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PCEP Extensions for BIER
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Abstract

Bit Index Explicit Replication (BIER)-TE shares architecture and packet formats with BIER as described in [I-D.ietf-bier-architecture]. BIER-TE forwards and replicates packets based on a BitString in the packet header, but every BitPosition of the BitString of a BIER-TE packet indicates one or more adjacencies.BIER-TE Path can be derived from a Path Computation Element (PCE).

This document specifies extensions to the Path Computation Element Protocol (PCEP) to handle requests and responses for the computation of paths for BIER-TE.

Status of This Memo

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This Internet-Draft will expire on August 10, 2018.

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1. Introduction

Bit Index Explicit Replication (BIER)-TE shares architecture and packet formats with BIER as described in [I-D.ietf-bier-architecture]. BIER-TE forwards and replicates packets based on a BitString in the packet header, but every BitPosition of the BitString of a BIER-TE packet indicates one or more adjacencies.BIER-TE Path can be derived from a Path Computation Element (PCE).

This document specifies extensions to the Path Computation Element Protocol (PCEP) to handle requests and responses for the computation of paths for BIER-TE.

2. Conventions used in this document

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.

3. Overview of PCEP Operation in BIER Networks

BIER-TE forwards and replicates packets based on a BitString in the packet header. In a PCEP session, An ERO object specified in [RFC5440] can be extended to carry a BIER-TE path consists of one or more BIER-ERO subobject(s). BIER-TE computed by a PCE can be represented in the following forms:

- o An ordered set of adjacencies BitString(s) in which each bit represents that the adjacencies to which the BFR should replicate packets to in the domain.

In this document, we define a set of PCEP protocol extensions, including a new PCEP capability,a new Path Setup Type (PST) ,a new BIER END-POINT Object, new ERO subobjects, new RRO subobjects, new PCEP error codes and procedures.

4. BIER PCEP Message Extensions

The following section describes the protocol extensions required to support BIER-TE path.

4.1. BIER Capability Advertisement

4.1.1. The OPEN Object

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

4.1.1.1. The BIER PCE Capability TLV

The BIER-PCE-CAPABILITY TLV is an optional TLV associated with the OPEN Object to exchange BIER capability of PCEP speakers. The format of the BIER-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               |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Reserved              |         Flags                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1

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

Length: 4 bytes.

The "Reserved" (2 octet) and "Flags" (2 octet) fields are currently unused, and MUST be set to zero on transmission and ignored on reception.

4.1.1.1.1. Exchanging BIER Capability

This document defines a new optional BIER-PCE-CAPABILITY TLV for use in the OPEN object to negotiate the BIER capability. The inclusion of this TLV in the OPEN message destined to a PCC indicates the PCE's capability to perform BIER-TE path computations, and the inclusion of this TLV in the OPEN message destined to a PCE indicates the PCC's capability to support BIER-TE Path.

A PCE that is able to support the BIER extensions defined in this document SHOULD include the BIER-PCE-CAPABILITY TLV on the OPEN message. If the PCE does not include the BIER-PCE-CAPABILITY TLV in the OPEN message and PCC does include the TLV, it is RECOMMENDED that the PCC indicates a mismatch of capabilities.

4.2. Path Computation Request/Reply Message Extensions

4.2.1. The RP/SPR Object

In order to setup an BIER-TE, a new PATH-SETUP-TYPE TLV[I-D.ietf-pce-lsp-setup-type] MUST be contained in RP or SRP object. This document defines a new Path Setup Type (PST) for BIER as follows:

o PST = 2: Path is setup using BIER Traffic Engineering technique.

If a PCEP speaker does not recognize the PATH-SETUP-TYPE TLV, it MUST ignore the TLV in accordance with [RFC5440]. If a PCEP speaker recognizes the TLV but does not support the TLV, it MUST send PCErr with Error-Type = 2 (Capability not supported).

4.2.2. The New BIER END-POINT Object

The END-POINTS object is used in a PCReq message to specify the BIER information of the path for which a path computation is requested. To represent the end points for a BIER path efficiently, we define a new END-POINT Object for the BIER path:

The format of the new END-POINTS Object is as follows:

```
 0                   1
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Subdomain-ID   |   BS Length   |         Source BFR-id         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Destination  BFR-id         ~        ...                    ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~        ...                    ~   Destination BFR-id          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2

Subdomain-id: Unique value identifying the BIER sub-domain. 1 octet

BS Length: A 1 octet field encoding the supported BitString length.

Source BFR-id:A 2 octet field encoding the source BFR-id.

Destniation BFR-id:A 2 octet field encoding the destniation BFR-id.

4.2.3. ERO Object

BIER-TE consists of one or more adjacencies BitStrings where every BitPosition of the BitString indicates one or more adjacencies, as described in([I-D.eckert-bier-te-arch]).

The ERO object specified in [RFC5440] is used to encode the path of a TE LSP through the network.The ERO is carried within a PCRep message to provide the computed TE LSP if the path computation was successful.In order to carry BIER-TE explicit paths, this document defines a new ERO subobjects referred to as "BIER-ERO subobjects" whose formats are specified in the following section. An BIER-ERO subobjects carrying a adjacencies BitStrings consists of one or more BIER-ERO subobject(s).

4.2.3.1. BIER-ERO Subobject

```
 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              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     BS Length |   Reserved    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Adjacency BitString                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3

Type: TBD

Length: 4 bytes

BS Length: A 1 octet field encoding the supported BitString length.

The "Reserved" (1 octets) fields are currently unused, and MUST be set to zero on transmission and ignored on reception.

Adjacency BitString: A 4 octet field encoding the Adjacency BitString where every BitPosition of the BitString indicates one or more adjacencies.

4.2.3.1.1. BIER-ERO Processing

If a PCC finds a non-recognize the BIER-ERO subobject, the PCC MUST respond with a PCErr 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") as described in [RFC5440] .

If a PCC receives an BIER-ERO subobject in which either BitStringLength or Adjacency BitString is absent, it MUST consider the entire BIER-ERO subobject invalid and send a PCErr message with Error-Type = 10 ("Reception of an invalid object") and Error-Value = TBD ("BitStringLength is absent ") and Error-Value = TBD ("Adjacency BitString is absent ")

If a PCC detects that all subobjects of BIER-ERO are not identical, it MUST send a PCErr message with Error-Type = 10 ("Reception of an invalid object") and Error-Value = TBD ("Non-identical BIER-ERO subobjects").

If a PCC receives an BIER-ERO subobject in which BitStringLength values are not chosen from: 64, 128, 256, 512, 1024, 2048, and 4096, as it described in ([I-D.ietf-bier-architecture]). The PCC MUST send a PCErr message with Error-Type = 10 ("Reception of an invalid object") and Error-Value = TBD ("Invalid BitStringLength").

4.2.4. RRO Object

A PCC can record BIER-ERO explicit paths and report the paths to a PCE via RRO. An RRO object contains one or more subobjects called "BIER-RRO subobjects" whose formats are the same as that of BIER-ERO subobject.

4.2.4.1. RRO Processing

Processing rules of BIER-RRO subobject are identical to those of BIER-ERO subobject defined in section 4.2.3.1 in this document.

5. Security Considerations

TBD.

6. IANA Considerations

6.1. PCEP Objects

As discussed in Section 4.2.2, a new END-POINTS Object-Type is defined. IANA has made the following Object-Type allocations from the "PCEP Objects" sub-registry:

Object	Object-Class Value
BIER END-POINT Object	TBD

As discussed in Section 4.2.3 and 4.2.4, a new sub-object type for the PCEP explicit route object (ERO), and a new sub-object type for the PCEP record route object (RRO) are defined.

IANA has made the following sub-objects allocation from the RSVP Parameters registry:

Object	Sub-Object	Sub-Object Type
EXPLICIT_ROUTE	BIER-ERO (PCEP-specific)	TBD
ROUTE_RECORD	BIER-RRO (PCEP-specific)	TBD

6.2. PCEP-Error Objects and Types

As described in Section 4.2.3.1.1, a number of new PCEP-ERROR Object Error Values have been defined.

Error-Type	Meaning	Reference
10	Reception of an invalid object.	RFC5540
	Error-value = TBD: BitStringLength is absent	This document
	Error-value = TBD: BitString is absent	This document
	Error-value = TBD: Invalid BitStringLength	This document

6.3. PCEP TLV Type Indicators

IANA is requested to allocate a new code point in the PCEP TLV Type Indicators registry, as follows:

Value	Meaning	Reference
TBD	BIER-PCE-CAPABILITY TLV	This document

6.4. New Path Setup Type

IANA is requested to allocate a new code point in the PCEP PATH_SETUP_TYPE TLV PST field registry, as follows:

Value	Description	Reference
2	Path is setup using BIER Traffic Engineering technique	This document

7. References

7.1. Normative references

[I-D.ietf-bier-architecture]
Wijnands, I., Rosen, E., Dolganow, A., Przygienda, T., and S. Aldrin, "Multicast using Bit Index Explicit Replication", draft-ietf-bier-architecture-08 (work in progress), September 2017.

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Sivabalan, S., Tantsura, J., Minei, I., Varga, R., and J. Hardwick, "Conveying path setup type in PCEP messages", draft-ietf-pce-lsp-setup-type-08 (work in progress), January 2018.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC5440] Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation Element (PCE) Communication Protocol (PCEP)", RFC 5440, DOI 10.17487/RFC5440, March 2009, <https://www.rfc-editor.org/info/rfc5440>.

7.2. Informative references

[I-D.eckert-bier-te-arch]
Eckert, T., Cauchie, G., Braun, W., and M. Menth, "Traffic Engineering for Bit Index Explicit Replication BIER-TE", draft-eckert-bier-te-arch-06 (work in progress), November 2017.

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