BIER
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Supporting BIER in IPv6 Networks (BIERin6)
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Abstract

BIER is a new architecture for the forwarding of multicast data packets without requiring per-flow state inside the network. This document describes how the existing BIER encapsulation specified in RFC 8296 works in an IPv6 non-MPLS network, referred to as BIERin6. Specifically, like in an IPv4 network, BIER can work over L2 links directly or over tunnels. In case of IPv6 tunneling, a new IP "Next Header" type is to be assigned for BIER.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

Status of This Memo

time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

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1. Introduction

BIER [RFC8279] is a new architecture for the forwarding of multicast data packets. It provides optimal forwarding through a "multicast

domain" and it does not precondition construction of a multicast distribution tree, nor does it require intermediate nodes to maintain any per-flow state.

This document specifies non-MPLS BIER forwarding in an IPv6 [RFC8200] environment, referred to as BIERin6, using non-MPLS BIER encapsulation specified in [RFC8296].

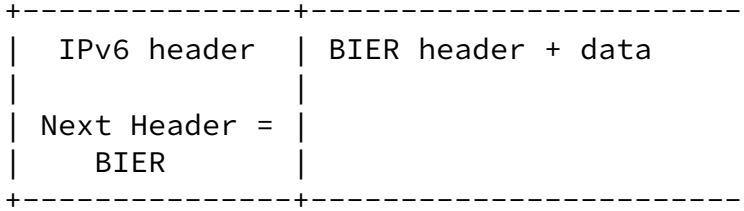
MPLS BIER forwarding in IPv6 is outside the scope of this document.

This document uses terminology defined in [RFC8279] and [RFC8296].

1.1. BIER over L2/Tunnels

[RFC8296] defines the BIER encapsulation format in MPLS and non-MPLS environment. In case of non-MPLS environment, a BIER packet is the payload of an "outer" encapsulation, which has a "next header" codepoint that is set to a value that means "non-MPLS BIER". This "BIER over L2/Tunnel" model can be used as is in an IPv6 non-mpls environment, and is referred to as BIERin6.

If a BFR needs to tunnel BIER packets to another BFR, e.g. per [RFC8279] Section 6.9, while any type of tunnel will work, for best efficiency native IPv6 encapsulation can be used with the destination address being the downstream BFR and the Next Header field set to a to-be-assigned value for "non-MPLS BIER".



Between two directly connected BFRs, a BIER header can directly follow link layer header, e.g., an Ethernet header (with the Ethertype set to 0xAB37). Optionally, IPv6 encapsulation can be used even between directly connected BFRs (i.e. one-hop IPv6 tunneling) in the following two cases:

- An operator mandates all traffic to be carried in IPv6.

- A BFR does not have BIER support in its "fast forwarding path" and relies on "slow/software forwarding path", e.g. in environments like [RFC7368] where high throughput multicast forwarding performance is not critical.

1.2. Considerations of Requirements for BIER in IPv6 Networks

[draft-ietf-bier-ipv6-requirements] lists mandatory and optional requirements for BIER in IPv6 Networks. As a solution based on the

BIER over L2/tunnel model [RFC8296], BIERin6 satisfies all the mandatory requirements.

For the two optional requirements for fragmentation and Encapsulating Security Payload (ESP), they can be satisfied by one of two ways:

- IPv6 based fragmentation/ESP: a BFIR encapsulates the payload in IPv6 with fragmentation and/or ESP header, and then the IPv6 packets are treated as BIER payload.

- Generic Fragmentation/ESP [I-D.zzhang-tsvwg-generic-transport-functions]: a BFIR does generic fragmentation and/or ESP (without using IPv6 encapsulation) and the resulting packets are treated as BIER payload.

Either way, the fragmentation/ESP is handled by a layer outside of BIER and then the resulting packets are treated as BIER payload.

BIERin6 does support SRv6 BGP based overlay services (e.g. MVPN/EVPN) as following. An ingress PE (which is a BFIR) encapsulates customer packets with an IPv6 header (with optional fragmentation and ESP extension headers). The destination address is a multicast locator plus the Fucn/Arg portion that identifies the VPN. That IPv6 packet is then treated as BIER payload. An egress PE (which is a BFER) uses the standard SRv6 procedures to forward the IPv6 packet that is exposed after the BIER header is decapsulated. Relevant overlay signaling will be specified separately.

BIERin6 being a solution based on [RFC8279] [RFC8296], ECMP is inherently supported by BFRs using the the 20-bit entropy field in the BIER header for the load balancing hash. When a BIER packet is transported over an IPv6 tunnel, the entropy value is copied into the 20-bit IPv6 Flow Label (instead of using local 5-tuple input key to a hash function to locally generate the stateless 20-bit flow label) so that routers along the tunnel can do ECMP based on Flow Labels. For a router along the tunnel doing deep packet inspection for ECMP purpose, if it understands BIER header it can go past the BIER header to look for the 5-tuple input key to a hash function, otherwise it stops at the BIER header. In either case the router will not mistake the BIER header as an IP header so no misordering should happen.

BIER has its own OAM functions independent of those related to the underlying links or tunnels. With BIERin6 following the "BIER over L2/tunnel" model, IPv6 OAM function and BIER OAM functions are used independently for their own purposes.

Specifically, BIERin6 works with all of the following OAM methods, or any future methods that are based on the "BIER over L2/tunnel" model:

- BIER OAM specified in [I-D.ietf-bier-ping]
- BIER BFD specified in [I-D.ietf-bier-bfd]
- BIER Performance Measurement specified in [I-D.ietf-bier-pmmm-oam]
- BIER Path Maximum Transmission Unit Discovery specified in [I-D.ietf-bier-path-mtu-discovery]
- BIER IOAM specified in [I-D.xzlnp-bier-ioam]

2. IPv6 Header

Whenever IPv6 encapsulation is used for BIER forwarding, The Next Header field in the IPv6 Header (if there are no extension headers), or the Next Header field in the last extension header is set to TBD, indicating that the payload is a BIER packet.

If the neighbor is directly connected, The destination address in

IPv6 header SHOULD be the neighbor's link-local address on this router's outgoing interface, the source destination address SHOULD be this router's link-local address on the outgoing interface, and the IPv6 TTL MUST be set to 1. Otherwise, the destination address SHOULD be the BIER prefix of the BFR neighbor, the source address SHOULD be this router's BIER prefix, and the TTL MUST be large enough to get the packet to the BFR neighbor.

The "Flow label" field in the IPv6 packet SHOULD be copied from the entropy field in the BIER encapsulation.

2.1. IPv6 Options Considerations

For directly connected BIER routers, IPv6 Hop-by-Hop or Destination options are irrelevant and SHOULD NOT be inserted by BFIR on the BIERin6 packet. In this case IPv6 header, Next Header field should be set to TBD. Any IPv6 packet arriving on BFRs and BFERs, with multiple extension header where the last extension header has a Next Header field set to TBD, SHOULD be discard and the node should transmit an ICMP Parameter Problem message to the source of the packet (BFIR) with an ICMP code value of TBD10 ('invalid options for BIERin6').

This also indicates that for disjoint BIER routers using IPv6 encapsulation, there SHOULD NOT be any IPv6 Hop-by-Hop or Destination options be present in a BIERin6 packet. In this case, if additional

traffic engineering is required, IPv6 tunneling (i.e. BIERin6 over SRv6) can be implemented.

3. BIER Header

The BIER header MUST be encoded per Section 2.2 of [RFC8296].

The BIFT-id is either encoded per [I-D.ietf-bier-non-mpls-bift-encoding] or per advertised by BFRs, as specified in [I-D.ietf-bier-lsr-ethernet-extensions].

4. IPv6 Encapsulation Advertisement

When IPv6 encapsulation is not required between directly connected BFRs, no signaling in addition to that specified in

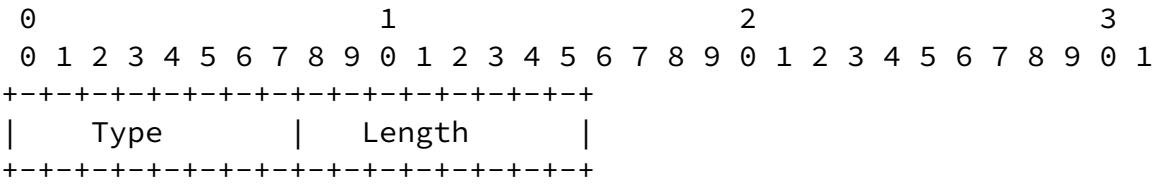
[I-D.ietf-bier-lsr-ethernet-extensions] is needed.

Otherwise, a node that requires IPv6 encapsulation MUST advertise the BIER IPv6 transportation sub-sub-sub-TLV/sub-sub-TLV according to local configuration or policy in the BIER domain to request other BFRs to always use IPv6 encapsulation.

In presence of multiple encapsulation possibilities hop-by-hop it is a matter of local policy which encapsulation is imposed and the receiving router MUST accept all encapsulations that it advertised.

4.1. Format

The BIER IPv6 transportation is a new sub-sub-TLV of BIER Ethernet Encapsulation sub-TLV defined in OSPFv3, and a new sub-sub-sub-TLV of BIER Ethernet Encapsulation sub-sub-TLV defined in ISIS, as per [I-D.ietf-bier-lsr-ethernet-extensions].



- Type: For OSPF, value TBD1 (prefer 1) is used to indicate it is the IPv6 transportation sub-TLV. For ISIS, value TBD2 (prefer 1) is used to indicate it is the IPv6 transportation sub-sub-TLV.

- Length: 0.

4.2. Inter-area prefix redistribution

When BFR-prefixes are advertised across IGP areas per [I-D.ietf-bier-lsr-ethernet-extensions] or redistributed across protocol boundaries per [I-D.ietf-bier-prefix-redistribute], the BIER IPv6 transportation sub-sub-TLV or sub-sub-sub-TLV MAY be re-advertised/re-distributed as well.

5. IANA Considerations

IANA is requested to assign a new "BIER" type for "Next Header" in the "Assigned Internet Protocol Numbers" registry.

IANA is requested to assign a new "BIERin6" type for "invalid options" in the "ICMP code value" registry.

IANA is requested to assign a new "BIER IPv6 transportation Sub-sub-TLV" type in the "OSPFv3 BIER Ethernet Encapsulation sub-TLV" Registry.

IANA is requested to set up a new "BIER IPv6 transportation Sub-sub-sub-TLV" type in the "IS-IS BIER Ethernet Encapsulation sub-sub-TLV" Registry.

6. Security Considerations

General IPv6 and BIER security considerations apply.

7. Acknowledgement

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