the case of multiple TE-PATH-BINDING TLVs, the

existing instances of TE-PATH-BINDING TLVs MAY be included in the LSP object. In case of an error condition, the whole message is rejected and the resulting PCErr message MAY include the offending TE-PATH-BINDING TLV in the PCEP-ERROR object.

If a PCE recognizes an invalid binding value (e.g., label value from the reserved MPLS label space), it MUST send a PCErr message with Error-Type = 10 ("Reception of an invalid object") and Error Value = 2 ("Bad label value") as specified in [RFC8664].

For SRv6 BSIDs, it is RECOMMENDED to always explicitly specify the SRv6 Endpoint Behavior and SID Structure in the TE-PATH-BINDING TLV by setting the BT (Binding Type) to 3. This enables the sender to have control of the SRv6 Endpoint Behavior and SID Structure. A sender MAY choose to set the BT to 2, in which case the receiving implementation chooses how to interpret the SRv6 Endpoint Behavior and SID Structure according to local policy.

If a PCC wishes to withdraw a previously reported binding value, it MUST send a PCRpt message with the specific TE-PATH-BINDING TLV with R flag set to 1. If a PCC wishes to modify a previously reported binding, it MUST withdraw the former old binding value (with R flag set in the former TE-PATH-BINDING TLV) and include a new TE-PATH-BINDING TLV containing the new binding value. Note that other instances of TE-PATH-BINDING TLVs that are unchanged MAY also be included.

If a PCE requires a PCC to allocate a (or several) specific binding value(s), it may do so by sending a PCUpd or PCInitiate message containing a TE-PATH-BINDING TLV(s). If the value(s) can be successfully allocated, the PCC reports the binding value(s) to the PCE. If the PCC considers the binding value specified by the PCE invalid, it MUST send a PCErr message with Error-Type = TBD2 ("Binding label/SID failure") and Error Value = TBD3 ("Invalid SID"). If the binding value is valid, but the PCC is unable to allocate the binding value, it MUST send a PCErr message with Error-Type = TBD2 ("Binding label/SID failure") and Error Value = TBD4 ("Unable to allocate the specified binding value"). Note that, in case of an error, the PCC rejects the PCUpd or PCInitiate message in its entirety and can include the offending TE-PATH-BINDING TLV in the PCEP-ERROR object.

If a PCE wishes to request the withdrawal of a previously reported binding value, it MUST send a PCUpd message with the specific TE-PATH-BINDING TLV with R flag set to 1. If a PCE wishes to modify a previously requested binding value, it MUST request the withdrawal of the former binding value (with R flag set in the former TE-PATH-

BINDING TLV) and include a new TE-PATH-BINDING TLV containing the new binding value.

In some cases, a stateful PCE can request the PCC to allocate any binding value. It instructs the PCC by sending a PCUpd message containing an empty TE-PATH-BINDING TLV, i.e., no binding value is specified (bringing the Length field of the TLV to 4). A PCE can also request a PCC to allocate a binding value at the time of initiation by sending a PCInitiate message with an empty TE-PATH-BINDING TLV. Only one such instance of empty TE-PATH-BINDING TLV SHOULD be included in the LSP object and others ignored on receipt. If the PCC is unable to allocate a new binding value as per the specified BT, it MUST send a PCErr message with Error-Type = TBD2 ("Binding label/SID failure") and Error-Value = TBD5 ("Unable to allocate a new binding label/SID").

As previously noted, if a message contains an invalid TE-PATH-BINDING TLV that leads to an error condition, the whole message is rejected including any other valid instances of TE-PATH-BINDING TLVs, if any. The resulting error message MAY include the offending TE-PATH-BINDING TLV in the PCEP-ERROR object.

If a PCC receives a TE-PATH-BINDING TLV in any message other than PCUpd or PCInitiate, it MUST close the corresponding PCEP session with the reason "Reception of a malformed PCEP message" (according to [RFC5440]). Similarly, if a PCE receives a TE-PATH-BINDING TLV in any message other than a PCRpt or if the TE-PATH-BINDING TLV is associated with any object other than an LSP or PCEP-ERROR object, the PCE MUST close the corresponding PCEP session with the reason "Reception of a malformed PCEP message" (according to [RFC5440]).

If a TE-PATH-BINDING TLV is absent in the PCRpt message and no binding values were reported before, the PCE MUST assume that the corresponding LSP does not have any binding. Similarly, if TE-PATH-BINDING TLV is absent in the PCUpd message and no binding values were reported before, the PCC's local policy dictates how the binding allocations are made for a given LSP.

6. Binding SID in SR-ERO

In PCEP messages, LSP route information is carried in the Explicit Route Object (ERO), which consists of a sequence of subobjects. [RFC8664] defines a new ERO subobject "SR-ERO subobject" capable of carrying a SID as well as the identity of the node/adjacency (NAI) represented by the SID. The NAI Type (NT) field indicates the type and format of the NAI contained in the SR-ERO. In case of binding SID, the NAI MUST NOT be included and NT MUST be set to zero. So as per Section 5.2.1 of [RFC8664], for NT=0, the F bit is set to 1, the

S bit needs to be zero and the Length is 8. Further, the M bit is set. If these conditions are not met, the entire ERO MUST be considered invalid and a PCErr message is sent by the PCC with Error-Type = 10 ("Reception of an invalid object") and Error-Value = 11 ("Malformed object").

7. Binding SID in SRv6-ERO

[I-D.ietf-pce-segment-routing-ipv6] defines a new ERO subobject "SRv6-ERO subobject" for an SRv6 SID. As stated in Section 6, in case of binding SID, the NAI is not included and NT is set to zero i.e., NT=0, the F bit is set to 1, the S bit needs to be zero and the Length is 24 [I-D.ietf-pce-segment-routing-ipv6]. As per [RFC8664], if these conditions are not met, the entire ERO is considered invalid and a PCErr message is sent by the PCC with Error-Type = 10 ("Reception of an invalid object") and Error-Value = 11 ("Malformed object").

8. PCE Allocation of Binding label/SID

Section 5 already includes the scenario where a PCE requires a PCC to allocate a specified binding value by sending a PCUpd or PCInitiate message containing a TE-PATH-BINDING TLV. This section specifies an OPTIONAL feature for the PCE to allocate the binding label/SID of its own accord in the case where the PCE also controls the label space of the PCC and can make the label allocation on its own as described in [RFC8283]. Note that the act of requesting a specific binding value (Section 5) is different from the act of allocating a binding label/SID as described in this section.

[RFC8283] introduces the architecture for PCE as a central controller as an extension of the architecture described in [RFC4655] and assumes the continued use of PCEP as the protocol used between PCE and PCC. [I-D.ietf-pce-pcep-extension-for-pce-controller] specifies the procedures and PCEP extensions for using the PCE as the central controller.

For an implementation that supports PCECC operations as per [I-D.ietf-pce-pcep-extension-for-pce-controller], the binding label/SID MAY also be allocated by the PCE itself. Both peers need to exchange the PCECC capability as described in [I-D.ietf-pce-pcep-extension-for-pce-controller] before the PCE can allocate the binding label/SID on its own.

A new P flag in the LSP object [RFC8231] is introduced to indicate the allocation needs to be made by the PCE:

o P (PCE-allocated binding label/SID): If the bit is set to 1, it indicates that the PCC requests PCE to make allocations for this LSP. The TE-PATH-BINDING TLV in the LSP object identifies that the allocation is for binding label/SID. A PCC MUST set this bit to 1 and include a TE-PATH-BINDING TLV in the LSP object to request for allocation of binding label/SID by the PCE in the PCEP message. A PCE MUST also set this bit to 1 and include a TE-PATH-BINDING TLV to indicate that the binding label/SID is allocated by PCE and encoded in the PCEP message towards the PCC. Further, a PCE MUST set this bit to 0 and include a TE-PATH-BINDING TLV in the LSP object to indicate that the binding label/SID should be allocated by the PCC as described in Section 5.

Note that -

o A PCE could allocate the binding label/SID of its own accord for a PCE-initiated or delegated LSP, and inform the PCC in the PCInitiate message or PCUpd message by setting P=1 and including TE-PATH-BINDING TLV in the LSP object.

o To let the PCC allocates the binding label/SID, a PCE MUST set P=0 and include an empty TE-PATH-BINDING TLV (i.e., no binding value is specified) in the LSP object in PCInitiate/PCUpd message.

o To request that the PCE allocate the binding label/SID, a PCC MUST set P=1, D=1, and include an empty TE-PATH-BINDING TLV in PCRpt message. The PCE SHOULD allocate it and respond to the PCC with PCUpd message including the allocated binding label/SID in the TE-PATH-BINDING TLV and P=1, D=1 in the LSP object.

o If both peers have not exchanged the PCECC capabilities as per [I-D.ietf-pce-pcep-extension-for-pce-controller] and a PCEP peer receives P=1 in the LSP object, it needs to act as per [I-D.ietf-pce-pcep-extension-for-pce-controller]:

   * Send a PCErr message with Error-Type=19 (Invalid Operation) and Error-Value=16 (Attempted PCECC operations when PCECC capability was not advertised)

   * Terminate the PCEP session

It is assumed that the label range to be used by a PCE is known and set on both PCEP peers. The exact mechanism is out of the scope of [I-D.ietf-pce-pcep-extension-for-pce-controller] or this document. Note that the specific BSID could be from the PCE-controlled or the PCC-controlled label space. The PCE can directly allocate the label from the PCE-controlled label space using P=1 as described above, whereas the PCE can request for the allocation of a specific BSID

from the PCC-controlled label space with P=0 as described in Section 5.

9. Implementation Status

[Note to the RFC Editor - remove this section before publication, as well as remove the reference to RFC 7942.]

This section records the status of known implementations of the protocol defined by this specification at the time of posting of this Internet-Draft, and is based on a proposal described in [RFC7942]. The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs. Please note that the listing of any individual implementation here does not imply endorsement by the IETF. Furthermore, no effort has been spent to verify the information presented here that was supplied by IETF contributors. This is not intended as, and must not be construed to be, a catalog of available implementations or their features. Readers are advised to note that other implementations may exist.

According to [RFC7942], "this will allow reviewers and working groups to assign due consideration to documents that have the benefit of running code, which may serve as evidence of valuable experimentation and feedback that have made the implemented protocols more mature. It is up to the individual working groups to use this information as they see fit".

9.1. Huawei

o Organization: Huawei

o Implementation: Huawei's Router and Controller

o Description: An experimental code-point is used and will be modified to the value allocated in this document.

o Maturity Level: Production

o Coverage: Full

o Contact: c.l@huawei.com

9.2. Cisco

o Organization: Cisco Systems

o Implementation: Head-end and controller.

- Description: An experimental code-point is used and will be modified to the value allocated in this document.

- Maturity Level: Production

- Coverage: Full

- Contact: mkoldych@cisco.com

10. Security Considerations

The security considerations described in [RFC5440], [RFC8231], [RFC8281] and [RFC8664] are applicable to this specification. No additional security measure is required.

As described [RFC8664], SR allows a network controller to instantiate and control paths in the network. A rogue PCE can manipulate binding SID allocations to move traffic around for some other LSP that uses BSID in its SR-ERO.

Thus, as per [RFC8231], it is RECOMMENDED that these PCEP extensions only be activated on authenticated and encrypted sessions across PCEs and PCCs belonging to the same administrative authority, using Transport Layer Security (TLS) [RFC8253], as per the recommendations and best current practices in BCP195 [RFC7525] (unless explicitly set aside in [RFC8253]).

11. Manageability Considerations

All manageability requirements and considerations listed in [RFC5440], [RFC8231], and [RFC8664] apply to PCEP protocol extensions defined in this document. In addition, requirements and considerations listed in this section apply.

11.1. Control of Function and Policy

A PCC implementation SHOULD allow the operator to configure the policy the PCC needs to apply when allocating the binding label/SID.

11.2. Information and Data Models

The PCEP YANG module [I-D.ietf-pce-pcep-yang] could be extended to include policy configuration for binding label/SID allocation.

11.3. Liveness Detection and Monitoring

The mechanisms defined in this document do not imply any new liveness detection and monitoring requirements in addition to those already listed in [RFC5440].

11.4. Verify Correct Operations

The mechanisms defined in this document do not imply any new operation verification requirements in addition to those already listed in [RFC5440], [RFC8231], and [RFC8664].

11.5. Requirements On Other Protocols

The mechanisms defined in this document do not imply any new requirements on other protocols.

11.6. Impact On Network Operations

The mechanisms defined in [RFC5440], [RFC8231], and [RFC8664] also apply to the PCEP extensions defined in this document. Further, the mechanism described in this document can help the operator to request control of the LSPs at a particular PCE.

12. IANA Considerations

IANA maintains the "Path Computation Element Protocol (PCEP) Numbers" registry. This document requests IANA actions to allocate code points for the protocol elements defined in this document.

12.1. PCEP TLV Type Indicators

This document defines a new PCEP TLV; IANA is requested to confirm the following early allocations from the "PCEP TLV Type Indicators" subregistry of the PCEP Numbers registry, as follows:

Value	Description	Reference
55	TE-PATH-BINDING	This document

12.1.1. TE-PATH-BINDING TLV

IANA is requested to create a new subregistry "TE-PATH-BINDING TLV BT field" to manage the value of the Binding Type field in the TE-PATH-BINDING TLV. Initial values for the subregistry are given below. New values are assigned by Standards Action [RFC8126].

Value	Description	Reference
0	MPLS Label	This document
1	MPLS Label Stack Entry	This document
2	SRv6 SID	This document
3	SRv6 SID with Behavior and Structure	This document
4-255	Unassigned	This document

IANA is requested to create a new subregistry "TE-PATH-BINDING TLV Flag field" to manage the Flag field in the TE-PATH-BINDING TLV. New values are to be assigned by Standards Action [RFC8126]. Each bit should be tracked with the following qualities:

- o Bit number (count from 0 as the most significant bit)

- o Description

- o Reference

Bit	Description	Reference
0	R (Removal)	This document
1-7	Unassigned	This document

12.2. LSP Object

IANA is requested to confirm the early allocation for a new code-point in the "LSP Object Flag Field" sub-registry for the new P flag as follows:

Bit	Description	Reference
0	PCE-allocated binding label/SID	This document

12.3. PCEP Error Type and Value

This document defines a new Error-type and Error-Values for the PCErr message. IANA is requested to allocate new error-type and error-values within the "PCEP-ERROR Object Error Types and Values" subregistry of the PCEP Numbers registry, as follows:

Error-Type	Meaning	Error-value	Reference
TBD2	Binding label/SID failure	0: Unassigned	This document
		TBD3: Invalid SID	This document
		TBD4: Unable to allocate the specified binding value	This document
		TBD5: Unable to allocate a new binding label/SID	This document

13. Acknowledgements

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