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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

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7371.

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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:

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

- [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.

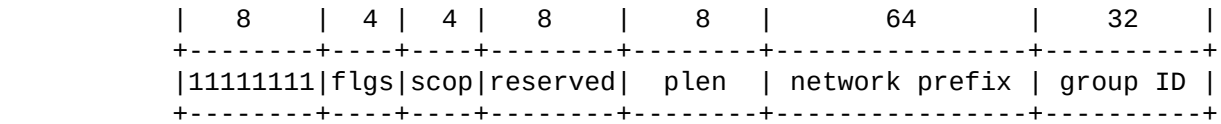
4. RFC Updates

4.1. Updates to RFC 3306

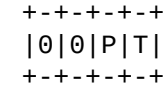
4.1.1. Update #1

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

OLD:



flgs is a set of 4 flags:



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

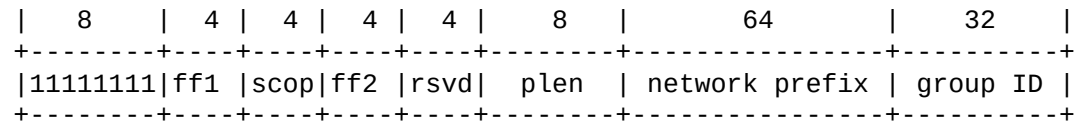
- P = 1 indicates a multicast address that is assigned based on the network prefix.

- 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:



ff1 (flag field 1) is a set of 4 flags:

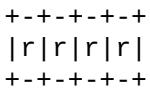
X and Y may each be set to 0 or 1. Note that X is for future assignment, while a meaning is associated with Y in RFC 3956.

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

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

- 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:



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:

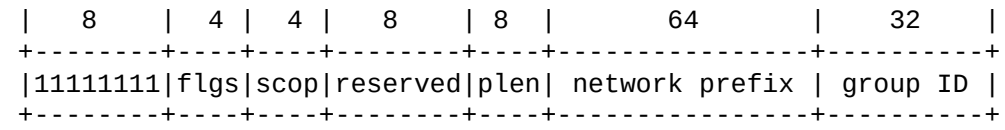
> If the flag bits in ff1 are set to 0011, these settings create an SSM range of ff3x::/32 (where 'x' is any valid scope value). The source address field in the IPv6 header identifies the owner of the multicast address. ff3x::/32 is not the only allowed SSM prefix range. For example, if the most significant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

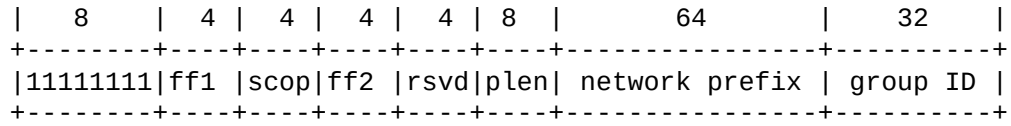
This document changes Section 2 of [RFC3956] as follows:

OLD:

> As described in [RFC3306], the multicast address format is as follows:
>
> 
>
>
> Where flgs are "0011". (The first two bits are as yet undefined, sent as zero and ignored on receipt.)

NEW:

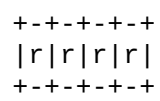
The multicast address format is as follows:



ff1 (flag field 1) is a set of four flags:

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:



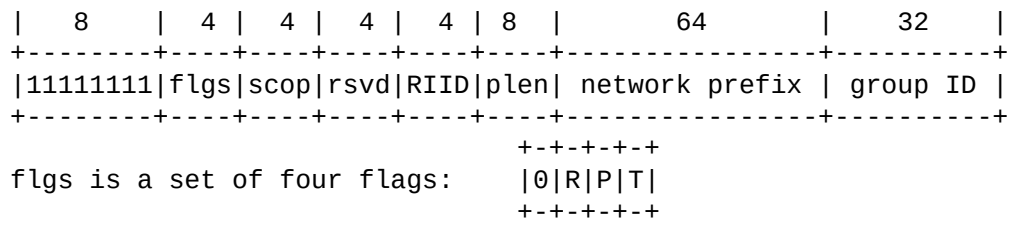
where "rrrr" are for future assignment as additional flag bits.
r bits MUST each be sent as zero and MUST be ignored
on receipt.

Flag bits denote both ff1 and ff2.

4.2.2. Update #2

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

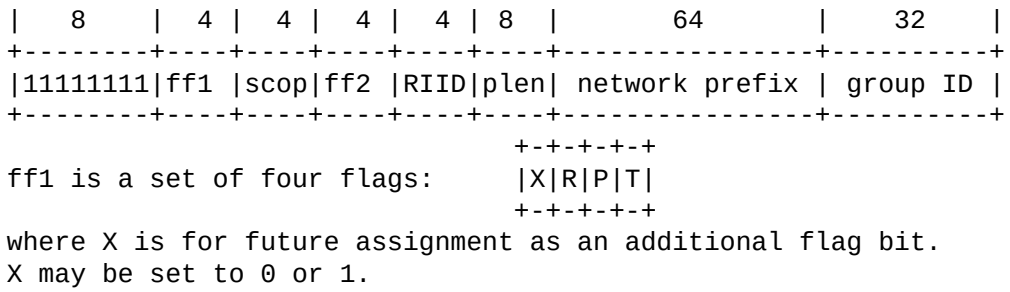
OLD:



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:



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.

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