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**BIER BFD**

## Abstract

   Point to multipoint (P2MP) BFD is designed to verify multipoint
   connectivity. This document specifies the application of P2MP BFD in
   BIER network.

## Status of This Memo

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1.  Introduction

Bit Index Explicit Replication (BIER) [RFC8279] provides the
forwarding of multicast data packets through a multicast domain. It
does so without requiring any explicit tree-building protocol and
without requiring intermediate nodes to maintain any per-flow state.

[RFC8562] defines a method of using Bidirectional Forwarding
Detection (BFD) to monitor and detect unicast failures between the
sender (head) and one or more receivers (tails) in multipoint or
multicast networks. [RFC8563] describes active tail extensions to
the BFD protocol for multipoint networks.

This document describes the procedures for using such mode of BFD
protocol to monitor connectivity between a multipoint sender, Bit-
Forwarding Ingress Router (BFIR), and a set of one or more
multipoint receivers, Bit-Forwarding Egress Routers (BFERs). The
BIER BFD only supports the unidirectional multicast. This document
defines the use of P2MP BFD as per [RFC8562], and active tail as
per [RFC8563] for BIER-specific domain.

## 2.  Conventions used in this document

### 2.1.  Terminology

This document uses the acronyms defined in [RFC8279] along with the following:

BFD: Bidirectional Forwarding Detection.

OAM: Operations, Administration, and Maintenance.

P2MP: Point to Multi-Point.

### 2.2.  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.  BIER BFD Encapsulation

BIER BFD encapsulation uses the BIER OAM packet format defined in [I-D.ietf-bier-ping]. The value of the Message Type field MUST be set to BIER BFD (TBD1 will be assigned by IANA Section 9.1). BFD Control packet, defined in Section 4 [RFC5880], immediately follows the BIER OAM header. The operation of Multipoint BFD with the BFD Control Packet is described in [RFC8562].

## 4.  BIER BFD Session Bootstrapping

As defined in [RFC8562], a BIER BFD session MAY be established to monitor the state of the multipoint path. The BIER BFD session could be created for each multipoint path and the set of BFERs over which the BFIR is requested to run BIER BFD. The BFIR MUST advertise the multipoint path and the value of My Discriminator associated with the path to the set of BFERs. Bootstrapping a BIER BFD session MAY use BIER OAM message Section 4.1 or the control plane Section 4.2.

The BIER BFD bootstrapping MUST be repeated when the value of this discriminator being changed.

### 4.1.  BIER OAM Bootstrapping

The BIER OAM could be used for bootstrapping the BIER BFD session. The BFIR sends the BIER OAM Echo request message carrying a BFD discriminator TLV which immediately follows the Target SI-Bitstring TLV (section 3.3.2 [I-D.ietf-bier-ping]).

The Target SI-Bitstring TLV MUST be used to carry the set of BFER information (including Sub-domain-id, Set ID, BS Len, Bitstring) for the purpose of the session establishment.

Figure 1 displays the format of BFD Discriminator TLV.

```
 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 = TBD2          |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        My Discriminator                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: BFD Discriminator TLV

where:

  *Type indicates BFD Discriminator TLV. The value (TBD2) is to be
   allocated by IANA (Section 9.2).

  *Length MUST be set to 4.

  *My Discriminator - four-octet long field. The value is the local
   discriminator generated by BFIR for this session. This
   discriminator MUST be used as the My Discriminator field n the
   BIER BFD Control packets sent by the BFIR.

## 4.2.  IGP Protocol Bootstrapping

An alternative option to bootstrap the BIER BFD is to advertise the
BFD information in the control plane. This document defines a new
BIER BFD Sub-sub-TLV carried in IGP protocol including IS-IS and
OSPF.

The BFIR generates the My Discriminator value for each multicast
flow and advertises it to the expecting BFERs, which is indicated by
the Bitstring and the BIFT-id, which is carried in BIER BFD sub-sub-
TLV. The corresponding BFERs SHOULD store the My Discriminator value
for packet Demultiplexing.

### 4.2.1.  IS-IS Extension for BIER BFD

The new BIER BFD Sub-sub-TLV is carried within the BIER Info sub-TLV
defined in [RFC8401]. The format is displayed in Figure 2.

```
 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 = TBD3  |    Length     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       My Discriminator                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     RESERVED          |              BIFT-id                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  BitString  (first 32 bits)                   ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                  BitString  (last 32 bits)                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: BIER BFD Sub-sub-TLV for IS-IS Extension

where:

   *Type indicates BIER BFD sub-sub-TLV. The value (TBD3) is to be
    allocated by IANA (Section 9.3).

   *Length is a two-octet field. The value is the length of the BIER
    BFD Sub-sub-TLV for IS-IS extension, in octets

   *My Discriminator is a four-octet long field. The value is a
    unique, nonzero discriminator value generated by BFIR for each
    multipoint path. This discriminator MUST be used as the My
    Discriminator field n the BIER BFD Control packets sent by the
    BFIR.

   *BIFT-id is a two-octet field. The value represents a particular
    Bit Index Forwarding Table (BIFT) as per [RFC8279].

   *BitString field carries the set of BFR-IDs of BFER(s) that the
    BFIR expects to establish the BIER BFD session.

### 4.2.2.  OSPF Extension for BIER BFD

The new BIER BFD Sub-TLV is a sub-TLV of the BIER Sub-TLV defined in
[RFC8444]. The format is displayed in Figure 3.

```
    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 = TBD4           |              Length           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     My Discriminator                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      RESERVED        |              BIFT-id                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                 BitString  (first 32 bits)                   ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ~                                                              ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ~                 BitString  (last 32 bits)                    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

               Figure 3: BIER BFD Sub-TLV for OSPF extension


            Figure 3: BIER BFD Sub-sub-TLV for IS-IS Extension

   where:

     *Type indicates BIER BFD sub-TLV. The value (TBD4) is to be
      allocated by IANA (Section 9.4).

     *Length is a two-octet field. The value is the length of the BIER
      BFD sub-TLV for OSPF extension, in octets

     *My Discriminator is a four-octet long field. The value is a
      unique, nonzero discriminator value generated by BFIR for each
      multipoint path. This discriminator MUST be used as the My
      Discriminator field n the BIER BFD Control packets sent by the
      BFIR.

     *BIFT-id is a two-octet field. The value represents a particular
      Bit Index Forwarding Table (BIFT) as per [RFC8279].

     *BitString field carries the set of BFR-IDs of BFER(s) that the
      BFIR expects to establish the BIER BFD session.

## 5.  Discriminators and Packet Demultiplexing

   As defined in [RFC8562], the BFIR sends BFD Control packets to the
   set of BFERs over the multipoint path via the BIER BFD session with
   My Discriminator is set to the value assigned by the BFIR, and the
   value of the Your Discriminator is set to zero. The set of BFERs
   MUST demultiplex BFD packets based on a combination of the source
   address, My Discriminator value. The source address is BFIR-id and
   BIER MPLS Label (MPLS network) or BFIR-id and BIFT-id (Non-MPLS
```

network) for BIER BFD. My Discriminator value is advertised in BIER
BFD bootstrapping using one of the options described in Section 4.

## 6.  Active Tail in BIER BFD

[RFC8563] defined an extension for Multipoint BFD, which allows the
head to discover the state of a multicast distribution tree for any
sub-set of tails. For BIER BFD in the active tail mode, the BFIR may
learn the state and connectivity of the BFERs by allowing the BFERs
to notify the BFIR. As per [RFC8563] provides detailed information
on how the BFIR can use multipoint Poll sequence message or a
combination of multicast and unicast Poll sequence messages to
determine the state of the multicast tree. Also, [RFC8563] describes
that a BFER can transmit an unsolicited unicast Poll sequence
message to the BFIR (note that a unicast message must be sent over a
path which is disjoint from the multicast distribution tree).

## 6.1.  Unsolicited Head Notification Mode

[I-D.ietf-mpls-p2mp-bfd] provides detailed information on using the
unsolicited notification method for P2MP MPLS LSP, which is also
applicable to BIER.

In Section 5.2.1 [RFC8563] is noted that "the tail sends unsolicited
BFD packets in response to the detection of a multipoint path
failure" but without the specifics on the information in the packet
and frequency of transmissions. This document defines the procedure
of the active tail with unsolicited notifications for BIER as
specified below.

Upon detecting the failure, a BFER sends a BFD control packet with
the following settings:

  *the Poll (P) bit is set;

  *the Status (Sta) field is set to Down value;

  *the Diagnostic (Diag) field is set to Control Detection Time
   Expired value;

  *the value of the Your Discriminator field is set to the value the
   BFER has been used to demultiplex that BFD multipoint session;

  *BFD Control packet is encapsulated in IP/UDP with the destination
   IP address of the BFIR and the UDP destination port number set to
   4784 per [RFC5883]

  *the BFD Control packets are transmitted at the rate of one per
   second until either the BFER receives valid for this BFD session

control packet with the Final (F) bit is set from the BFIR or the
defect condition clears.

To improve the likelihood of notifying the BFIR of the failure, the
BFER SHOULD transmit three BFD Control packets defined above in
short succession.

A BFIR that has received the BFD Control packet, as described above,
sends the unicast IP/UDP encapsulated BFD control packet with the
Final (F) bit set to the BFER.

## 7.  Security Considerations

For BIER OAM packet processing security considerations, see [I-
D.ietf-bier-ping].

For general multipoint BFD security considerations, see [RFC8562].

No additional security issues are raised in this document beyond
those that exist in the referenced BFD documents.

## 8.  Acknowledgements

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## 9.  IANA Considerations

## 9.1.  BIER OAM Message Type

IANA is requested to assign a new type from the BIER OAM Message
Type registry as follows:

| Value | Description | Reference |
|-------|-------------|-----------|
| TBD1  | BIER BFD    | [this document] |

Table 1

## 9.2.  BFD Discriminator TLV

IANA is requested to assign a new type from the BIER OAM TLV
registry as follows:

| Value | Description | Reference |
|-------|-------------|-----------|
| TBD2  | BFD discriminator TLV | [this document] |

Table 2

## 9.3.  BIER BFD Sub-sub-TLV

IANA is requested to assign a new BIER BFD Sub-sub-TLV within the
BIER Info sub-TLV registry is defined in [RFC8401] as follows:

| Value | Description | Reference |
|-------|-------------|-----------|
| TBD3 | BIER BFD Sub-sub-TLV | [this document] |

Table 3

## 9.4. BIER BFD Sub-TLV

IANA is requested to assign a new BIER BFD Sub-TLV from the BIER
Sub-TLV registry is defined in [RFC8444] as follows:

| Value | Description | Reference |
|-------|-------------|-----------|
| TBD4 | BIER BFD Sub-TLV | [this document] |

Table 4

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