

Internet Engineering Task Force  
Internet-Draft  
Updates: [8296](#) (if approved)  
Intended status: Standards Track  
Expires: 4 August 2022

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31 January 2022

LSR Extensions for BIER over Ethernet  
draft-ietf-bier-lsr-ethernet-extensions-03

## Abstract

Bit Index Explicit Replication (BIER) is an architecture that provides multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain multicast related per-flow state. BIER can be supported in MPLS and non-MPLS networks.

This document specifies the required extensions to the IS-IS, OSPFv2 and OSPFv3 protocols for supporting BIER in non-MPLS networks using BIER in Ethernet encapsulation.

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## [1.](#) Introduction

Bit Index Explicit Replication (BIER) [[RFC8279](#)] is an architecture that provides multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain multicast related per-flow state. BIER can be supported in MPLS and non-MPLS networks.

[[RFC8296](#)] specifies a common BIER header format for both MPLS and non-MPLS networks, though the first 20-bits of the BIER header (referred as BIFT-id) is a "MPLS Label" in case of MPLS networks and is a "domain-wide-unique-value" representing the combination of SD-BSL-SI in case of non-MPLS networks.

[[I-D.ietf-bier-non-mpls-bift-encoding](#)] specifies two optional ways of statically assigning domain-wide-unique mapping between BIFT-id's and

SD-BSL-SI combination.

However, BIER architecture [[RFC8279](#)] does not require domain-wide-unique BIFT-id's to be used (even for non-MPLS encapsulation). As discussed in [[I-D.zzhang-bier-rift](#)], the BIFT-id in case of non-MPLS

encapsulation can also just be a local 20-bit opaque value and signaled just like in MPLS case. This document updates [section 2.2.1.1 of \[RFC8296\]](#) that the BIFT-id for a SD-BSL-SI in case of non-MPLS encapsulation need not be unique through out the BIER domain. In such a case when the BIFT-id is not unique, the BIFT-id in the packet is expected to change as the packet travels.

As an example, suppose a particular BIER domain contains a SD (SD 0), supports two BSLs (256 and 512), and contains 1024 BFRs. A BFR that is provisioned for above SD, and that supports both BSLs, could advertise the following set of BIFT-id's:

BIFT-id 1: corresponding to SD 0, BSL 256, SI 0.

BIFT-id 2: corresponding to SD 0, BSL 256, SI 1.

BIFT-id 3: corresponding to SD 0, BSL 256, SI 2.

BIFT-id 4: corresponding to SD 0, BSL 256, SI 3.

BIFT-id 5: corresponding to SD 0, BSL 512, SI 0.

BIFT-id 6: corresponding to SD 0, BSL 512, SI 1.

Notice that the example uses ranges of continuous BIFT-id's:

BIFT-id range [1 to 4] correspond to <SD 0, BSL 256>. The first BIFT-id in the range correspond to SI=0, the second correspond to SI=1, and so on.

BIFT-id range [5 to 6] correspond to <SD 0, BSL 512>. The first BIFT-id in the range correspond to SI=0, the second correspond to SI=1.

Strictly speaking, using contiguous range is not required, but it is done for the purpose of simplified signaling similar to MPLS label

blocks (notice that locally assigning BIFT-id ranges requires no manual processing just like in the case of MPLS label block allocation).

Processing and forwarding of BIER packets requires special software and hardware capabilities. The BFRs supporting a BIER encapsulation type MUST advertise this capability (along with the other required parameters specific to the encapsulation) to the other routers in BIER domain. This advertisement, for example, will enable the other BFRs in the BIER domain in deciding, whether to include or exclude the advertising router from the BAR and/or IPA algorithm while computing the multicast path for a specific encapsulation type.

[[RFC8401](#)], [[RFC8444](#)] and [[I-D.ietf-bier-ospfv3-extensions](#)] specifies the required extensions to the IS-IS [[RFC1195](#)], OSPFv2 [[RFC2328](#)] and OSPFv3 [[RFC8362](#)] protocols respectively for the distribution of BIER sub-domain information including the Sub-sub-TLV required to support BIER in MPLS encapsulation for MPLS networks.

This document specifies the required extensions to the IS-IS [[RFC1195](#)], OSPFv2 [[RFC2328](#)] and OSPFv3 [[RFC8362](#)] protocols for supporting BIER using BIER in Ethernet encapsulation with dynamically and locally assigned BIFT-id's.

Support for other encapsulation types are outside the scope of this document.

## [2.](#) Terminology

Some of the terminology specified in [[RFC8279](#)] is replicated here and extended by necessary definitions:

**BIER:** Bit Index Explicit Replication

(The overall architecture of forwarding multicast using a Bit Position).

**BIER-MPLS:** BIER in MPLS encapsulation.

(Encapsulation of BIER header inside MPLS header in MPLS networks).

BIER-ETH: BIER in Ethernet encapsulation.

(Encapsulation of BIER header inside Ethernet header  
(EtherType=0xAB37) in non-MPLS networks).

BFR: Bit Forwarding Router (A router that participates in Bit Index  
Multipoint Forwarding). A BFR is identified by a unique BFR-  
prefix in a BIER domain.

BIFT: Bit Index Forwarding Table used to forward the BIER packets in  
a domain.

BAR: BIER Algorithm. Used to calculate underlay nexthops  
as defined by the BAR value.

IPA: IGP Algorithm. May be used to modify, enhance or replace the

calculation of underlay paths as defined by the BAR value

SD: BIER sub-domain

## [2.1.](#) 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.](#) Specification

A BIER sub-domain MAY support multiple BIER encapsulation types like  
BIER-MPLS, BIER-ETH. The different encapsulation types supported by  
a BFR in a sub-domain MUST share the same BFR-id. This would allow  
the BFR's in transit to translate the encapsulation from one type to  
the other while forwarding the packet in the BIER sub-domain.

When a BFIR/BFR supports multiple BIER encapsulation types, when  
sending to a BIER neighbor it MUST use a type that the neighbor also

supports. If the neighbor also supports more than one encapsulation type that this BFIR/BFR supports, the type selection could be a matter of local policy and is outside the scope of this document.

### 3.1. IS-IS BIER Ethernet Encapsulation Sub-sub TLV

BIER Info sub-TLV defined in [RFC8401] is used to advertise the sub-domain id, and other associated parameters of the sub-domain like BFR-id, MT, BAR, IPA.

This document introduces new sub-sub-TLV under BIER Info sub-TLV to advertise the ethernet encapsulation capability and other associated parameters of the encapsulation.

This sub-sub-TLV carries the information for the BIER Ethernet encapsulation including the BitString length supported for a certain <MT,SD> pair.

It is advertised within the BIER Info sub-TLV defined in [RFC8401] which in-turn is carried within the TLVs 235, 237 [RFC5120] or TLVs 135 [RFC5305], or TLV 236 [RFC5308].

This sub-sub-TLV MAY appear multiple times within a single BIER Info sub-TLV. If the same BitString length is repeated in multiple BIER Ethernet encapsulation sub-sub-TLVs inside the same BIER Info sub-TLV, the BIER Info sub-TLV MUST be ignored.

```

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   |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   Max SI   |BS Len |               BIFT-id               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Type: TBD1 (To be assigned by IANA).

Length: 4

Max SI: A 1 octet field encoding the Maximum Set Identifier

([Section 1 of \[RFC8279\]](#)) used in the encapsulation for this BIER subdomain for this BitString length. The first BIFT-id is for SI=0, the second BIFT-id is for SI=1, etc. If the BIFT-id associated with the Maximum Set Identifier exceeds the 20-bit range, the sub-sub-TLV MUST be ignored.

Local BitString Length (BS Len): A 4 bit field encoding the bitstring length (as per [\[RFC8296\]](#)) supported for the encapsulation.

BIFT-id: A 20 bit field encoding the first BIFT-id of the BIFT-id range.

The "BIFT-id range" is the set of 20-bit values beginning with the BIFT-id and ending with (BIFT-id + (Max SI)). These BIFT-id's are used for BIER forwarding as described in [\[RFC8279\]](#) and [\[RFC8296\]](#).

The size of the BIFT-id range is determined by the number of SI's ([Section 1 of \[RFC8279\]](#)) that are used in the network. Each SI maps to a single BIFT-id in the BIFT-id range: the first BIFT-id is for SI=0, the second BIFT-id is for SI=1, etc.

If the BIFT-id associated with the Maximum Set Identifier exceeds the 20-bit range, the BIER Ethernet Encapsulation Sub-sub-TLV containing the error MUST be ignored.

BIFT-id ranges within all the BIER Ethernet Encapsulation sub-sub-TLVs advertised by the same BFR MUST NOT overlap. If the overlap is detected, the advertising router MUST be treated as if it did not advertise any BIER Ethernet encapsulation sub-sub-TLVs. However the BIFT-id ranges may overlap across different encapsulation types and is allowed. As an example, the BIFT-id value in the Ethernet encapsulation sub-sub-TLV may overlap with the Label value in the Label range in BIER MPLS encapsulation sub-sub-TLV ([\[RFC8401\]](#)) and is allowed.

### [3.2.](#) OSPFv2 BIER Ethernet Encapsulation Sub-TLV

BIER Sub-TLV defined in [\[RFC8444\]](#) is used to advertise the sub-domain id, and other associated parameters of the sub-domain like BFR-id, MT, BAR, IPA.

This document introduces new Sub-TLV under BIER Sub-TLV to advertise the ethernet encapsulation capability and other associated parameters





ignored.

The "BIFT-id range" is the set of 20-bit values beginning with the BIFT-id and ending with (BIFT-id + (Max SI)). These BIFT-id's are used for BIER forwarding as described in [[RFC8279](#)] and [[RFC8296](#)].

The size of the BIFT-id range is determined by the number of SI's ([Section 1 of \[RFC8279\]](#)) that are used in the network. Each SI maps to a single BIFT-id in the BIFT-id range: the first BIFT-id is for SI=0, the second BIFT-id is for SI=1, etc.

If the BIFT-id associated with the Maximum Set Identifier exceeds the 20-bit range, the BIER Ethernet Encapsulation Sub-sub-TLV containing the error MUST be ignored.

BIFT-id ranges within all the BIER Ethernet Encapsulation sub-sub-TLVs advertised by the same BFR MUST NOT overlap. If the overlap is detected, the advertising router MUST be treated as if it did not advertise any BIER Ethernet encapsulation sub-sub-TLVs. However the BIFT-id ranges may overlap across different encapsulation types and is allowed. As an example, the BIFT-id value in the Ethernet encapsulation sub-sub-TLV may overlap with the Label value in the Label range in BIER MPLS encapsulation sub-sub-TLV ([\[RFC8444\]](#)) and is allowed.

Local BitString Length (BS Len): A 4 bit field encoding the bitstring length (as per [[RFC8296](#)]) supported for the encapsulation.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

### [3.3.](#) OSPFv3 BIER Ethernet Encapsulation Sub-TLV

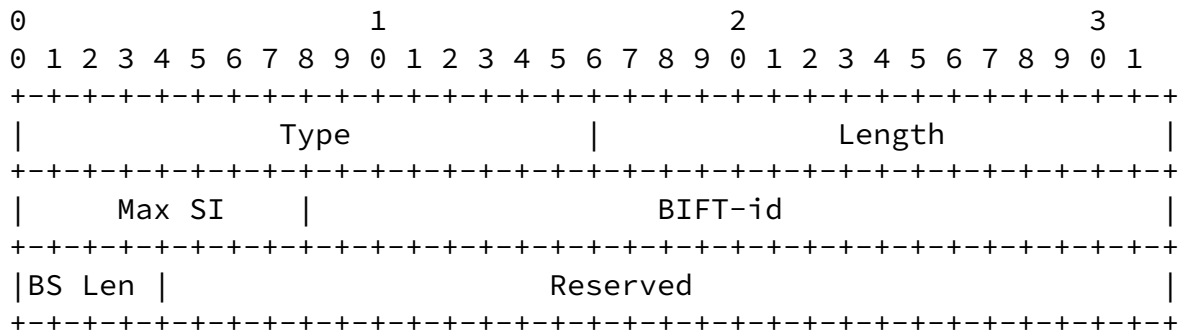
BIER Sub-TLV defined in [[I-D.ietf-bier-ospfv3-extensions](#)] is used to advertise the sub-domain id, and other associated parameters of the sub-domain like BFR-id, MT, BAR, IPA.

This document introduces new Sub-TLV under BIER Sub-TLV to advertise the ethernet encapsulation capability and other associated parameters of the encapsulation.

This Sub-TLV carries the information for the BIER Ethernet encapsulation including the BitString length supported for a certain <MT,SD> pair.

It is advertised within the BIER Sub-TLV defined in [[I-D.ietf-bier-non-mpls-bift-encoding](#)] which in-turn is carried within the Intra-Area-Prefix TLV or Inter-Area-Prefix TLV in OSPFv2 Extended LSA TLV defined in [[RFC8362](#)].

This Sub-TLV MAY appear multiple times within a single BIER Sub-TLV. If the same BitString length is repeated in multiple BIER Ethernet encapsulation Sub-TLVs inside the same BIER Sub-TLV, the BIER Sub-TLV MUST be ignored.



Type: TBD3 (To be assigned by IANA).

Length: 8

Max SI: A 1 octet field encoding the Maximum Set Identifier ([Section 1 of \[RFC8279\]](#)) used in the encapsulation for this BIER subdomain for this BitString length. The first BIFT-id is for SI=0, the second BIFT-id is for SI=1, etc. If the BIFT-id associated with the Maximum Set Identifier exceeds the 20-bit range, the sub-sub-TLV MUST be ignored.

BIFT-id: A 3-octet field, where the 20 rightmost bits represent the first BIFT-id in the BIFT-id range. The 4 leftmost bits MUST be ignored.

The "BIFT-id range" is the set of 20-bit values beginning with the BIFT-id and ending with (BIFT-id + (Max SI)). These BIFT-id's are used for BIER forwarding as described in [\[RFC8279\]](#) and [\[RFC8296\]](#).

The size of the BIFT-id range is determined by the number of SI's ([Section 1 of \[RFC8279\]](#)) that are used in the network. Each SI maps to a single BIFT-id in the BIFT-id range: the first BIFT-id is for SI=0, the second BIFT-id is for SI=1, etc.

If the BIFT-id associated with the Maximum Set Identifier exceeds the 20-bit range, the BIER Ethernet Encapsulation Sub-sub-TLV containing the error MUST be ignored.

BIFT-id ranges within all the BIER Ethernet Encapsulation sub-sub-

TLVs advertised by the same BFR MUST NOT overlap. If the overlap is detected, the advertising router MUST be treated as if it did not advertise any BIER Ethernet encapsulation sub-sub-TLVs. However the BIFT-id ranges may overlap across different encapsulation types and is allowed. As an example, the BIFT-id value in the Ethernet encapsulation sub-sub-TLV may overlap with the Label value in the Label range in BIER MPLS encapsulation sub-sub-TLV ([\[I-D.ietf-bier-non-mpls-bift-encoding\]](#)) and is allowed.

Local BitString Length (BS Len): A 4 bit field encoding the bitstring length (as per [\[RFC8296\]](#)) supported for the encapsulation.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

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

Security concerns for IS-IS are addressed in [\[RFC5304\]](#) and [\[RFC5310\]](#) and the security concerns for IS-IS extensions for BIER are addressed in [\[RFC8401\]](#). This document introduces new sub-sub-TLV for the already existing IS-IS TLVs defined for distributing the BIER sub-domain information in [\[RFC8401\]](#). It does not introduce any new security risks to IS-IS.

Security concerns and required extensions for OSPFv2 are addressed in [\[RFC2328\]](#) and [\[RFC7684\]](#) and the security concerns for OSPFv2 extensions for BIER are addressed in [\[RFC8444\]](#). This document introduces new Sub-TLV for the already existing OSPFv2 TLV defined for distributing the BIER sub-domain information in [\[RFC8444\]](#). It does not introduce any new security risks to OSPFv2.

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

The document requests new allocations from the IANA registries as follows

##### [5.1.](#) IS-IS sub-sub-TLVs for BIER Info sub-TLV Registry

BIER Ethernet Encapsulation sub-sub-TLV: TBD1 (suggested value 2)

## [5.2.](#) OSPFv2 Extended Prefix TLV Sub-TLVs Registry

BIER Ethernet Encapsulation Sub-TLV: TBD2 (suggested value 11)

## [5.3.](#) OSPFv3 Extended LSA Sub-TLVs Registry

BIER Ethernet Encapsulation Sub-TLV: TBD3 (suggested value 11)

## [6.](#) Acknowledgments

The author wants to thank Antonie Przygienda for his comments and suggestions.

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