Updates to the IPv6 Multicast Addressing Architecture

Abstract

   This document updates the IPv6 multicast addressing architecture by
   redefining the reserved bits as generic flag bits. The document also
   provides some clarifications related to the use of these flag bits.

   This document updates RFCs 3956, 3306, and 4291.

Status of This Memo

Table of Contents

1. Introduction

   This document updates the IPv6 addressing architecture [RFC4291] by
   redefining reserved bits as generic flag bits (Section 2). The
   document also provides some clarifications related to the use of
   these flag bits (Section 3).

   This document updates [RFC3956], [RFC3306], and [RFC4291]. These
   updates are logical consequences of the new processing rules in
   Section 3.

   Textual representation of IPv6 addresses included in the RFC updates
   follows the recommendation in [RFC5952].

1.1. Requirements Language

   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. Addressing Architecture Update

   Bits 17-20 of a multicast address, where bit 1 is the most
   significant bit, are defined in [RFC3956] and [RFC3306] as reserved
   bits. This document defines these bits as generic flag bits so that
   they apply to any multicast address. These bits are referred to as
   "ff2" (flag field 2), while the "flgs" bits in [RFC4291] [RFC3956]
   are renamed to "ff1" (flag field 1).

   Within this document, flag bits denote both ff1 and ff2.

   Defining the bits 17-20 as flags for all IPv6 multicast addresses
   allows addresses to be treated in a more uniform and generic way, and
   allows for these bits to be defined in the future for different
   purposes, irrespective of the specific type of multicast address.
   For the record, this design choice was initially triggered by the
   specification in [ADDR-FORMAT], which proposed associating a meaning
   with one of the reserved bits. Moreover, [ADDR-FORMAT] also
   considered the use of the last remaining flag in ff1, but that
   approach was abandoned because it is not clear at this stage whether
   there are other usage scenarios of the flag.

   Section 4 specifies the updated structure of the addressing
   architecture.

   Further specification documents may define a meaning for these
   flag bits.

3. Flag Bits: New Processing Rules

   Some implementations and specification documents do not treat the
   flag bits as separate bits but tend to use their combined value as a
   4-bit integer. This practice is a hurdle for assigning a meaning to
   the remaining flag bits. Below are listed some examples for
   illustration purposes:

   o The reading of [RFC3306] may lead one to conclude that ff3x::/32
      is the only allowed Source-Specific Multicast (SSM) IPv6 prefix
      block.

   o [RFC3956] states that only ff70::/12 applies to Embedded-RP.
      Particularly, implementations should not treat the fff0::/12 range
      as Embedded-RP.

   To avoid such confusion and to unambiguously associate a meaning with
   the remaining flags, the following requirement is made:

      Implementations MUST treat flag bits as separate bits.

4. RFC Updates

4.1. Updates to RFC 3306

4.1.1. Update #1

   This document changes Section 4 of [RFC3306] as follows:

   OLD:

```
   |   8    | 4 | 4 |   8    |   8    |        64        |    32    |
   +--------+----+----+--------+--------+------------------+----------+
   |11111111|flgs|scop|reserved|  plen  | network prefix   | group ID |
   +--------+----+----+--------+--------+------------------+----------+
```

```
                                   +-+-+-+-+
   flgs is a set of 4 flags:       |0|0|P|T|
                                   +-+-+-+-+
```

      o P = 0 indicates a multicast address that is not assigned
         based on the network prefix. This indicates a multicast
         address as defined in [ADDRARCH].

      o P = 1 indicates a multicast address that is assigned based
         on the network prefix.

o If P = 1, T MUST be set to 1, otherwise the setting of the T
   bit is defined in Section 2.7 of [ADDRARCH].

The reserved field MUST be zero.

Note: [ADDRARCH] is a reference listed in [RFC3306]. [ADDRARCH]
has been since obsoleted by [RFC4291].

NEW:

```
| 8      | 4 | 4 | 4 | 4 |   8    |       64        |   32    |
+--------+----+----+----+----+--------+----------------+---------+
|11111111|ff1 |scop|ff2 |rsvd|  plen  | network prefix | group ID |
+--------+----+----+----+----+--------+----------------+---------+
```

```
                                       +-+-+-+-+
ff1 (flag field 1) is a set of 4 flags:   |X|Y|P|T|
                                       +-+-+-+-+
```

X and Y may each be set to 0 or 1. Note that X is for future
assignment, while a meaning is associated with Y in RFC 3956.

o P = 0 indicates a multicast address that is not assigned
   based on the network prefix. This indicates a multicast
   address as defined in [RFC4291].

o P = 1 indicates a multicast address that is assigned based
   on the network prefix.

o If P = 1, T MUST be set to 1; otherwise, the setting of the
   T bit is defined in Section 2.7 of [RFC4291].

```
                                       +-+-+-+-+
ff2 (flag field 2) is a set of 4 flags:   |r|r|r|r|
                                       +-+-+-+-+
```

where "rrrr" are for future assignment as additional flag bits.
r bits MUST each be sent as zero and MUST be ignored on receipt.

Flag bits denote both ff1 and ff2.

4.1.2. Update #2

   This document changes Section 6 of [RFC3306] as follows:

   OLD:

      These settings create an SSM range of FF3x::/32 (where 'x' is any
      valid scope value). The source address field in the IPv6 header
      identifies the owner of the multicast address.

   NEW:

      If the flag bits in ff1 are set to 0011, these settings create an
      SSM range of ff3x::/32 (where 'x' is any valid scope value). The
      source address field in the IPv6 header identifies the owner of
      the multicast address. ff3x::/32 is not the only allowed SSM
      prefix range. For example, if the most significant flag bit in
      ff1 is set, then we would get the SSM range ffbx::/32.

4.2. Updates to RFC 3956

4.2.1. Update #1

   This document changes Section 2 of [RFC3956] as follows:

   OLD:

      As described in [RFC3306], the multicast address format is
      as follows:

      | 8 | 4 | 4 | 8 | 8 | 64 | 32 |
      +--------+----+----+--------+----+----------------+----------+
      |11111111|flgs|scop|reserved|plen| network prefix | group ID |
      +--------+----+----+--------+----+----------------+----------+

      Where flgs are "0011". (The first two bits are as yet undefined,
      sent as zero and ignored on receipt.)

NEW:

   The multicast address format is as follows:
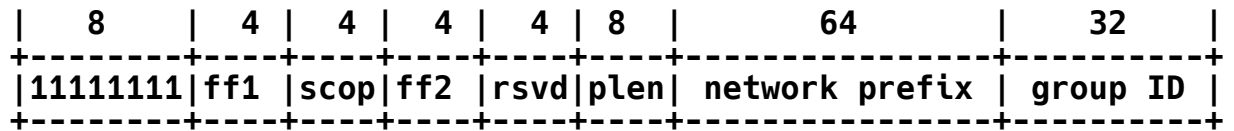
```
  | 8      | 4 | 4 | 4 | 4 | 8 |        64        |   32    |
  +--------+----+----+----+----+----+----------------+----------+
  |11111111|ff1 |scop|ff2 |rsvd|plen| network prefix | group ID |
  +--------+----+----+----+----+----+----------------+----------+

                                        +-+-+-+-+
  ff1 (flag field 1) is a set of four flags:   |X|R|P|T|
                                        +-+-+-+-+
```

   where X is for future assignment as an additional flag bit.
   X may be set to 0 or 1.

```
                                        +-+-+-+-+
  ff2 (flag field 2) is a set of 4 flags:      |r|r|r|r|
                                        +-+-+-+-+
```

   where "rrrr" are for future assignment as additional flag bits.
   r bits MUST each be sent as zero and MUST be ignored
   on receipt.

   Flag bits denote both ff1 and ff2.

4.2.2. Update #2

   This document changes Section 3 of [RFC3956] as follows:

   OLD:

```
  | 8      | 4 | 4 | 4 | 4 | 8 |        64        |   32    |
  +--------+----+----+----+----+----+----------------+----------+
  |11111111|flgs|scop|rsvd|RIID|plen| network prefix | group ID |
  +--------+----+----+----+----+----+----------------+----------+
                                +-+-+-+-+
  flgs is a set of four flags:        |0|R|P|T|
                                +-+-+-+-+
```
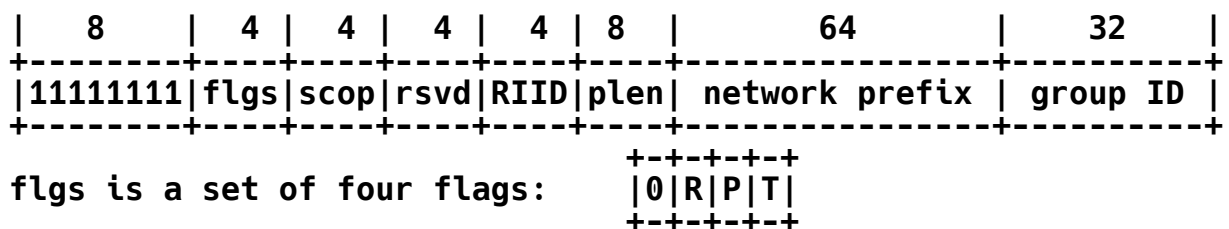
   When the highest-order bit is 0, R = 1 indicates a multicast address
   that embeds the address on the RP. Then P MUST be set to 1, and
   consequently T MUST be set to 1, as specified in [RFC3306]. In
   effect, this implies the prefix FF70::/12. In this case, the last 4
   bits of the previously reserved field are interpreted as embedding
   the RP interface ID, as specified in this memo.

   The behavior is unspecified if P or T is not set to 1, as then the
   prefix would not be FF70::/12. Likewise, the encoding and the
   protocol mode used when the two high-order bits in "flgs" are set to
   11 ("FFF0::/12") is intentionally unspecified until such time that
   the highest-order bit is defined. Without further IETF
   specification, implementations SHOULD NOT treat the FFF0::/12 range
   as Embedded-RP.

   NEW:
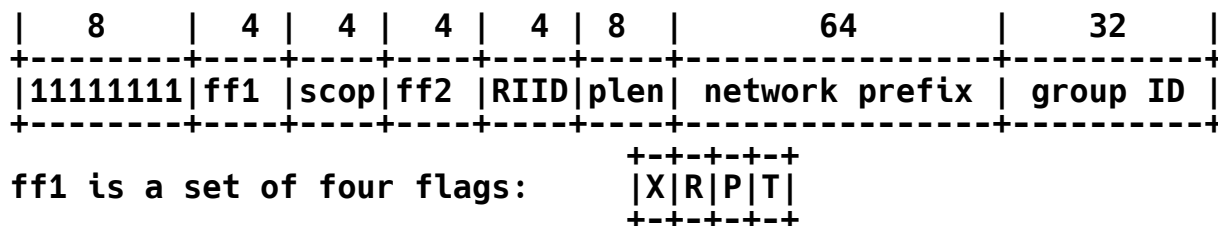
```
    |   8    | 4 | 4 | 4 | 4 | 8 |       64         |   32    |
    +--------+----+----+----+----+----+-----------------+----------+
    |11111111|ff1 |scop|ff2 |RIID|plen| network prefix | group ID |
    +--------+----+----+----+----+----+-----------------+----------+
                                  +-+-+-+-+
    ff1 is a set of four flags:   |X|R|P|T|
                                  +-+-+-+-+
    where X is for future assignment as an additional flag bit.
    X may be set to 0 or 1.
```

   R = 1 indicates a multicast address that embeds the address of the
   RP. Then, P MUST be set to 1, and consequently T MUST be set
   to 1, according to [RFC3306], as this is a special case of
   unicast-prefix-based addresses. This implies that, for instance,
   prefixes ff70::/12 and fff0::/12 are embedded RP prefixes. When
   the R-bit is set, the last 4 bits of the field that were reserved
   in [RFC3306] are interpreted as embedding the RP interface ID, as
   specified in this memo.

4.2.3. Update #3

   This document changes Section 4 of [RFC3956] as follows:

   OLD:

   o It MUST be a multicast address with "flgs" set to 0111, that is, to
     be of the prefix FF70::/12,

   NEW:

   o It MUST be a multicast address with the R-bit set to 1.

   o It MUST have the P-bit and T-bit both set to 1 when using the
      embedding in this document as it is a prefix-based address.

4.2.4. Update #4

   This document changes Section 7.1 of [RFC3956] as follows:

   OLD:

      To avoid loops and inconsistencies, for addresses in the range
      FF70::/12, the Embedded-RP mapping MUST be considered the longest
      possible match and higher priority than any other mechanism.

   NEW:

      To avoid loops and inconsistencies, for addresses with the R-bit
      set to 1, the Embedded-RP mapping MUST be considered the longest
      possible match and higher priority than any other mechanism.

5. Security Considerations

   The same security considerations as those discussed in [RFC3956],
   [RFC3306], and [RFC4291] are to be taken into account.

6. Acknowledgements

   Special thanks to Brian Haberman for the discussions prior to the
   publication of this document.

   Many thanks to Jouni Korhonen, Tatuya Jinmei, Charlie Kaufman, and
   Ben Campbell for their review.

7. References

7.1. Normative References

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

   [RFC3306] Haberman, B. and D. Thaler, "Unicast-Prefix-based IPv6
              Multicast Addresses", RFC 3306, August 2002.

   [RFC3956] Savola, P. and B. Haberman, "Embedding the Rendezvous
              Point (RP) Address in an IPv6 Multicast Address",
              RFC 3956, November 2004.

   [RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing
              Architecture", RFC 4291, February 2006.

   [RFC5952] Kawamura, S. and M. Kawashima, "A Recommendation for IPv6
              Address Text Representation", RFC 5952, August 2010.

7.2. Informative References

   [ADDR-FORMAT]
               Boucadair, M., Qin, J., Lee, Y., Venaas, S., Li, X., and
               M. Xu, "IPv6 Multicast Address With Embedded IPv4
               Multicast Address", Work in Progress, April 2013.

Authors' Addresses

   Mohamed Boucadair
   France Telecom
   Rennes 35000
   France

   EMail: mohamed.boucadair@orange.com

   Stig Venaas
   Cisco
   USA

   EMail: stig@cisco.com