

BIER Workgroup
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PIM Signaling Through BIER Core
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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. Neither does BIER require an 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. Such header contains a bit-string 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 the according set of bits switched on in BIER packet header.

This document describes the procedure needed for PIM Joins and Prunes to be signaled through a BIER core. Allowing PIM routers to run traditional PIM multicast services through a BIER core.

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[1. Introduction](#)

Consider large networks deploying traditional PIM multicast service. Typically, each portion of these large networks have their own mandates and requirements.

It might be desirable to deploy BIER technology in some part of these networks to replace traditional PIM services. In such cases downstream PIM states need to be signaled over BIER Domain toward the source.

This draft explains the procedure to signal PIM joins and prunes through a BIER Domain, as such enable provisioning of traditional PIM services through a BIER Domain.

[2. Conventions used in this document](#)

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](#)].

[2.1. Definitions](#)

Some of the terminology specified in [I-D. [rfc8279](#)] is replicated here and extended by necessary definitions:

BIER:

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

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.

BFIR:

Bit Forwarding Ingress Router (The ingress border router that inserts the BM into the packet). Each BFIR must have a valid BFR-id assigned. In this draft BIER will be used for forwarding and tunneling of control plain packet (i.e. PIM) and forwarding dataplane packets. BFIR is term used for dataplane packet forwarding.

BFER:

Bit Forwarding Egress Router. A router that participates in Bit Index Forwarding as leaf. Each BFER must be a BFR. Each BFER must have a valid BFR-id assigned. In this draft BIER will be used for forwarding and tunneling of control plain packet (i.e. PIM) and forwarding dataplane packets. BFIR is term used for dataplane packet forwarding.

BBR:

BIER Boundary router. A router between the PIM domain and BIER domain. Maintains PIM adjacency for all routers attached to it on the PIM domain and terminates the PIM adjacency toward the BIER domain.

IBBR:

Ingress BIER Boundary Router. An ingress router from signaling point of view. It maintains PIM adjacency toward the PIM domain and determines if PIM joins and prunes arriving from PIM domain need to be signaled across the BIER domain. If so it terminates the PIM adjacency toward the BIER domain and signals the PIM joins/prunes through the BIER core.

EBBR:

Egress BIER Boundary Router. An egress router in BIER domain from signaling point of view. It terminates the BIER packet and forwards the signaled joins and prunes into PIM Domain.

BFT:

Bit Forwarding Tree used to reach all BFERS in a domain.

BIFT:

Bit Index Forwarding Table.

BIER sub-domain:

A further distinction within a BIER domain identified by its unique sub-domain identifier. A BIER sub-domain can support multiple BitString Lengths.

BFR-id:

An optional, unique identifier for a BFR within a BIER sub-domain.

3. PIM Signaling Through BIER domain

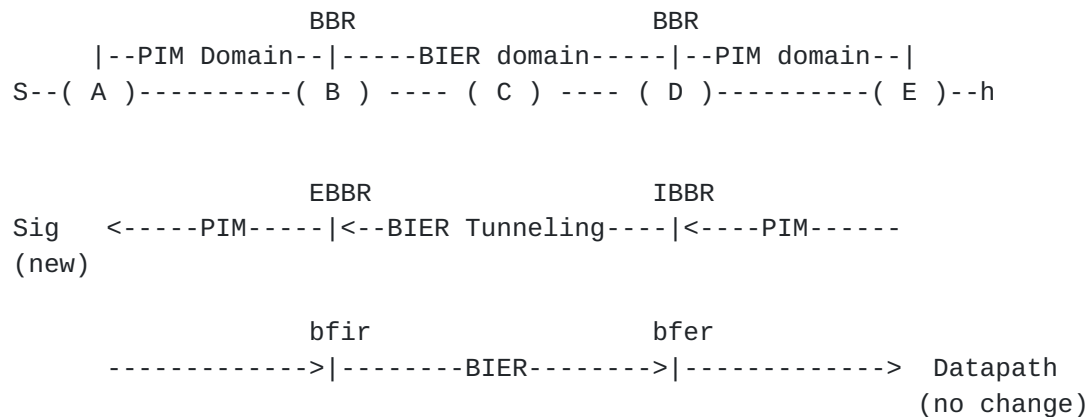


Figure 1: BIER boundary router

As per figure 1, the procedures of PIM signaling is done at the BIER boundary router. The BIER boundary router (BBR) are connected to PIM capable routers toward the PIM domain and BIER routers toward the BIER domain. PIM routers in PIM domain continue to send PIM state messages to the BBR. The BBR will create PIM adjacency between all the PIM routers attached to it on the PIM domain. That said the BBR does not propagate all PIM packets natively into the BIER domain. Instead when it determines that the PIM join or prune messages needs to be signaled through the BIER domain it will tunnel the PIM packet through the BIER network. This tunneling is only done for signaling purposes and not for creating a PIM adjacency between the two disjoint PIM domains through the BIER domain.

The terminology ingress BBR (IBBR) and egress BBR (EBBR) are relative from signaling point of view.

The ingress BBR will determine if an arriving PIM join or prune needs

to be signaled across the BIER domain. While the egress BBR will determine if the arriving BIER packet is a signaling packet and if so it will generate a PIM signaling packet toward its attached PIM domain.

The BFER and BFIR are BBR from datapath point of view. It should be noted the new procedures in this draft are only applicable to signaling and there are no changes from datapath point of view.

3.1. Ingress BBR procedure

IBBR will create PIM adjacency to all PIM routers attached to it toward the PIM domain.

When a PIM join or prune for certain (S,G) arrives, the IBBR first determines weather the join or prune is meant for a source that is reachable through the BIER domain. As an example, this source is located on a disjoint PIM domain that is reachable through the BIER domain. If so the IBBR will try to resolve the source via an EBBR closest to the source.

The procedure to find the EBBR (BFIR from datapath point of view) can be via many mechanisms explained in more detail in upcoming section.

After discovering the EBBR and its BFR-ID (flooded via IGP BIER extension), the IBBR will construct a PIM Join Attribute encoded as TLVs into the Source Address field of the PIM Join Message as per [\[RFC5384\]](#) and include it in PIM signaling message. Two new "BIER IBBR" attributes are define and explained in upcoming section. The PIM Join Attribute is used on EBBR to obtain necessary bier information to build its multicast states. In addition the IBBR will change the PIM signaling packet source IP address to its BIER prefix address (standard PIM procedure). It will also keep the destination address as the well known multicast IP address. It then will construct the BIER header. The signaling packet, in this case the PIM join/prune packet, is encapsulated in the BIER header and transported through BIER domain to EBBR.

The IBBR will track all the PIM interfaces on the attached PIM domain which are interested in a certain (S,G). It creates multicast states for arriving (S,G)s from PIM domain, with incoming interface as BIER "tunnel" interface and outgoing interface as the PIM domain interface(s) on which PIM Join(s) were received on.

3.1.1. Determining EBBR on IBBR

As it was explained in previous section, IBBR needs to determine the EBBR closest to the source. This is needed to encode the BIER header BitString field to forward the signaling packet through the BIER domain.

It should be noted, the PIM domains can be either part of the same IGP area as BIER domain(single area) or are stitched to the BIER domain via an ABR or ASBR routers. As such on IBBR, there can be many different procedures to determine the EBBR. Some examples of these procedures have been provided in [Appendix A](#).

3.1.4. Pim Signaling packet construction at IBBR

To ensure all necessary bier information needed by EBBR is present in the PIM signaling message, PIM Join Attribute [[RFC5384](#)] is used. EBBR can use this attribute to build its multicast states, as described in EBBR procedure section. The PIM Join Attribute format is as follow:

```

      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
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|F|E|  Type=tbd |   Length   | Addr Family | BIER info
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+...
```

F bit: The Transitive bit. Specifies whether this attribute is transitive or non-transitive. MUST be set to zero. This attribute is ALWAYS non-transitive.

E bit: End-of-Attributes bit. Specifies whether this attribute is the last. Set to zero if there are more attributes. Set to 1 if this is the last attribute.

Type: TBD assign by IANA

Length: The length in octets of the attribute value. MUST be set to the length in octets of the BIER info +1 octet to account for the Address Family field. For Ipv4 AF Length = 7+1 For Ipv6 AF Length = 19+1

Addr Family: BIER prefix address family as defined in [[RFC7761](#)]

BIER Info: IBBR Prefix (ipv4 or ipv6), SD, bfr-id

3.1.4.1 BIER packet construction at IBBR

The BIER header will be encoded with the BFR-id of the IBBR(with appropriate bit set in the bitstring) and the PIM signaling packet is then encapsulated in the packet.


```

    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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           BIFT-id           | TC |S|      TTL      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Nibble | Ver | BSL |           Entropy           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|OAM|Rsv|   DSCP   | Proto |           BFIR-id       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           BitString (first 32 bits)           ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
~           BitString (last 32 bits)           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

BIERHeader.Proto = IPv4 or IPv6

BIERHeader.BitString= Bit corresponding to the BFR-ID of the EBBR

BIERHeader.BFIR-id = BFR-Id of the BER originating the encapsulated PIM packet, i.e. the IBBR.

Rest of the values in the BIER header are determined based on the network (MPLS/non-MPLS), capabilities (BSL), and network configuration.

3.2. Signaling PIM through the BIER domain procedure

Throughout the BIER domain the BIER forwarding procedure is in par with [RFC 8279](#). No BIER router will examine the BIER packet encapsulating the PIM signaling packet. As such there is no multicast state build in the BIER domain.

The packet will be forwarded through the BIER domain until it reaches the BER with matching BFR-ID as in the BIERHeader.Bitstring. EBBR will remove the BIER header and examine the PIM IPv4 or IPv6 signaling packet farther as per EBBR Procedure section.

3.3. EBBR procedure

After receiving the BIER packet and determining this packet is a signaling packet, EBBR will remove the BIER header from PIM packet. The Received PIM join/prune Signaling packet is processed as if it were received from neighbors on a virtual interface, (i.e. as if the pim adjacency was presents, regardless of the fact there is no adjacency)

With same token the EBBR creates a multicast state with incoming interface as same interface that PIM join packet was forwarded and outgoing interfaces of BIER tunnel to BFER identified with BFIR-id and its corresponding Sub-Domain obtained from the BIER header or via PIM Join Attributes added to the PIM signaling packet by the IBBR.

The EBBR will also build a forwarding table for the arriving (S,G) using the obtained BFIR-id and the Sub-Domain information, in short it tracks all IBBRs interested in this (S,G). This is explained in [section 4.1](#).

It should be noted EBBR will maintain PIM adjacency toward the PIM domain and all PIM routers which are connected to it.

At this point the end-to-end multicast traffic flow setup is complete.

[4. Datapath Forwarding](#)

[4.1. BFIR tracking of \(S,G\)](#)

For a specific Source and Group, BFIR (EBBR) should track all the interested BFERs (IBBRs) via arriving PIM signaling from BIER Domain. BFIR builds its (s,g) forwarding state with incoming interface (IIF) as the RPF interface (in PIM domain) towards the source and one of the outgoing interfaces as for sending to tracked BFERs in the SD.

[4.2. Datapath traffic flow](#)

When the multicast data traffic arrives on the BFIR (EBBR) the router will find all the interested BFERs for that specific (S,G). The router then constructs the BIERHeader.BitString with all the BFER interested in the group and will forward the packet to the BIER domain. The BFER(s) will accept the packets and remove the BIER header and forward the multicast packet as per pre-build multicast state for (S,G) and its outgoing interfaces.

[5. PIM-ASM behavior](#)

In case of PIM ASM the procedure for LEAFs joining RP is same as above. It should be noted that for ASM, the EBBR is determined with respect to the RP instead of the source.

[6. Applicability to MVPN](#)

With just minor changes, the above procedures apply to MVPN as well, with BFIR/BFER/EBBR/IBBR being VPN PEs.

All the PIM related procedures, and the determination of EBBR happens in the context of a VRF, following procedures for PIM-MVPN.

When a PIM packet arrives from PIM domain attached to the vrf (IBBR), and it is determine that the source is reachable via the vrf through the BIER domain, a PIM signaling message is sent via BIER to the EBBR. In this case usually the PE terminating the PIM-MVPN is the EBBR. A label is imposed before the BIER header is imposed, and the "proto" field in the BIER header is set to 1 (for "MPLS packet with downstream-assigned label at top of stack"). The label is advertised by the EBBR/BFIR to associate incoming packets to its correct VRF. In many scenarios a label is already bound to the VRF loopback address on the EBBR/BFIR and it can be used.

When a multicast data packet is sent via BIER by an EBBR/BFIR, a label is imposed before the BIER packet is imposed, and the "proto" field in the BIER header is set to 1 (for "MPLS packet with downstream-assigned label at top of stack"). The label is assigned to the VPN consistently on all VRFs [[draft-zzhang-bess-mvpn-evpn-aggregation-label](#)].

If the more complicated label allocation scheme is needed for the data packets as specified in [[draft-zzhang-bess-mvpn-evpn-aggregation-label](#)], then additional PMSI signaling is needed as specified in [[RFC6513](#)].

To support per-area subdomain in this case, the ABRs would need to become VPN PEs and maintain per-VPN state so it is unlikely practical.

7. IANA Considerations

This document contains no actions for IANA.

8. Security Considerations

The procedures of this document do not, in themselves, provide privacy, integrity, or authentication for the control plane or the data plane. For a discussion of the security considerations regarding the use of BIER, please see [RFC8279](#) and [RFC8296](#). Security considerations regarding PIM protocol is based on [RFC4601](#).

9. References

9.1. Normative References

[BIER_ARCH] Wijnands, IJ., Rosen, E., Dolganow, A., Przygienda, T., and S. Aldrin, "Multicast using Bit Index Explicit Replication", rfc

8279, October 2016.

9.2. Informative References

[BIER_MVPN] Rosen, E., Ed., Sivakumar, M., Wijnands, IJ., Aldrin, S., Dolganow, A., and T. Przygienda, "Multicast VPN Using Bier", internet-draft [draft-ietf-bier-mvpn-11](#), March 2018.

[ISIS_BIER_EXTENSIONS] Ginsberg, L., Przygienda, T., Aldrin, S., and Z. Zhang, "BIER Support via ISIS", internet-draft [draft-ietf-bier-isis-extensions-11.txt](#), June 2018.

[OSPF_BIER_EXTENSIONS] Psenak, P., Kumar, N., Wijnands, IJ., Dolganow, A., Przygienda, T., Zhang, Z., and S. Aldrin, "OSPF Extensions for Bit Index Explicit Replication", internet-draft [draft-ietf-ospf-bier-extensions-18.txt](#), June 2018.

10. Acknowledgments

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Appendix A

This section provides some examples and routing procedures that can be used to determine the EBBR on IBBR. It should be noted, the PIM domains can be either part of the same IGP area as BIER domain(single area) or are stitched to the BIER domain via an ABR or ASBR routers. As such on IBBR, there can be many different procedures to determine the EBBR. Not all procedures are listed below.

A.1. SPF

On IBBR SPF procedures can be used to find the EBBR closest to the source.

Assuming the BIER domain is consist of all BIER forwarding routers, SPF calculation can identify the router advertising the prefix for the source. A post process can find the EBBR by walking from the advertising router back to the IBBR in the reverse direction of shortest path tree branch until the first BFR is encountered.

A.2. Indirect next-hop

Alternatively, the route to the source could have an indirect next-hop that identifies the EBBR. These methods are explained in the following sections.

[A.2.1. Static Route](#)

On IBBR there can be a static route configured for the source, with source next-hop set as EBBR BIER prefix.

[A.2.2. Interior Border Gateway Protocol \(iBGP\)](#)

Consider the following topology:

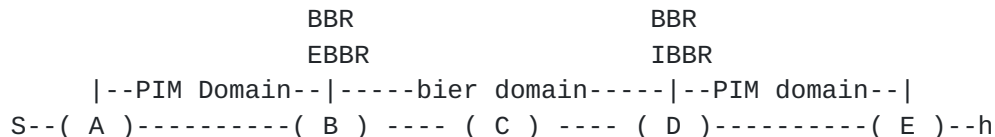


Figure 2

Suppose BGP is enable between EBBR (B) and IBBR (D) and the PIM Domain routes are redistributed to the BIER domain via BGP. This would include the Multicast Source IP address (S), which resides in the PIM Domain. In such case BGP should use the same loopback interface as its next-hop as the BBR prefix. This will ensure that all PIM domain routes, including the Multicast Source IP address (S) are resolve via BBR's bier prefix id as their next-hop. When the host (h) triggers a PIM join message to IBBR (D), IBBR tries to resolve (S). It resolves (S) via BGP installed route and realizes its next-hop is EBBR (B). IBBR will use this next-hop (B) to find its corresponding BIER bit index.

This procedure is inline with [RFC6826](#) mLDP in-band signaling [section 2](#).

[A.3. Inter-area support](#)

If each area has its own BIER sub-domain, the above procedure for post-SPF could identify one of the ABRs and the EBBR. If a sub-domain spans multiple areas, then additional procedures as described in A.2 is needed.

[A.3.1. Inter-area Route summarization](#)

In a multi-area topology, a BIER sub-domain can span a single area. Suppose this single area is constructed entirely of Bier capable routers and the ABRs are the BIER Boundary Routers attaching the BIER sub-domain in this area to PIM domains in adjacent areas. These BBRs can summarize the PIM domain routes via summary routes, as an example for OSPF, a type 3 summary LSAs can be used to advertise summary routes from a PIM domain area to the BIER area. In such scenarios the

IBBR can be configured to look up the Source via IGP database and use the summary routes and its Advertising Router field to resolve the EBBR. The IBBR needs to ensure that the IGP summary route is generated by a BFR. This can be achieved by ensuring that bier sub-tlv exists for this route. If multiple BBRs (ABRs) have generated the same summary route the lowest Advertising Router IP can be selected or a vendor specific hashing algorithm can select the summary route from one of the BBRs.

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