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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

Greenfield deployment of BIER might not be possible for some large network. These networks deploy traditional PIM multicast services in GRT or in mvpnns such as multicast vpns [rfc 6037](#). Typically, each portion of these large networks have their own mandates and requirements.

Consider the case of converged core, where single core is used for fixed, business and wireless services. In this case there is a desire for next generation "lean" core. Where a single IGP protocol or SDN controller could enable unicast and multicast services. BIER is a natural fit for this core. That said because of cost and operational complexity the migration to BIER might fall into below categories:

1. Gradual migration of the network to BIER, starting with the "lean" core and eventually to access networks.
2. Migrating only the core to BIER and keeping traditional pim services in access. As an example, in wireless networks where there are thousands of cell site routers. Each cell site router is a leaf as such for scaling and cost it might be desired to keep traditional PIM multicast services in the access network.

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

It should be noted that this "lean" core is usually a single IGP area. As such the procedures in this draft is concentrating on a single BIER IGP area.

## [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 dataplain packets. BFIR is term used for dataplain packet forwarding.

BBR:

BIER Boundary router. The 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. The 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. The 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 BFRs 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

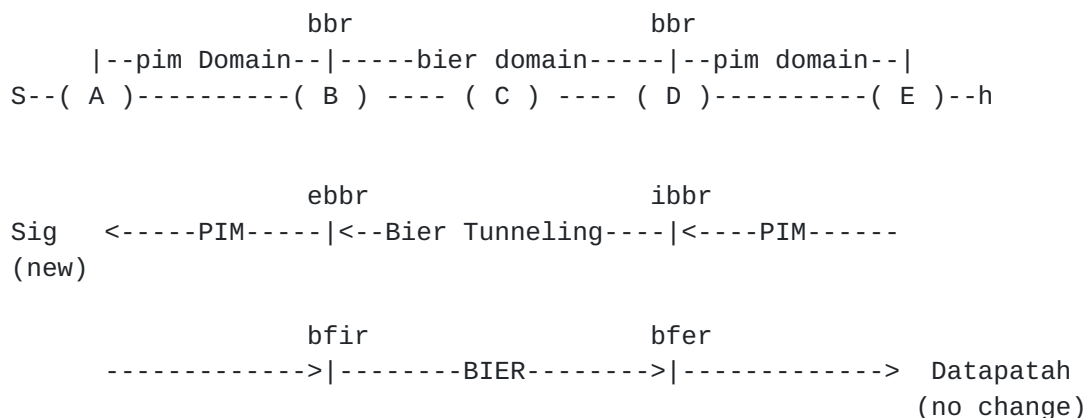


Figure 1: bier boundary router

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 attach 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 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 bier packet is a signaling packet and propagate the packet to its attach 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 attach 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 sections. It should be noted that in most cases the BIER domain is a single IGP area. The PIM domains are part of the same IGP area as BIER domain(single area) or are stitched to the BIER domain via an ABR or ASBR. in either case the BBRs are all located in the same area as bier domain. Below are two examples of resolving ebbrs:

- 1.The ebbr can be an ABR or ASBR router in the same IGP area as bier



domain. In this case the ebbbr summarizes the route to the source, and as such the ebbbr is the IGP source of this route. The IGP source information can be used for identifying the ebbbr and resolving it.

- 2.If source and ebbbr are within a single IGP area, the ebbbr can be resolved via SPF calculation. As an example, the closest ebbbr to the source. The ebbbr BFR-ID is signaled via IGP to all BFRs, as such making it possible to do SFP calculation.

After discovering the EBBR and its BFR-ID (flooded via IGP BIER extension), the IBBR will construct the BIER header via the BIFT. The signaling packet, in this case the PIM join/prune packet, is encapsulated in the BIER header and transported through BIER domain to EBBR.

On forwarding plane the IBBR will track all the PIM interfaces on the attach 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 (RPF) as BIER "tunnel" interface and outgoing interface as the pim domain interface(s) on which PIM Join(s) were received on. If there is another PIM Join for the same multicast (S,G) entry on another interface arriving from pim domain, that interface gets added in the outgoing interface list as well.

### **3.1.1. 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. This BER (EBBR) will remove the BIER header and examine the PIM IPv4 or IPv6 signaling packet farther.

### **3.3 Procedure to determine 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 for forwarding of the signaling packet. There can be many mechanism to determine the EBBR. This section explain some routing methods that can be used to achieve this.

#### **3.3.1 EBBR identification via next-hop**

Assuming on the IBBR the source is resolved via EBBR bier prefix-id as its next-hop, the next-hop can be used to lookup the EBBR bit-index via the BIFT. In most cases the bier prefix-id is a loopback address. The next-hop of the source on IBBR can be set to EBBR via multiple methods, including Static Route and BGP.

##### **3.3.1.1 Static Route**

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

##### **3.3.1.2 Interior Border Gateway Protocol (iBGP)**

Consider the following topology:



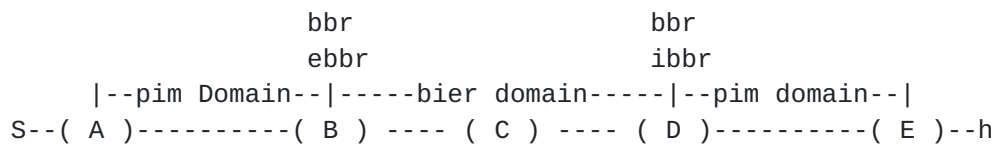


Figure 2

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-id. This will ensure that all PIM domain routes, including the Multicast Source IP address (S) are resolve via BBR's bier prefix id as thier 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 do a lookup in the BIFT and find its corresponding BIER bit index in the BIFT. Next IBBR will build the BIER header with corresponding EBBR bit index and tunnel the PIM signaling message toward EBBR. This procedure is inline with [RFC6826](#) mLDP in-band signaling [section 2](#).

### 3.3.2 Route summarization at EBBR

The BIER domain can be an IGP area, in this case the EBBRs and IBBRs would act as an area boundary router (ABR). ABR could summarize routes and/or generate new routes with advertising router field set to EBBR bier prefix-id. When IBBR resolves the Source it can use the advertising router field to generate the BIER BitString Header for the EBBR closest to the source.

### 3.3.4 Constrain shortest path first

In the BIER domain the edge BIER routers use IGP or BGP to advertise BIER extension TLVs. As such the routing protocols have a view of the EBBR closest to the source in PIM domain. To find the EBBR, IBBR can do a lookup for the source and ask for the closest EBBR on the path to the source. This look up can be a CSPF lookup. The IGP should return the EBBR closest to the source as part of this lookup.

### 3.4. EBBR procedure

After receiving the BIER packet and determining this packet is a signaling packet. As such the EBBR will remove the BIER header from PIM packet and does a route lookup for the source of the pim packet, if the source is on a local attach pim domain, it forwards the PIM





packet toward the source.

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 with BIER-Header.BFIR-id as one of the BFER of the tunnel.

The EBBR will also build a BIER reverse path forwarding table, using the BIERHeader.BFIR-id and the arriving PIM packet (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 via arriving PIM signaling from BIER Domain. BFIR should build its multicast tree with incoming interface (IIF) as PIM interface (in PIM domain) and out going interfaces OIFs set as the <SD, BFR-ID> of the interested BFERs (in BIER Domain).

### **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 (G) and its outgoing interfaces.

## **5. PIM-ASM behavior**

In case of PIM ASM the procedure for LEAFs joining RP is same as above. The unicast (source registration) traffic from source to RP will be flooded throughout the BIER domain as regular unicast traffic without BIER involvement.

## **6. IANA Considerations**

This document contains no actions for IANA.



## **7. Security Considerations**

TBD

## **8. References**

### **8.1. Normative References**

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## **7. Acknowledgments <Add any acknowledgements>**

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