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BIER-TE Ping and Trace
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Abstract

Bit Index Explicit Replication (BIER)-TE shares architecture and packet formats with 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.

This document describes the mechanism and basic BIER-TE OAM packet format that can be used to perform Ping and Traceroute on the BIER-TE network.

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Table of Contents

1.	Introduction	2
2.	Conventions used in this document	3
3.	BIER-TE OAM Packet format	3
3.1.	Target FEC Stack	3
3.1.1.	BIER-TE forward-connected TLV	4
3.1.2.	BIER-TE local-decap sub-TLV	5
3.1.3.	BIER-TE forward-routed TLV	6
3.2.	Downstream Mapping TLV	6
3.2.1.	FEC Stack Change Sub-TLV	6
3.3.	Reply-To TLV	7
4.	BIER-TE OAM Processing	8
4.1.	Sending BIER Echo Request	8
4.2.	Receiving BIER Echo Request	9
4.3.	Sending Echo Reply	10
4.4.	Receiving Echo Reply	11
5.	Security Considerations	11
6.	IANA Considerations	12
6.1.	TLVs	12
6.2.	Target FEC Stack	12
6.3.	Downstream Detailed Mapping Sub-TLVs	12
7.	Normative references	12
	Authors' Addresses	14

[1.](#) Introduction

[I-D.ietf-bier-te-arch] introduces and explains BIER-TE architecture that provides policy-based multicast forwarding through a "BIER-TE domain" without requiring intermediate routers to maintain any multicast related per-flow state. 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.

This document describes the mechanism and the basic BIER-TE OAM packet format that can be used to perform Ping and Traceroute on the BIER-TE network.

This document enhances the BIER Ping and Traceroute, as defined in [I-D.ietf-bier-ping]. [RFC8296] defines a 4-bit field as "Proto" to identify the payload following BIER header. When the payload is

BIER-TE OAM, the "Proto" field is the same with the BIER OAM "Proto" field.

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. BIER-TE OAM Packet format

The BIER-TE OAM packet header format and the fields are the same as the BIER OAM header [[I-D.ietf-bier-ping](#)]. This document defines two new return codes and the new TLVs and Sub-TLVs.

The new Return codes are follows:

TBA1 Replying BFR is not in the path to any target BFER

TBA2 Mapping for this FEC is not the given BitPosition in BitString

The TLVs and Sub-TLVs requested by this document for IANA consideration are the following:

Type	value field
-----	-----
9	Target FEC Stack
10	Reply-To TLV

3.1. Target FEC Stack

A BIER-TE echo request MAY include the Target FEC Stack TLV that describes the FEC Stack being tested. If there aren't adjacency keyword information in BFIR, the FEC Stack MUST not be tested, and the Nil FEC MUST be used.

We define three new FEC Stack types. The Target FEC Stack is a list of sub-TLVs.

Sub-Type	Length	Value Field
-----	-----	-----
29	20 or 48 octets	BIER-TE forward-connected
30	8 or 10 octets	BIER-TE local-decap
31	4 or 6 octets	BIER-TE forward-routed

Local BFR assigns Local Interface ID for a link to which Adjacency ID is bound. This field is set to local link address (IPv4 or IPv6).

Remote Interface ID

Remote BFR assigns Remote Interface ID for a link to which Adjacency ID is bound. This field is set to remote link address (IPv4 or IPv6).

Advertising Node Identifier

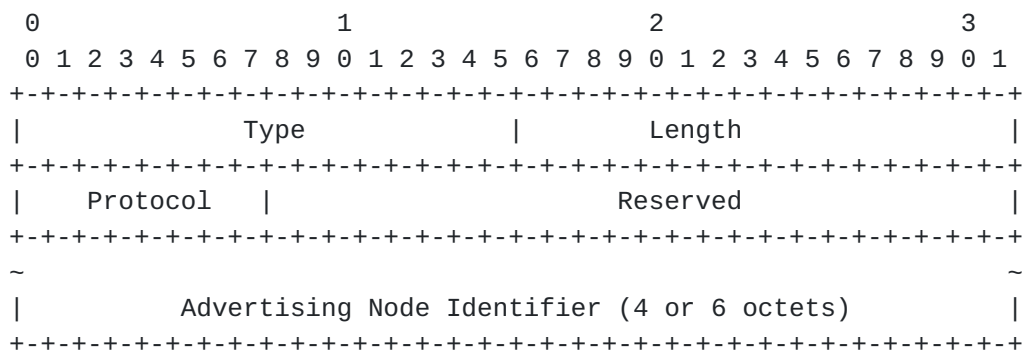
Advertising Node Identifier is the advertising node identifier. When Protocol is set to 1, then the 32 rightmost bits represent OSPF Router ID, and if Protocol is set to 2, this field carries 48 bit ISIS System ID.

Receiving Node Identifier

Receiving Node Identifier is the downstream node identifier. When Protocol is set to 1, then the 32 rightmost bits represent OSPF Router ID, and if Protocol is set to 2, this field carries 48 bit ISIS System ID.

3.1.2. BIER-TE local-decap sub-TLV

The format is as below:



Advertising Node Identifier

Advertising Node Identifier is the advertising node identifier. When Protocol is set to 1, then the 32 rightmost bits represent OSPF Router ID and if protocol is set to 2, this field carries 48 bit ISIS System ID.

The `ipv4` format is as below:

IPv4 Prefix: This field carries the IPv4 prefix.

The ipv6 format is as below:

IPv6 Prefix: This field carries the IPv6 prefix.

This TLV format is the same with the BIER OAM [[I-D.ietf-bier-ping](#)] and we a new Sub-TLV: FEC stack change Sub-TLV.

3.2.1. FEC Stack Change Sub-TLV

The format and the usage as defined in [\[RFC6424\]](#).

4. BIER-TE OAM Processing

BIER-TE OAM packet MUST be sent to BIER control plane for OAM processing if one of the following conditions is true:

- o The receiving BFR is a BFER.
- o TTL of BIER-MPLS Label expired.
- o Presence of Router Alert label in the label stack.

4.1. Sending BIER Echo Request

- o Message Type:1.
- o Return Code:0.
- o Proto:0.
- o Sender's Handle and Sequence number:The local matter to Initiator and SHOULD increment the Sequence number by 1 for every subsequent Echo Request.
- o QTF:Initiator's local timestamp format.
- o TimeStamp Sent:the time that the Echo Request is sent.
- o MUST include Original SI-BitString TLV.
- o In Ping mode, the Initiator MAY include Target SI-BitString TLV to control the responding BFER(s) by listing all local-decap Adjacency ID of the BFERs from which the Initiator expects a response. Initiator on receiving a reply with Return code as "Replying BFR is the only BFER in header Bitstring" or "Replying router is one of the BFER in header Bitstring", SHOULD remove the BFER's local-decap ID from Target SI-BitString for any subsequent Echo Request.
- o When the Reply mode is set to 2, Initiator MUST include Reply-To TLV in the Echo Request.
- o The Initiator MAY include Downstream Mapping TLV in the Echo Request to query additional information from transit BFRs and BFERs. In the case of ECMP discovery, Initiator MUST include the Multipath Entropy Data Sub-TLV and SHOULD set the Target SI-BitString TLV carrying a specific BFER's local-decap Adjacency ID.

- o The Initiator MUST encapsulate the OAM packet with BIER header and MUST set the Proto as 6 and further encapsulates with BIER-MPLS label. In ping mode, the BIER-MPLS Label TTL MUST be set to 255. In traceroute mode, the BIER-MPLS Label TTL is set successively starting from 1 and MUST stop sending the Echo Request if it receives a reply with Return code as "Replying router is the only BFER in BIER header Bitstring" from all BFER listed in Target SI-BitString TLV.
- o MUST PUSH the corresponding FEC to Target FEC stack, in the same with as the order of the adjacency's bit-position in the BitString.

4.2. Receiving BIER Echo Request

Reply-Flag: This flag is initially set to 1.

Interface-I: The incoming interface on which the Echo Request was received.

BIER-Label-L: The BIER-MPLS Label received as the top label on received Echo Request.

Header-H: The BIER header from the received Echo Request.

Best-return-code: contains the return code for the echo reply packet as currently best known.

If the received Echo Request carries Target SI-BitString TLV, a BFR SHOULD run boolean AND operation between BitString in Header-H and BitString in Target SI-BitString TLV.

If the resulting BitString is all-zero, Set Best-return-code to "Mapping for this FEC is not the given BitPosition in BitString" and Go to [section 4.3](#), Else:

- o If the BIER-Label-L does not correspond to the local label assigned for {sub-domain, BitStringLength, SI} in Original SIBitString TLV, Set the Best-return-code to "Set-Identifier Mismatch" and Go to [section 4.3](#).
- o If any of the TLVs in Echo Request message is not understood. Set the Best-return-code to "One or more of the TLVs was not understood" and Go to [section 4.3](#).
- o If the forwarding lookup defined in [section 6.5 of RFC8279](#) does not match any entry for the received BitString in BIER header.

Set the Best-return-code to "No matching entry in forwarding table" and Go to [section 4.3](#).

- o If any FEC which get from the matched BIFT entry is not consistent with the FEC get from the FEC stack at the same position as entry's BitPosition in Header-H, Set the Best-return-code to "Mapping for this FEC is not the given BitPosition in BitString" and Go to [section 4.3](#).
- o If the DSMAP TLV carries Multipath Entropy Data Sub-TLV and if the BitString in Header-H carries more than one forward routed adjacency and each matches the BIFT entry. Set the Best-return-code to "Invalid Multipath Info Request" and Go to [section 4.3](#). Else, list the ECMP downstream neighbors to reach forward routed adjacency, calculate the Entropy considering the BitString in Header-H and Multipath Entropy Data Sub-TLV from received Echo Request. Set the Best-return-code to 5 (Packet-Forward-Success).
- o For all the forward-connected adjacencies and all the local-decap adjacencies which match the BIFT entry, FEC Change sub-TLV SHOULD be carried in DSMAP TLV and set the operation type filed in the FEC change sub-TLV to remove.
- o For all the forward-routed adjacencies which match the BIFT entry, if the BIFT entry indicates that not the local decapsulation but continue forwarding the OAM packet, FEC change sub-TLV SHOULD NOT be carried in DSMAP TLV. If the BIFT entry indicate that the local decapsulation the OAM packet, FEC change sub-TLV SHOULD be carried in DSMAP TLV, and set the operation type filed in the FEC change sub-TLV to remove.
- o If the responder is BFER which matches the local-decap BIFT, and there are no more bits in BIER header BitString left for forwarding. Set the Best-return-code to "Replying router is the only BFER in BIER header BitString", and go to [section 4.3](#).
- o If the responder is BFER which match the local-decap BIFT, and there are more bits in the BitString left for forwarding. Set the Best-return-code to "Replying router is one of the BFER in BIER header BitString", and go to [section 4.3](#).

[4.3](#). Sending Echo Reply

- o Message Type:2.
- o Return Code:Best-return-code.
- o The Proto :0.

- o When the Best-return-code is "Replying BFR is one of the BFER in header BitString", it MUST include Responder BFER TLV.
- o If the received Echo Request had DSMAP with Multipath Entropy Data Sub-TLV, Responder BFR MUST include DSMAP for each outgoing interface over which the packet will be replicated and include the respective Multipath Entropy Data Sub-TLV.
- o If the received Echo Request had DSMAP without Multipath Entropy Data Sub-TLV, Responder BFR MUST include DSMAP for each outgoing interface over which the packet will be replicated.
- o When the Best-return-code is "Replying BFR is the only BFER in header BitString", it MUST include Responder BFER TLV.
- o When the Reply mode in received Echo Request is set to " Reply via BIER packet", Responder appends BIER header listing the BitString with the BFIR's local-decap id and set the Proto to "OAM" and set the BFIR value to 0.
- o When the Reply mode in received Echo Request is set to "Reply via IPv4/IPv6 UDP packet", Responder encapsulates with IP/UDP header. The UDP destination port MUST be set to TBD1 and source port MAY be randomly selected from the dynamic range of port numbers. The source IP is any local address of the responder and destination IP is derived from Reply-To TLV.

4.4. Receiving Echo Reply

- o Initiator on receiving Echo Reply will use the Sender's Handle to match with Echo Request sent. If no match is found, Initiator MUST ignore the Echo Reply.
- o If receiving Echo Reply have Downstream Mapping, Initiator SHOULD copy the same to subsequent Echo Request(s).
- o If one of the Echo Reply is received with Return Code as "Replying BFR is one of the BFER in header BitString", it SHOULD remove the BFER's local-decap ID from Target SI-BitString for any subsequent Echo Request.

5. Security Considerations

TBD.

6. IANA Considerations

This document request UDP port TBD1 to be allocated by IANA for BIER-TE Echo.

This document request the IANA for creation and management of below registries and sub-registries:

Return codes defined in this document are the following:

Value	value Meaning
-----	-----
10	Replying BFR is not in the path to any target BFER
11	Mapping for this FEC is not the given BitPosition in BitString

6.1. TLVs

The TLVs and Sub-TLVs requested by this document for IANA consideration are the following:

6.2. Target FEC Stack

Sub-Type	Value Field
-----	-----
29	BIER-TE forward-connected
30	BIER-TE local-decap
31	BIER-TE forward-routed

6.3. Downstream Detailed Mapping Sub-TLVs

This section defines the optional Sub-TLVs that can be included in Downstream Mapping TLV.

Sub-TLV Type	Value
-----	-----
3	FEC stack change

7. Normative references

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