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BGP Link-State extensions for BIER
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Abstract

Bit Index Explicit Replication (BIER) is an architecture that provides optimal multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain any multicast related per-flow state. BIER also does not require any explicit tree-building protocol for its operation. A multicast data packet enters a BIER domain at a "Bit-Forwarding Ingress Router" (BFIR), and leaves the BIER domain at one or more "Bit-Forwarding Egress Routers" (BFERs). The BFIR router adds a BIER header to the packet. The BIER header contains a bitstring in which each bit represents exactly one BFER to forward the packet to. The set of BFERs to which the multicast packet needs to be forwarded is expressed by setting the bits that correspond to those routers in the BIER header.

BGP Link-State (BGP-LS) enables the collection of various topology informations from the network, and the topology informations are used by the controller to calculate the fowarding tables and then propagate them onto the BFRs(instead of having each node to calculate on its own) and that can be for both inter-as and intra-as situations.

This document specifies extensions to the BGP Link-state address-family in order to advertise the BIER informations.

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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1. Introduction

Bit Index Explicit Replication (BIER) is an architecture that provides optimal multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain any multicast related per-flow state. BIER also does not require any explicit tree-building protocol for its operation. A multicast data packet enters a BIER domain at a "Bit-Forwarding Ingress Router" (BFIR), and leaves the BIER domain at one or more "Bit-Forwarding Egress Routers" (BFERs). The BFIR router adds a BIER header to the packet. The BIER header contains a bitstring in which each bit represents exactly one BFER to forward the packet to. The set of BFERs to which the multicast packet needs to be forwarded are expressed by setting the bits that correspond to those routers in the BIER header.

The BGP-LS address-family/sub-address-family have been defined to allow BGP to carry Link-State informations. This document specifies extensions to the BGP Link-state address-family in order to advertise BIER-specific informations, Similar to BGP-LS Advertisement of IGP Traffic Engineering Performance Metric Extensions([RFC8571]). An external component (e.g., a controller/a PCE(see [RFC4655] for PCE-Based Architecture ,[RFC5440] for PCEP and [RFC5376] for Inter-AS Requirements for the PCEP.))then can learn the BIER informations in the "northbound" direction and calculate BIRT/BIFT and then propagate them onto BFRs (instead of having each BFR to calculate on its own), and that can be for both inter-as and intra-as situations.

2. Requirements Language

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 RFC 2119 [RFC2119].

3. BGP-LS Extensions for BIER

[RFC8279] defines the BFR - A router that supports BIER is known as a "Bit-Forwarding Router"(BFR), and each BFR MUST be assigned a "BFR-Prefix". A BFR's Prefix MUST be an IP address (either IPv4 or IPv6) of the BFR, and MUST be unique and routable within the BIER domain as described in section 2 of [RFC8279], and then external component (e.g., a controller) need to collect BIER informations of BIER routers are associated with the BFR-Prefix in the "northbound" direction within the BIER domain.

Given that the BIER informations are associated with the prefix, the Prefix Attribute TLV [RFC7752] can be used to carry the BIER informations. The new Prefix Attribute TLVs are defined for the encoding of BIER informations.

3.1. Prefix Attributes TLVs

The following Prefix Attribute TLVs are defined:

Type	Description	Section
TBD1	BIER information	section 3.2
TBD2	BIER MPLS Encapsulation	section 3.3
TBD3	BIER non-MPLS Encapsulation	section 3.4
TBD3	BIER Nexthop	section 3.5

Table 1: The new Prefix Attribute TLVs

3.2. The BIER information TLV

A new Prefix Attribute TLV (defined in [RFC7752] is defined for distributing BIER informations. The new TLV is called the BIER information TLV. The BIER information TLV may appear multiple times.

The following BIER information TLV is defined:

Figure 1

Type: A 2-octet field with value TBD, see IANA Considerations section.

Length: 2 octets.

Subdomain-id: Unique value identifying the BIER sub-domain, 1 octet.

BFR-ID: A 2-octet field encoding the BFR-ID, as documented in [RFC8279]. If the BFR-ID is zero, it means, the advertising router is not advertising any BIER-id.In some environment, BFR-ID can be configured by NMS, The BFR-ID should be sent to a controller.

BAR: A 1-octet field encoding the BIER Algorithm, used to calculate underlay paths to reach BFERs. Values are allocated from the "BIER Algorithms" registry which are defined in [RFC8401], [RFC8444]and [I-D.ietf-bier-ospfv3-extensions].

IPA: A 1-octet field encoding the IGP Algorithm, used to either modify,enhance, or replace the calculation of underlay paths to reach BFERs as defined by the BAR value. Values are from the "IGP Algorithm" registry.

Reserved: MUST be 0 on transmission, ignored on reception. May be used in future versions.

3.3. The BIER MPLS Encapsulation TLV

The BIER MPLS Encapsulation TLV is used in order to advertise MPLS specific informations used for BIER. It MAY appear multiple times.

In some environment, each router allocates its labels, and advertises it to the controller. That solution is simpler as the controller does not need to deal with label allocation. If the controller has to deal with Label allocation , there needs to be a (global) range carved out such there are no conflicts. We can avoid all that by having the router allocate the BIER Label range and advertise it to the controller.

The following the BIER MPLS Encapsulation Sub-TLV is defined:

Figure 2

Type: A 2-octet field with value TBD, see IANA Considerations section.

Length: 2 octets.

Max SI: A 1-octet field encoding the maximum Set Identifier(as defined in [RFC8279]), used in the encapsulation for this BIER subdomain for this BitString length.

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

BS Len: A 4-bit field field encoding the Bitstring length as per [RFC8296].

BS length in multiple BIER MPLS Encapsulation Sub-TLV associated with the same BIER Sub-TLV MUST NOT repeat, otherwise only the first BIER MPLS Encapsulation Sub-TLV with such BS length MUST be used and any subsequent BIER MPLS Encapsulation Sub-TLVs with the same BS length MUST be ignored.

3.4. The BIER non-MPLS Encapsulation TLV

The BIER non-MPLS Encapsulation TLV is used in order to advertise non-MPLS encapsulation(e.g. ethernet encapsulation) capability and other associated parameters of the encapsulation.It MAY appear multiple times.

The following the BIER non-MPLS Encapsulation Sub-TLV is defined:

Figure 3

Type:A 2-octet field with value TBD, see IANA Considerations section.

Length: 2 octets.

Max SI:A 1-octet field encoding the maximum Set Identifier(as defined in [RFC8279]), used in the encapsulation for this BIER subdomain for this BitString length.

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)). A unique BIFT-id range is allocated for each BitString length and sub-domain-id. These BIFT-id's are used for BIER forwarding as described in [RFC8279])and [RFC8296].

Local BitString Length (BS Len): A 4-bit field encoding the Bitstring length as per [RFC8296].

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

3.5. The BIER Nexthop TLV

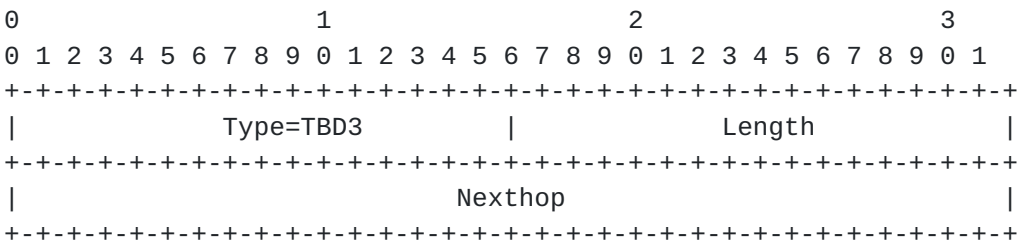

Figure 4

Type:A 2-octet field with value TBD, see IANA Considerations section.

Length: 2 octets.

Nexthop: 4 or 16 octets of IPv4/IPv6 address.

4. Equivalent IS-IS BIER TLVs/Sub-TLVs

This section illustrates the IS-IS BIER Extensions Sub-TLVs/Sub-Sub-TLVs mapped to the ones defined in this document.

The following table illustrates for each BGP-LS TLV, and its equivalence in IS-IS.

Description	IS-IS TLV/ Sub-TLV	Reference
BIER information	BIER info Sub-TLV	[RFC8401]
BIER MPLS Encapsulation	BIER MPLS Encapsulation Sub-Sub-TLV	[RFC8401]
BIER non-MPLS Encapsulation	BIER non-MPLS Encapsulation Sub-Sub-TLV	[I-D.ietf-bier-lsr-non-mpls-extensions]

Table 2: IS-IS BIER Extensions Sub-TLVs/Sub-Sub-TLVs

5. Equivalent OSPFv2/OSPFV3 BIER TLVs/Sub-TLVs

This section illustrates the BIER Extensions TLVs/Sub-TLVs mapped to the ones defined in this document.

The following table illustrates for each BGP-LS TLV, and its equivalence in OSPFv2/OSPFV3.

Description	OSPFv2/OSPFV3 sub-TLV/Sub-Sub-TLV	Reference
BIER information	BIER Sub-TLV	[RFC8444],[I-D.ietf-bier-ospfv3-extensions]
BIER MPLS Encapsulation	BIER MPLS Encapsulation Sub-TLV	[RFC8444],[I-D.ietf-bier-ospfv3-extensions]
BIER non-MPLS Encapsulation	BIER non-MPLS Encapsulation Sub-TLV	[I-D.ietf-bier-lsr-non-mpls-extensions]

Table 3: OSPFv2/OSPFV3 BIER TLVs/Sub-TLVs

6. Equivalent BGP BIER TLVs/Sub-TLVs

This section illustrates the BIER Extensions TLVs/Sub-TLVs mapped to the ones defined in this document.

The following table illustrates for each BGP-LS TLV, and its equivalence in BGP.

Description	BGP sub-TLV/ Sub-Sub-TLV	Reference
BIER information	BIER TLV	[I-D.ietf-bier-idr-extensions]
BIER MPLS Encapsulation	BIER MPLS Encapsulation Sub-TLV	[I-D.ietf-bier-idr-extensions]
BIER non-MPLS Encapsulation	BIER non-MPLS Encapsulation Sub-TLV	[I-D.ietf-bier-idr-extensions]
BIER Nexthop	BIER Nexthop Sub-TLV	[I-D.ietf-bier-idr-extensions]

Table 4: BGP BIER TLVs/Sub-TLVs

7. IANA Considerations

This document requests assigning code-points from the registry for the new Prefix Attribute TLVs.

TLV Code Point	Description	Value defined
TBD1	BIER information	this document
TBD2	BIER MPLS Encapsulation	this document
TBD3	BIER non-MPLS Encapsulation	this document
TBD4	BIER Nexthop	this document

Table 5: The new Prefix Attribute TLVs

8. Security Considerations

Procedures and protocol extensions defined in this document do not affect the BGP security model. See the "Security Considerations"section of [RFC4271] for a discussion of BGP security.Security considerations for acquiring and distributing BGP-LS information are discussed in [RFC7752].

The TLVs introduced in this document are used to propagate the Bit Index Explicit Replication (BIER) defined in [RFC8401], [RFC8444] , [I-D.ietf-bier-ospfv3-extensions], [I-D.ietf-bier-lsr-non-mpls-extensions] and [I-D.ietf-bier-idr-extensions]. These TLVs represent the bier information associated with the prefix. It is assumed that the IGP/ BGP instances originating these TLVs will support all the required security and authentication mechanisms in [RFC8401], [RFC8444], [I-D.ietf-bier-ospfv3-extensions] , [I-D.ietf-bier-lsr-non-mpls-extensions] and [I-D.ietf-bier-idr-extensions] in order to prevent any security issues when propagating the TLVs into BGP-LS. The advertisement of the link attribute information defined in this document present no additional risk beyond that associated with the existing link attribute informations already supported in [RFC7752].

9. Acknowledgements

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