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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 [[RFC8279](#)]. 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 as described in [[I-D.ietf-bier-te-arch](#)]. BIER-TE Path can be derived from a Path Computation Element (PCE).

This document specifies extensions to the Path Computation Element Protocol (PCEP) that allow a PCE to compute and initiate the path for the BIER-TE.

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## [1.](#) Introduction

Bit Index Explicit Replication (BIER)-TE shares architecture and packet formats with BIER as described in [\[RFC8279\]](#). 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 as described in [\[I-D.ietf-bier-te-arch\]](#). BIER-TE Path can be derived from a Path Computation Element (PCE).

[\[RFC8231\]](#) specifies a set of extensions to PCEP that allow a PCE to compute and recommend network paths in compliance with [\[RFC4657\]](#) and

defines objects and TLVs for MPLS-TE LSPs.

This document uses a PCE for computing one or more BIER-TE paths taking into account various constraints and objective functions.

## [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, and every BitPosition of the BitString of a BIER-TE packet indicates one or more adjacencies as described in [\[I-D.ietf-bier-te-arch\]](#). 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 PCEP error codes and procedures.

## [4.](#) Object Formats

### [4.1.](#) The OPEN Object

#### [4.1.1.](#) The BIER-TE PCE Capability sub-TLV

[\[RFC8408\]](#) defines the PATH-SETUP-TYPE-CAPABILITY TLV for use in the OPEN object. The PATH-SETUP-TYPE-CAPABILITY TLV contains an optional list of sub-TLVs which are intended to convey parameters that are associated with the path setup types supported by a PCEP speaker.

This document defines a new Path Setup Type (PST) for BIER as follows:

- o PST = TBD2: Path is setup using BIER Traffic Engineering technique.

A PCEP speaker SHOULD indicate its support of the function described in this document by sending a PATH-SETUP-TYPE-CAPABILITY TLV in the OPEN object with this new PST included in the PST list.

This document also defines the BIER-TE-PCE-CAPABILITY sub-TLV. PCEP speakers use this sub-TLV to exchange BIER capability. If a PCEP

speaker includes PST=TBD1 in the PST List of the PATH-SETUP-TYPE-CAPABILITY TLV then it MUST also include the BIER-TE-PCE- CAPABILITY sub-TLV inside the PATH-SETUP-TYPE-CAPABILITY TLV.

The format of the BIER-TE-PCE-CAPABILITY sub-TLV is shown in the following figure:

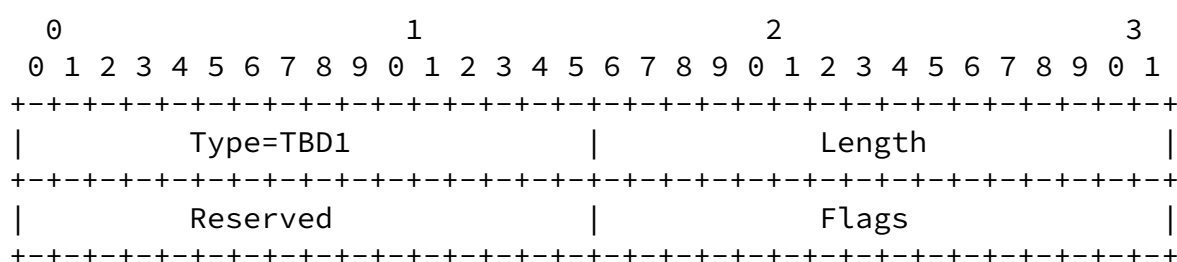


Figure 1

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.

## 4.2. The SRP Object

In order to setup an BIER-TE, a new PATH-SETUP-TYPE TLV MUST be

contained in RP/SRP object. This document defines a new Path Setup Type (PST=TBD2) for BIER-TE.

### 4.3. END-POINTS object

#### 4.3.1. P2MP END-POINTS object

The END-POINTS object which is defined in [\[RFC8306\]](#) 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 reuse the P2MP END-POINTS object body for IPv4(Object-Type 3) and END-POINTS object body for IPv6 (Object-Type 4) which is defined in [\[RFC8306\]](#).

#### 4.3.2. The New BIER END-POINT Object

In the case of BIER and BIER-TE coexistence scenario, we reuse the BFR-id where is assigned

For each sub-domain to which a given BFR belongs, if the BFR is capable of acting as a BFIR or a BFER, it MUST be provisioned with a "BFR-id" that is unique within the sub-domain which is defined in [\[RFC8279\]](#), so in this scenario, we define a new BIER END-POINT Object. It is optional.

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

```

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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Leaf type                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           Source BFR-id           |                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Destination BFR-id           ~           ...           ~           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
~           ...           ~           Destination BFR-id           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Figure 2

leaf type: It is the same with the type which is defined in [\[RFC8306\]](#).

Source BFR-id: A 2 octet field encoding the source BFR-id, A BFR-id is just a number in the range [1,65535], identifies a BFIR uniquely in a BIER subdomain. If no BFR-id has been assigned, the value of this field is set to "Invalid BFR-id", which is defined as illegal in [\[RFC8279\]](#).

Destination BFR-id: A 2 octet field encoding the destination BFR-id. A BFR-id is just a number in the range [1,65535], identifies a BFER uniquely. If no BFR-id has been assigned, the value of this field is set to "Invalid BFR-id", which is defined as illegal in [\[RFC8279\]](#).

#### [4.4.](#) 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 [\[RFC8279\]](#).

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).

##### [4.4.1.](#) 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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|L|   Type=TBD4   |           Length           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

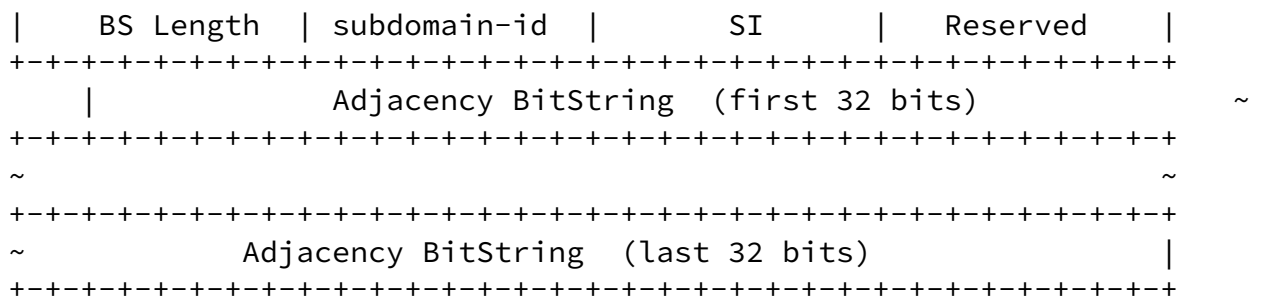


Figure 3

The 'L' Flag: Indicates whether the subobject represents a loose-hop in the LSP[RFC3209]. If the bit is not set, the subobject represents a strict hop in the explicit route.

Type: TBD4

Length: 1 octet ([RFC3209]). Contains the total length of the subobject in octets. The Length MUST be at least 8, and MUST be a multiple of 4.

BS Length: A 1 octet field encodes the length in bits of the BitString as per [RFC8296], the maximum length of the BitString is 5, it indicates the length of BitString is 1024.It is used to refer to the number of bits in the BitString.

subdomain-id: Unique value identifying the BIER subdomain. 1 octet.

SI: Set Identifier (Section 1 of [RFC8279] used in the encapsulation for this BIER subdomain for this BitString length, 1 octet.

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

Adjacency BitString: a variable length field encoding the Adjacency BitString where every BitPosition of the BitString indicates one or more adjacencies.the length of this field is according the BS length. The minimum value of this field is 64 bits, and the maximum value of this field is 1024 bits.

Notice:

The maximum value of BS Length is limited to the 1024 bits, in case the BIER-ERO Subobject is too long.

#### [4.4.2.](#) BIER-ERO Processing

The ERO and SR-ERO subobject processing remains as per [\[RFC5440\]](#).

If a PCC receives an BIER-ERO subobject in which either BitStringLength or Adjacency BitString or SI 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"), Error-Value = TBD5 ("BitStringLength is absent ") or Error-Value = TBD6 ("Adjacency BitString is absent") or Error-Value = TBD7 ("SI is absent ").

If a PCC receives an BIER-ERO subobject in which BitStringLength values are not chosen from: 64, 128, 256, 512, 1024, as it described in ( [\[RFC8279\]](#)). The PCC MUST send a PCErr message with Error-Type =10 ("Reception of an invalid object") and Error-Value = TBD8 ("Invalid BitStringLength").

### [5.](#) Security Considerations

TBD.

### [6.](#) IANA Considerations

#### [6.1.](#) PCEP Objects

IANA has made the following Object-Type allocations from the "PCEP Objects" sub-registry.

##### [6.1.1.](#) BIER-TE-PCE-CAPABILITY Sub-TLV Type Indicators



-----	-----	-----
TBD1	BIER-TE-PCE-CAPABILITY	This Document

#### [6.1.2.](#) New Path Setup Type

vlaue	Meaning	Reference
-----	-----	-----
TBD2	Path is setup using BIER Traffic Engineering technique	This Doc

#### [6.1.3.](#) New BIER END-POINT Object

vlaue	Meaning	Reference
-----	-----	-----
TBD3	END-POINTS Object for BFR-id	This Document

#### [6.1.4.](#) BIER-ERO Subobject

This document defines a new subobject type for the BIER explicit route object (ERO),The code points for subobject types of these objects is maintained in the RSVP parameters registry.

Object	Sub-Object	Sub-Object Type
-----	-----	-----
EXPLICIT_ROUTE	BIER-ERO (PCEP-specific)	TBD4

#### [6.1.5.](#) PCEP-Error Objects and Types

IANA is requested to allocate code-points in the "PCEP-ERROR Object Error Types and Values" subregistry for the following new error-types and error-values:

Error-Type	Meaning	Reference
-----	-----	-----
10	Reception of an invalid object	<a href="#">RFC5440</a>
	Error-value = TBD5 BitStringLength is absent	This document
	Error-value = TBD6 Adjacency BitString is absent	This document
	Error-value = TBD7 SI is absent	This document
	Error-value = TBD8 Invalid BitStringLength	This document

## 7. Normative references

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