Stateless Multicast with Bit Indexed Explicit Replication (BIER)

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Bit Indexed Explicit Replication (BIER)

- Only encode the end-receivers in the packet header.
  - Not the intermediate nodes.
- Assign end-receivers a Bit Position from a Bit String.
  - The smallest identifier possible.
- Encode the Bit String in the packet header.
  - Using some sort of encapsulation.
- Create a Bit Forwarding Table on all BIER nodes to allow multicast packet forwarding using the Bit String in the packet.
  - Derived from the RIB, SPF based.
• The BIER idea was presented in a BOF at the IETF in Hawaii. November 2014.

• A new BIER Working Group has been formed (bier@ietf.org)

draft-ietf-bier-problem-statement-00
draft-ietf-bier-architecture-00
draft-ietf-bier-encapsulation-mpls-00
draft-ietf-bier-use-cases-00
draft-ietf-l3vpn-mvpn-bier-00
draft-ietf-ospf-bier-extensions-00
draft-przygienda-bier-isis-ranges-01
draft-eckert-bier-te-arch-00
draft-xu-idr-bier-extensions-00
Solution Overview
1. Assign a unique Bit Position from a BitString to each BFER in the BIER domain.
2. Each BFER floods their Bit Position to BFR-prefix mapping using the IGP (OSPF, ISIS)
Basic Idea BIER

1. Assign a unique Bit Position from a BitString to each BFER in the BIER domain.
2. Each BFER floods their Bit Position to BFR-prefix mapping using the IGP (OSPF, ISIS)

<table>
<thead>
<tr>
<th>BitMask</th>
<th>Nbr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>A</td>
</tr>
<tr>
<td>0010</td>
<td>B</td>
</tr>
<tr>
<td>0011</td>
<td>C</td>
</tr>
</tbody>
</table>
Bit Index Forwarding Table

- D, F and E advertise their Bit positions in the IGP (flooded).
- Based on shortest path route to RID, the Bit Mask Forwarding Table is created.
Forwarding Packets

**BM** | **Nbr**
---|---
0111 | B
0011 | C
0100 | E
0001 | D
0010 | F
0100 | E
0011 | C
0011 | B

**AND**

A <--- B

A <--- C

B <--- C

B <--- E

C <--- E

E <--- F

E <--- D

D <--- F

D <--- A
Forwarding Packets
Forwarding Packets
Duplicate bit positions need to be resolved, ECMP logic needs to select based on Hash. In the example we selected C.
MPLS encapsulation

- We've analyzed the MPLS option, CRS and ASR9K platform.
- Both these platforms can do 256 bits.
- We consider 256 a good starting point.
- Other vendors confirmed they can do 256.
BIER Header

<table>
<thead>
<tr>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 0 1</td>
</tr>
</tbody>
</table>
|-----------------------------------------------------------------
|BitString (first 32 bits)                                       |
|-----------------------------------------------------------------
|BitString (last 32 bits)                                        |
|-----------------------------------------------------------------
|OAM| Reserved | Proto | BFIR-id |

256 bits = 32 bytes

http://www.ietf.org/id/draft-ietf-bier-mpls-encapsulation-01.txt
Sets and Areas
BIER Sets

To increase the scale we group the egress routers in Sets.

<table>
<thead>
<tr>
<th>Set</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0111</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>0111</td>
<td>I</td>
</tr>
</tbody>
</table>

Note, Bit Positions 1,2,3 appear in both Sets, and do not overlap due to Sets.

Note, we create different forwarding entries for each Set.

• To increase the scale we group the egress routers in Sets.
BIER Sets

There is no topological restriction which set an egress belongs to

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Note, we create different forwarding entries for each Set
BIER Area

- A bit Mask only needs to be unique in its own area.
- ABR’s translate Bit Masks between area’s.
- Requires a IP lookup and state on the ABRs.
- This is very similar for ‘Segmented Inter-AS MVPN’.

<table>
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</tr>
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<tbody>
<tr>
<td>0:10</td>
<td>ABR</td>
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</tr>
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Area 1

Area 2
Native BIER
Native BIER

• With Native BIER there is NO PIM involved, just IGMP and BIER.
• The Source and Receiver(s) are connected to BIER router.
• There are no RP’s.
• There is no equivalent of PIM modes, like sparse, ssm, bidir etc..
• We speak of ‘single’ sender and ‘multi’ sender, which is basically the same solution.
• The overlay can be BGP or SDN based.
Native BIER

- E and F announce their Group membership via overlay to all other routers.
- A BIER router connected to the Source can immediately start sending.
Native BIER

- When B learns about a new source, it can immediately start sending.

```
(S1,G)  (S2,G)

A  B

0100  1000

0  Nbr
1011  C

0  Nbr
0111  C

0011  D
0100  A
1000  B

0001  E
0010  F
1100  C

0  Nbr
1110  D

0  Nbr
1101  D

(*)G:00001
(*)G:00010

(*)G:00001
(*)G:00010

0100

0001

0  Nbr
1110  D

0010

0  Nbr
1101  D

(*)G:00001
(*)G:00010

IGMP

(*)G

IGMP

E  F

0001  0010

0  Nbr
1110  D

0010

0  Nbr
1101  D
```
MVPN over BIER
MVPN over BIER

- BIER replaces PIM, mLDP, RSVP-TE or IR in the core.
- BIER represents a full mesh (P2MP) connectivity between all the PE’s in the network.
- There is no need to explicitly signal any MDT’s (or PMSI’s).
- With MVPN there are many profiles,
  - This is partly due to the tradeoff between ‘State’ and ‘Flooding’.
  - Different C-multicast signaling options.
- MVPN over BIER, there is one profile.
  - BGP for C-multicast signaling.
- No need for Data-MDTs.
• The BGP control plane defined for MVPN can be re-used.
• Big difference, there is no Tree per VPN…!!!
• The BIER packets needs to carry Source ID and upstream VPN context label
Advantages

- Packets forwarded via BIER follow the unicast path towards the receiver, inheriting unicast features like FRR and LFA.
- There is no per multicast flow state in the network.
- Multicast convergence is as fast as unicast, there is no multicast state to re-converge, signal, etc.
- Nice plugin for SDN, its only the ingress and egress that need to exchange Sender and Receiver information.
- The core network provides a many-2-many connectively between all BIER routers by default following the IGP.
- No Multicast control protocol in the network.
- Goes hand in hand with Segment Routing
Disadvantages

- The Bit String length has an upper bound and may not cover all deployment scenarios.
- Using sets to increase the number of egress routers may cause the ingress to replicate the packet multiple times.
- Using area’s requires the ABR to have state.