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PCEP Extensions for BIER-TE
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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.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on January 10, 2022.

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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-TE-ERO subobject(s). BIER-TE computed by a PCE can be represented in the following forms:

- 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) ,reuse BIER END-POINT Object,a new Objective Functions subobjects,a new ERO subobjects, a new RRO subobjects, a 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-TE as follows:

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

A PCEP speaker MUST 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=TBD2 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:

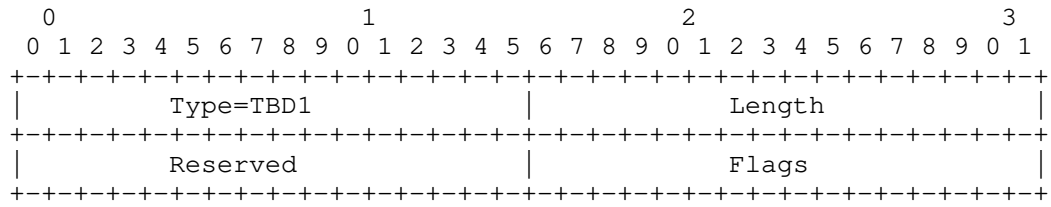

Figure 1 BIER-TE-PCE-CAPABILITY sub-TLV format

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 RP/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

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].

4.4. Objective Functions

[RFC5541] defines a mechanism to specify an objective function (OF) that is used by a PCE when it computes a path. For a BIER-TE path,a new OF is defined.

```
Objective Function Code: TBD3
Name: Minimum Bit Sets (MBS)
Description: Find a path represented by BitPositions that has
             the minimum number of bit sets.
```

4.5. 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-TE-ERO subobjects" whose formats are specified in the following section. An BIER-TE-ERO subobjects carrying a adjacencies BitStrings consists of one or more BIER-TE-ERO subobject(s).

4.5.1. BIER-TE-ERO Subobject

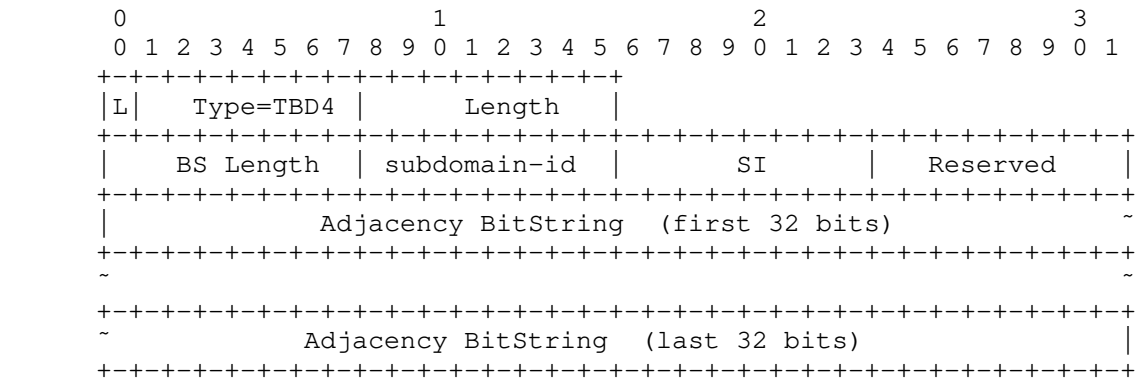

Figure 3

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-TE-ERO Subobject is too long.

4.6. RRO Object

An RRO contains one or more subobjects called "BIER-TE-RRO subobjects", whose format is shown below:

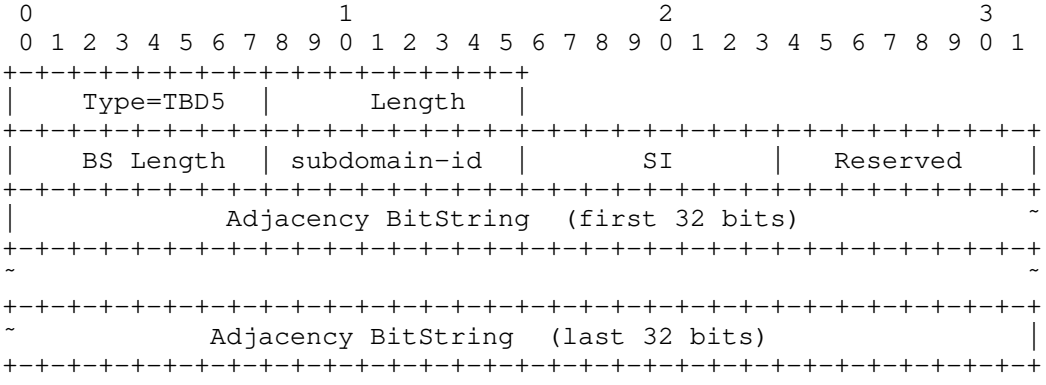

Figure 4

The format of the BIER-TE-RRO subobject is the same as that of the BIER-TE-ERO subobject, but without the L-Flag.

For the integrity of the protocol, we define a new BIER-TE-RRO object, but its actual value is consistent with ERO. The PCC reports an BIER-TE to a PCE by sending a PCRpt message with RRO object.

5. Procedures

5.1. Exchanging the BIER-TE Capability

A PCC indicates that it is capable of supporting the head-end functions for BIER-TE by including the BIER-TE-PCE-CAPABILITY sub-TLV in the Open message that it sends to a PCE. A PCE indicates that it is capable of computing BIER-TE by including the BIET-TE-PCE-CAPABILITY sub-TLV in the Open message that it sends to a PCC.

If a PCEP speaker receives a PATH-SETUP-TYPE-CAPABILITY TLV with a PST list containing PST=TBD2, and supports that path setup type, then it checks for the presence of the SR-PCE-CAPABILITY sub-TLV. If that sub-TLV is absent, then the PCEP speaker MUST send a PCErr message

with Error-Type = 10 ("Reception of an invalid object") and Error-value = TBD6("Missing PCE-BIER-TE-CAPABILITY sub-TLV") and MUST then close the PCEP session. If a PCEP speaker receives a PATH-SETUP-TYPE- CAPABILITY TLV with a BIER-TE-PCE-CAPABILITY sub-TLV, but the PST list does not contain PST=TBD2, then the PCEP speaker MUST ignore the BIER-TE-PCE-CAPABILITY sub-TLV.

5.2. BIER-TE-ERO Processing

If a PCC does not support the BIER-TE PCE Capability and thus cannot recognize the BIER-TE-ERO or BIER-TE-RRO subobjects,The ERO and BIER-TE-ERO subobject processing remains as per [RFC5440].

If a PCC receives an BIER-TE-ERO subobject in which either BitStringLength or Adjacency BitString or SI is absent, it MUST consider the entire BIER-TE-ERO subobject invalid and send a PCErr message with Error-Type = 10 ("Reception of an invalid object"), Error-Value = TBD7 ("BitStringLength is absent ") or Error-Value = TBD8 ("Adjacency BitString is absent")or Error-Value = TBD9("SI is absent").

If a PCC receives an BIER-TE-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 = TBD10 ("Invalid BitStringLength").

When a PCEP speaker detects that all subobjects of ERO are not of type TBD4, and if it does not handle such ERO, it MUST send a PCErr message with Error-Type = 10 ("Reception of an invalid object") and Error-Value = TBD11 ("Non-identical ERO subobjects")as per [RFC8664].

5.3. BIER-TE-RRO Processing

The syntax checking rules that apply to the BIER-TE-RRO subobject are identical to those of the BIER-TE-ERO subobject

The actual value of BIER-TE-RRO subobject is consistent with ERO. The PCC reports an BIER-TE to a PCE by sending a PCRpt message with RRO object.

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

vlaue	Meaning	Reference
TBD1	BIER-TE-PCE-CAPABILITY	This Document

6.1.2. New Path Setup Type

vlaue	Meaning	Reference
TBD2	Path is setup using BIER TE technique	This Document

6.1.3. Objective Functions

vlaue	Meaning	Reference
TBD3	Minimum Bit Sets (MBS)	This Document

6.1.4. BIER-TE-ERO and RRO Subobjects

This document defines a new subobject type for the PCEP explicit route object (ERO) and a new subobject type for the PCEP RRO.The code points for subobject types of these objects are maintained in the RSVP parameters registry, under the EXPLICIT_ROUTE and ROUTE_RECORD objects, respectively.

Object	Subobject	Subobject Type
EXPLICIT_ROUTE	BIER-TE-ERO (PCEP specific)	TBD4
ROUTE_RECORD	BIER-TE-RRO (PCEP specific)	TBD5

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	Error-value
10	Reception of an invalid object	
		TBD6: Missing PCE-BIER-TE-CAPABILITY subobjects
		TBD7: BitStringLength is absent
		TBD8: Adjacency BitString is absent
		TBD9: SI is absent
		TBD10: Invalid BitStringLength
		TBD11: Non-identical ERO subobjects

7. Security Considerations

The security considerations described in [RFC5440], [RFC8231], [RFC8281] and[RFC8408]are applicable to this specification. No additional security measures are required.

8. Acknowledgements

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