                  An IPv6 based BIER Routing Underlay
                     draft-pfister-bier-over-ipv6-00

Abstract

   This document specifies a routing underlay which enables transport of
   IPv6 payloads to multiple IPv6 destinations using the Bit Index
   Explicit Replication (BIER). The BIER bits are stored within the
   low-order bits of the IPv6 destination address while the high-order
   bits are left untouched and used in order to decide whether an IPv6
   packet is a regular IPv6 packet or an IPv6 BIER packet, and if so, to
   identify the BIER set identifier.

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1. Introduction

The Bit Index Explicit Replication (BIER -
[I-D.ietf-bier-architecture]) forwarding technique enables IP
multicast transport across a BIER domain. It operates using three
different elements, a multicast flow overlay, a BIER Layer, and a
routing underlay. This document specifies a way to send IPv6
payloads to multiple destinations using regular IPv6 packets with no
additional extension header.

BIER bits are encoded in the low-order bits of the IPv6 destination
address of each packet. The high-order bits of the IPv6 destination
address are left untouched and used by intermediate BIER routers to
decide whether the packet should be forwarded as a regular IPv6
packet or an IPv6 BIER packet, and if so, to know the BIER Set
Identifier.

Transported payloads can be of many types such as IPv6 or IPv4
unicast or multicast packets (e.g. using generic packet tunneling
[RFC2473]), or transported data (e.g. using UDP). Special care must
be taken when forwarding some types of payloads. For example, the
UDP checksum must be recomputed when the BIER bits are changed.

2. Terminology

In this document, the key words "MAY", "MUST", "MUST NOT",
"RECOMMENDED", and "SHOULD", are to be interpreted as described in
[RFC2119].

3. IPv6 BIER Packet Format

BIER IPv6 packets are IPv6 unicast packets. There is no
specificities to the format of the packet. The BIER bits are encoded
in the low-order bits of the IPv6 destination address of the packet
while the high-order bits are used by intermediate routers to
identify that the forwarded packet is an IPv6 BIER packet, and which
BIER Set Identifier to use.

```
|     p bits       | i bits  |           128-p-i bits           |
+------------------+---------+----------------------------------+
|  BIER IPv6 Prefix | SI bits |            BitString bits         |
+------------------+---------+----------------------------------+
```
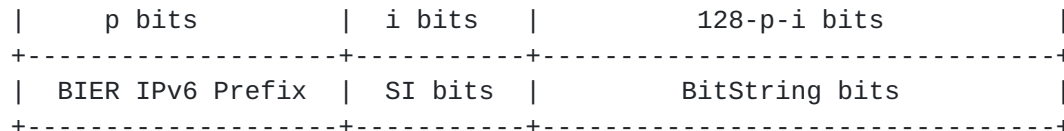
              Figure 1: IPv6 BIER destination address format

BIER IPv6 Prefix: This is a prefix used for BIER forwarding within
      the domain. BIER routers will consider all packets sent to
      this prefix as IPv6 BIER packets.

SI bits: These bits are used to encode the Set Identifier. It is
      used in order to address more BFERs than there are bits in the
      last part of the IPv6 address.

BitString bits: Set of bits encoding the set of BFERs the packet
      should be sent to. Those bits are modified as the packet is
      replicated by intermediate BIER routers. The length of this
      field is equal to 128-p-i and specifies the value of the
      BitStringLength to be used in the BIER forwarding process.

For example, a BIER domain assigns the prefix 2001:db8::/56 as a BIER
IPv6 Prefix, and sets i to 8. Every BIER router within the domain is
configured with such values and is therefore able to identify all
BIER packets and treat them accordingly. As the SI bits length is 8,
the lowest-weight 64 bits are used as a BIER bit field. A single
packet can be sent to at most 64 different BFERs, while the entire
domain can include up to 64 * 2^8 = 16384 BFERs.

4. BIER Layer Operations

When a multicast packet enters the BIER domain, the BFIR first
consults the multicast flow overlay and obtains the set of BFERs the
packet must be sent to. This set is used in order to compute the set
of bit indexes representing the set of destination BFERs. All
indexes that have the same SI are grouped in order to create a set of
BitString associated with their respective SI. For each SI, the
multicast packet is encapsulated within an IPv6 BIER packet, as
specified in Section 3.

The same process is used when a given IPv6 payload should be sent to
a set of destinations. But instead of encapsulating the packet, the
payload is attached to the BIER IPv6 header and the IPv6 protocol
number is set to the type of the payload.

5. Routing Underlay Operations

A BIER router is configured with at least one, and possibly more,
rules. Each rule includes a BIER IPv6 Prefix (value and prefix
length), the value of 'i', and the set of mappings used by BIER in
order to associate BIER bits with IPv6 destinations.

For each packet forwarded by a BFR, the router first performs a
longest prefix match operation over the destination address. If the
found entry corresponds to a BIER rule, the packet is treated as a
BIER packet. Otherwise, it is treated as a regular IPv6 packet.

When an IPv6 BIER packet is forwarded, the BFR retrieves the SI value
and BitString and performs the BIER forwarding algorithm. For each
replicated packet, the BitString is possibly modified and the packet
is sent on the outgoing interface.

6. Advantages of this Technique

The technique described in this document offers different advantages:

   BIER IPv6 packets are regular IPv6 packets. If the BIER IPv6
   Prefix is a globally unique IPv6 prefix, reachable from outside
   the BIER domain, it is possible to send a packet from outside the
   BIER domain to multiple destination within the BIER domain.

   It may be used for transporting IP multicast packets, but also for
   sending IP payloads directly to multiple destinations.

   It does not rely on a new IPv6 extension header, which simplifies
   deployment and is likely to improve performances.

   It makes use of a typical IP longest match in order to decide
   whether a packet is a BIER packet or not, which means hardware and
   software existing solutions may be used for that purpose.

   It is possible to configure a host with an address which
   corresponds to a BIER address with a single bit set. From the
   host perspective, such address is not different from a regular
   IPv6 address. Which means a BIER-unaware host may receive BIER
   packets transparently (With possible additional duplication by the
   last BFR when multiple hosts are located on the same link).

7. Security Considerations

   This technique allows IPv6 BIER packets to be sent across the
   internet toward multiple destination located in a given BIER domain.
   If this is considered a threat, a firewall at the entrance of the
   BIER domain in order to avoid BIER packets from being injected and
   replicated within the network.

8. IANA Considerations

   This specification does not require any action from IANA.

9. References

9.1. Normative References

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
              Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC2473] Conta, A. and S. Deering, "Generic Packet Tunneling in
              IPv6 Specification", RFC 2473, DOI 10.17487/RFC2473,
              December 1998, <http://www.rfc-editor.org/info/rfc2473>.

9.2. Informative References

   [I-D.ietf-bier-architecture]
              Wijnands, I., Rosen, E., Dolganow, A., Przygienda, T., and
              S. Aldrin, "Multicast using Bit Index Explicit
              Replication", draft-ietf-bier-architecture-01 (work in
              progress), June 2015.

Appendix A. Acknowledgements

   Comments concerning this document are very welcome.

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