BGP Link-State extensions for BIER
draft-ietf-bier-bgp-ls-bier-ext-12

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.

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   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. A 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 3.1.1 |
+------+----------------------------+---------------+
| TBD2 |    BIER MPLS Encapsulation   | section 3.1.2 |
+------+----------------------------+---------------+
| TBD3 | BIER non-MPLS Encapsulation | section 3.1.3 |
+------+----------------------------+---------------+
```

Table 1: The new Prefix Attribute TLVs

3.1.1. 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:

```
 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             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| sub-domain-id |     MT-ID      |              BFR-id            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     BAR       |     IPA        |             Reserved           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
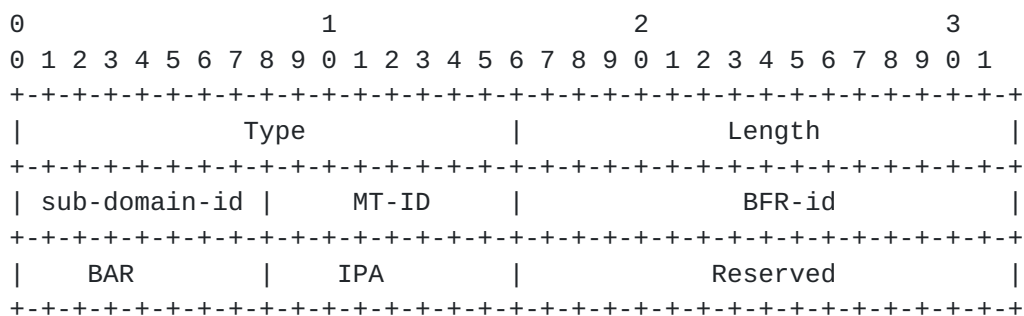
Figure 1

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.

MT-ID: Multi-Topology ID that identifies the topology that is
associated with 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 is defined in [RFC8401].

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.

If the MT-ID value is outside of the values specified in [RFC4915],
the BIER Sub-TLV MUST be ignored.

3.1.2. 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:

```
     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    |                  Label                        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |BS Len |                    Reserved                          |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                            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.

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

   BS length in multiple BIER MPLS Encapsulation Sub-TLV inside 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.

3.1.3. 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:

```
    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    |                  BIFT-id                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |BS Len |                     Reserved                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                               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.

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: OIS-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. 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

Table 4: The new Prefix Attribute TLVs

7. 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]] and
   [[I-D.ietf-bier-lsr-non-mpls-extensions]] . These TLVs represent the
   bier information associated with the prefix. It is assumed that the
   IGP instances originating these TLVs will support all the required
   security and authentication mechanisms in [[RFC8401]], [[RFC8444]]
   [[I-D.ietf-bier-ospfv3-extensions]] and
   [[I-D.ietf-bier-lsr-non-mpls-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].

8. Acknowledgements

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   Benchong Xu and many others for their suggestions and comments.

9. Normative References

   [I-D.ietf-bier-lsr-non-mpls-extensions]
             Dhanaraj, S., Yan, G., Wijnands, I., Psenak, P., Zhang,
             Z., and J. Xie, "LSR Extensions for BIER non-MPLS
             Encapsulation", Work in Progress, Internet-Draft, draft-
             ietf-bier-lsr-non-mpls-extensions-00, 1 March 2022,
             <https://datatracker.ietf.org/doc/html/draft-ietf-bier-
             lsr-non-mpls-extensions-00>.

   [I-D.ietf-bier-ospfv3-extensions]
             Psenak, P., Nainar, N. K., and I. Wijnands, "OSPFv3
             Extensions for BIER", Work in Progress, Internet-Draft,
             draft-ietf-bier-ospfv3-extensions-05, 19 November 2021,
             <https://datatracker.ietf.org/doc/html/draft-ietf-bier-
             ospfv3-extensions-05>.

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
             Requirement Levels", BCP 14, RFC 2119,
             DOI 10.17487/RFC2119, March 1997,
             <https://www.rfc-editor.org/info/rfc2119>.

   [RFC4655] Farrel, A., Vasseur, J.-P., and J. Ash, "A Path
              Computation Element (PCE)-Based Architecture", RFC 4655,
              DOI 10.17487/RFC4655, August 2006,
              <https://www.rfc-editor.org/info/rfc4655>.

   [RFC4915] Psenak, P., Mirtorabi, S., Roy, A., Nguyen, L., and P.
              Pillay-Esnault, "Multi-Topology (MT) Routing in OSPF",
              RFC 4915, DOI 10.17487/RFC4915, June 2007,
              <https://www.rfc-editor.org/info/rfc4915>.

   [RFC7752] Gredler, H., Ed., Medved, J., Previdi, S., Farrel, A., and
              S. Ray, "North-Bound Distribution of Link-State and
              Traffic Engineering (TE) Information Using BGP", RFC 7752,
              DOI 10.17487/RFC7752, March 2016,
              <https://www.rfc-editor.org/info/rfc7752>.

   [RFC8279] Wijnands, IJ., Ed., Rosen, E., Ed., Dolganow, A.,
              Przygienda, T., and S. Aldrin, "Multicast Using Bit Index
              Explicit Replication (BIER)", RFC 8279,
              DOI 10.17487/RFC8279, November 2017,
              <https://www.rfc-editor.org/info/rfc8279>.

   [RFC8296] Wijnands, IJ., Ed., Rosen, E., Ed., Dolganow, A.,
              Tantsura, J., Aldrin, S., and I. Meilik, "Encapsulation
              for Bit Index Explicit Replication (BIER) in MPLS and Non-
              MPLS Networks", RFC 8296, DOI 10.17487/RFC8296, January
              2018, <https://www.rfc-editor.org/info/rfc8296>.

   [RFC8401] Ginsberg, L., Ed., Przygienda, T., Aldrin, S., and Z.
              Zhang, "Bit Index Explicit Replication (BIER) Support via
              IS-IS", RFC 8401, DOI 10.17487/RFC8401, June 2018,
              <https://www.rfc-editor.org/info/rfc8401>.

   [RFC8444] Psenak, P., Ed., Kumar, N., Wijnands, IJ., Dolganow, A.,
              Przygienda, T., Zhang, J., and S. Aldrin, "OSPFv2
              Extensions for Bit Index Explicit Replication (BIER)",
              RFC 8444, DOI 10.17487/RFC8444, November 2018,
              <https://www.rfc-editor.org/info/rfc8444>.

   [RFC8571] Ginsberg, L., Ed., Previdi, S., Wu, Q., Tantsura, J., and
              C. Filsfils, "BGP - Link State (BGP-LS) Advertisement of
              IGP Traffic Engineering Performance Metric Extensions",
              RFC 8571, DOI 10.17487/RFC8571, March 2019,
              <https://www.rfc-editor.org/info/rfc8571>.

10. Informative references

   [RFC4271]   Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A
               Border Gateway Protocol 4 (BGP-4)", RFC 4271,
               DOI 10.17487/RFC4271, January 2006,
               <https://www.rfc-editor.org/info/rfc4271>.

   [RFC5376]   Bitar, N., Zhang, R., and K. Kumaki, "Inter-AS
               Requirements for the Path Computation Element
               Communication Protocol (PCECP)", RFC 5376,
               DOI 10.17487/RFC5376, November 2008,
               <https://www.rfc-editor.org/info/rfc5376>.

   [RFC5440]   Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation
               Element (PCE) Communication Protocol (PCEP)", RFC 5440,
               DOI 10.17487/RFC5440, March 2009,
               <https://www.rfc-editor.org/info/rfc5440>.

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