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LSR Extensions for BIER non-MPLS Encapsulation

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 non-MPLS 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 specific forwarding state, while not per-flow, are maintained in Bit Index Forwarding Tables (BIFTs) and used to forward BIER-encapsulated packets.

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 (referred to as BIFT-id) of the BIER header is an "MPLS Label" in case of MPLS networks and is a "domain-wide unique value" in case of non-MPLS networks. It identifies the BIFT used to forwarding the packet. [[I-D.ietf-bier-non-mpls-bift-encoding](#)] specifies two optional ways of statically assigning domain-wide unique BIFT-id's.

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.

As an example, suppose a particular BIER domain contains a Sub-Domain (SD) 0, supports two BitStringLengths (BSLs - 256 and 512), and contains 1024 BIER Forwarding Egress Routers (BFERs). Because the number of BFERs is larger than the BSL, the BFERs are grouped into different sets, and multiple copies of a packet may need to be sent by an BIER Forwarding Ingress Router (BFIR) - one for each set. Each set has a Set Identifier (SI), and one BIFT is needed for each <SD, BSL, SI>. A BIER Forwarding Router (BFR) that is provisioned for the 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 required parameters specific to the encapsulation to the other routers in BIER domain. This advertisements are used by other BFRs to calculate the BIFTs 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-TLVs required to support BIER in MPLS encapsulation for MPLS networks.

This document specifies the required similar extensions to the IS-IS [RFC1195], OSPFv2 [RFC2328] and OSPFv3 [RFC8362] protocols for supporting BIER non-MPLS encapsulation with dynamically and locally assigned BIFT-id's.

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. Specification

This document updates section 2.2.1.1 of [RFC8296] that the BIFT-id in case of non-MPLS encapsulation need not be unique throughout the BIER domain and can change as the packet travels.

A BIER sub-domain MAY use both MPLS and non-MPLS BIER encapsulation. The assignment of BFR-id in a sub-domain is independent of the encapsulation type. This allows this same bit string to be used regardless of the encapsulation types used to reach BFERs.

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.

The procedures in [RFC8401] and [RFC8444] apply to non-MPLS encapsulation, except the encoding and procedure differences specified below.

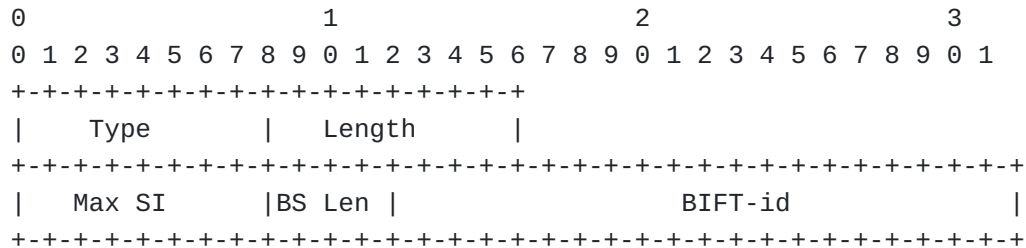
3.1. IS-IS BIER non-MPLS Encapsulation Sub-sub TLV

As specified in [RFC8401] and updated in [I-D.ietf-bier-bar-ipa], BIER Info sub-TLV is used to advertise BIER information except that its MPLS Encapsulation sub-sub-TLV is replaced with a new non-MPLS Encapsulation sub-sub-TLV specified as following.

The BIER Info sub-TLV is carried within the TLVs 235, 237 [RFC5120] or TLVs 135 [RFC5305], or TLV 236 [RFC5308]. Its non-MPLS Encapsulation sub-sub-TLV carries the information for the BIER non-MPLS encapsulation and is very similar to the MPLS Encapsulation sub-sub-TLV.

When a prefix reachability advertisement is leaked between levels, if it has a BIER sub-TLV with non-zero BFR-id the BIER sub-TLV MUST be included but its non-MPLS Encapsulation sub-sub-TLV MAY be omitted.

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



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 non-MPLS Encapsulation Sub-sub-TLV containing the error **MUST** be ignored.

BIFT-id ranges within all the BIER non-MPLS 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 non-MPLS 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 non-MPLS 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 non-MPLS Encapsulation Sub-TLV

As specified in [RFC8444] and updated in [I-D.ietf-bier-bar-ipa], BIER Sub-TLV is used to advertise BIER information except that its MPLS Encapsulation sub-TLV is replaced with a new non-MPLS Encapsulation sub-TLV specified as following.

The BIER sub-TLV [RFC8444] is carried within the OSPFv2 Extended Prefix TLV [RFC7684]. Its non-MPLS Encapsulation sub-TLV carries information for the BIER non-MPLS encapsulation, and is very similar to MPLS Encapsulation sub-TLV.

When a prefix reachability is re-advertised into other areas, if it has a BIER sub-TLVs with a non-zero BFR-id the BIER sub-TLV MUST be included but its non-MPLS Encapsulation sub-TLV MAY be omitted.

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

[illegible]

Type: TBD2 (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 non-MPLS Encapsulation Sub-sub-TLV containing the error MUST be ignored.

BIFT-id ranges within all the BIER non-MPLS 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 non-MPLS 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 non-MPLS 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 non-MPLS Encapsulation Sub-TLV

As specified in [I-D.ietf-bier-ospfv3-extensions], BIER Sub-TLV is used to advertise BIER information except that its MPLS

Encapsulation sub-TLV is replaced with a new non-MPLS encapsulation sub-TLV specified as following.

The BIER Sub-TLV is carried within the Intra-Area-Prefix TLV or Inter-Area-Prefix TLV in OSPFv3 Extended LSA TLV defined in [\[RFC8362\]](#). its non-MPLS Encapsulation Sub-TLV carries information for the BIER non-MPLS encapsulation, and is very similar to the MPLS Encapsulation sub-TLV.

When a prefix reachability is re-advertised into other areas, if it has a BIER sub-TLVs with a non-zero BFR-id the BIER sub-TLV MUST be included but its non-MPLS Encapsulation sub-TLV MAY be omitted.

The non-MPLS Encapsulation Sub-TLV MAY appear multiple times within a single BIER Sub-TLV. If the same BitString length is repeated in multiple BIER non-MPLS 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 non-MPLS Encapsulation Sub-sub-TLV containing the error MUST be ignored.

BIFT-id ranges within all the BIER non-MPLS 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 non-MPLS 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 non-MPLS 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 non-MPLS Encapsulation sub-sub-TLV: TBD1 (suggested value 2)

5.2. OSPFv2 Extended Prefix TLV Sub-TLVs Registry

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

5.3. OSPFv3 Extended LSA Sub-TLVs Registry

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

6. Acknowledgments

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