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Internet Group Management Protocol version 3 (IGMPv3) and Multicast Listener Discovery version 2 (MLDv2) Message Extension

Abstract

This document specifies a generic mechanism to extend IGMPv3 and MLDv2 by using a list of TLVs (Type, Length and Value).

Status of This Memo

Copyright Notice

Table of Contents

1. Introduction

This document defines a generic method to extend IGMPv3 [RFC3376] and MLDv2 [RFC3810] messages to accommodate information other than what is contained in the current message formats. This is done by allowing a list of TLVs (Type, Length and Value) to be used in the Additional Data section of IGMPv3 and MLDv2 messages. This document defines a registry for such TLVs, while other documents will define the specific types and their values, and their semantics. The extension would only be used when at least one TLV is to be added to the message. This extension also applies to the lightweight versions of IGMPv3 and MLDv2 as defined in [RFC5790].

When this extension mechanism is used, it replaces the Additional Data section defined in IGMPv3/MLDv2 with TLVs.

Additional Data is defined for Query messages in IGMPv3 [RFC3376] Section 4.1.10 and MLDv2 [RFC3810] Section 5.1.12, and for Report messages in IGMPv3 [RFC3376] Section 4.2.11 and MLDv2 [RFC3810] Section 5.2.11.

2. Conventions used in this document

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.

3. Extension Format

For each of the IGMPv3 and MLDv2 headers, a previously reserved bit is used to indicate the presence of this extension. When this extension is used, the Additional Data of IGMPv3 and MLDv2 messages is formatted as follows. Note that this format contains a variable number of TLVs. It MUST contain at least one TLV.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Extension Type 1       |       Extension Length 1      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Extension Value 1                      |
.                               .                               .
.                               .                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Extension Type 2       |       Extension Length 2      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Extension Value 2                      |
.                               .                               .
.                               .                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Extension Type n       |       Extension Length n      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Extension Value n                      |
.                               .                               .
.                               .                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Figure 1: Extension Format

Extension Type: 2 octets. This identifies a particular Extension Type as defined in the IGMP/MLD Extension Type Registry. If this is not the first TLV, it will follow immediately after the end of the previous one. There is no alignment or padding.

Extension Length: 2 octets. This specifies the length in octets of the following Extension Value field. The length may be zero if no value is needed.

Extension Value: This field contains the value. The length and the contents of this field is according to the specification of the Extension Type.

IGMPv3 and MLDv2 messages are defined so that they can fit within the network MTU, in order to avoid fragmentation. An IGMPv3/MLDv2 report message contains a number of records. The records are called

Group Records for IGMPv3, and Address Records for MLDv2. When this extension mechanism is used, the number of records in each Report message SHOULD be kept small enough that the entire message, including any extension TLVs can fit within the network MTU.

3.1. Multicast Listener Query Extension

The MLDv2 Query Message format [RFC3810] with extension is shown below. The E-bit MUST be set to 1 to indicate that the extension is present. Otherwise, it MUST be 0.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Type = 130   |      Code     |           Checksum            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Maximum Response Code      |           Reserved            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
*                                                               *
|                                                               |
*                       Multicast Address                       *
|                                                               |
*                                                               *
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|E| Resv|S| QRV |     QQIC      |     Number of Sources (N)     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
*                                                               *
|                                                               |
*                       Source Address [1]                      *
|                                                               |
*                                                               *
|                                                               |
+-                                                             -+
|                                                               |
*                                                               *
|                                                               |
*                       Source Address [2]                      *
|                                                               |
*                                                               *
|                                                               |
+-                              .                              -+
.                               .                               .
.                               .                               .
+-                                                             -+
|                                                               |
*                                                               *
|                                                               |
*                       Source Address [N]                      *
|                                                               |
*                                                               *
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Extension                         |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: Figure 2: MLD Query Extension

3.2. Version 2 Multicast Listener Report Extension

The MLDv2 Report Message format [RFC3810] with extension is shown below. The E-bit MUST be set to 1 to indicate that the extension is present. Otherwise, it MUST be 0.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Type = 143   |    Reserved   |           Checksum            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|E|         Reserved            |Nr of Mcast Address Records (M)|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                  Multicast Address Record [1]                 .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                  Multicast Address Record [2]                 .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                               .                               |
.                               .                               .
|                               .                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                  Multicast Address Record [M]                 .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Extension                          |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: Figure 3: MLD Report Extension

3.3. IGMP Membership Query Extension

The IGMPv3 Query Message format [RFC3376] with the extension is shown below. The E-bit MUST be set to 1 to indicate that the extension is present. Otherwise, it MUST be 0.

```
  0                   1                   2                   3
  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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |  Type = 0x11  | Max Resp Code |           Checksum            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                         Group Address                         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |E| Resv|S| QRV |     QQIC      |     Number of Sources (N)     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                       Source Address [1]                      |
 +-                                                             -+
 |                       Source Address [2]                      |
 +-                              .                              -+
 .                               .                               .
 .                               .                               .
 +-                                                             -+
 |                       Source Address [N]                      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                            Extension                          |
 ~                                                               ~
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: Figure 4: IGMP Query Extension

3.4. IGMP Version 3 Membership Report Extension

The IGMPv3 Report Message format [RFC3376] with the extension is shown below. The E-bit MUST be set to 1 to indicate that the extension is present. Otherwise, it MUST be 0.

```
  0                   1                   2                   3
  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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |  Type = 0x22  |    Reserved   |           Checksum            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |E|         Reserved            |  Number of Group Records (M)  |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 .                                                               .
 .                        Group Record [1]                       .
 .                                                               .
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 .                                                               .
 .                        Group Record [2]                       .
 .                                                               .
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                               .                               |
 .                               .                               .
 |                               .                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 .                                                               .
 .                        Group Record [M]                       .
 .                                                               .
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                            Extension                          |
 ~                                                               ~
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: Figure 5: IGMP Report Extension

4. No-op TLV

The no-op TLV is a No-Operation TLV that MUST be ignored during processing. This TLV may be useful for verifying that implementations correctly implement this extension mechanism. Note that there is no alignment requirement, so there is no need to use this Extension Type to provide alignment.

```
 0                   1                   2                   3
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        No-op Type = 0         |          No-op Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Value                             |
.                               .                               .
.                               .                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: Figure 6: No-op TLV Format

No-op Type: 2 octets. The type of the No-op TLV extension is the value 0.

Extension Length: 2 octets. This specifies the length in octets of the following Value field. The length may be zero if no value is needed.

Value: This field contains the value. As this Extension Type is always ignored, the value can be arbitrary data. The number of octets used MUST match the specified length. contents of this field is according to the specification of the Extension Type.

5. Processing the extension

The procedure specified in this document applies only when the E-bit is set.

If the validation of the TLVs fails, the entire Additional Data field MUST be ignored as specified in IGMPv3 [RFC3376] and MLDv2 [RFC3810]. The following checks must pass for the validation of the TLVs not to fail:

At least one TLV MUST be present.

There MUST NOT be any data in the IP payload after the last TLV. To check this, the parser needs to walk through each of the TLVs until there are less than four octets left in the IP payload. If there are any octets left, validation fails.

The total length of the Extension MUST NOT exceed the remainder of the IP payload length. For this validation, one only examines the content of the Extension Length fields.

Future documents defining a new Extension Type MUST specify any additional processing and validation. These rules, if any, will be examined only after the general validation (above) succeeds.

TLVs with unsupported Extension Types MUST be ignored.

6. Applicability and backwards compatibility

IGMP and MLD implementations, particularly implementations on hosts, rarely change, and the adoption process of this extension mechanism is expected to be slow. Also, as new extension TLVs are defined, it may take a long time before they are supported. Due to this, defining new extension TLVs should not be taken lightly, and it is crucial to consider backwards compatibility.

Implementations that do not support this extension mechanism will ignore it, as specified in [RFC3376] and [RFC3810]. Also, as mentioned in the previous section, unsupported extension TLVs are ignored.

It is possible that a new extension TLV only applies to queries, or only to reports, or there may be other specific conditions for when it is to be used. A document defining a new Extension Type MUST specify under what conditions the new Extension Type should be used, including for which message types. It MUST also be specified what the behavior should be if a message is not used in the defined manner, e.g., if it is present in a query message, when it was only expected to be used in reports.

When defining new Extension Types, care should be taken to consider the effect of partial support for the new TLV, by either the hosts or routers, on the same link. Further, it must be considered whether there are any dependencies or restrictions on combinations between the new Extension Types and any pre-existing Extension Types.

This document defines an extension mechanism only for IGMPv3 and MLDv2. Hence, this mechanism does not apply if hosts or routers send older version messages.

7. Security Considerations

The Security Considerations of [RFC3376] and [RFC3810] also apply here.

This document extends the IGMP and MLD message formats, allowing for a variable number of TLVs. Implementations must take care when parsing the TLVs to not exceed the packet boundary, an attacker could intentionally specify a TLV with a length exceeding the boundary.

An implementation could add a large number of minimal TLVs in a message to increase the cost of processing the message to magnify a Denial of Service attack.

8. IANA Considerations

IANA is asked to create a new registry called "IGMP/MLD Extension Types" in the "Internet Group Management Protocol (IGMP) Type Numbers" section, with registration procedure "IETF Review" [RFC8126], and with this document as a reference. The registry is common for IGMP and MLD.

Two Extension Types are provided for "Experimental Use" [RFC8126]. Any experiments should be confined to closed environments where it is unlikely that they may conflict with other experiments, see [RFC3692].

The initial content of the registry should be as below.

Extension Type	Length	Name	Reference
0	variable	No-op	[this document]
1-65533		Unassigned	
65534	variable	Experimental use	
65535	variable	Experimental use	

9. Acknowledgements

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10. References

10.1. Normative References

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10.2. Informative References

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