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Enhanced Alternate Marking Method

Abstract

This document extends the IPv6 Alternate Marking Option to provide
enhanced capabilities and allow advanced functionalities. With this
extension, it can be possible to perform thicker packet loss
measurements and more dense delay measurements with no limitation
for the number of concurrent flows under monitoring.

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1. Introduction

The [Alternate Marking](#) [[RFC8321](#)] and [Multipoint Alternate Marking](#)
[[RFC8889](#)] define the Alternate Marking technique that is a hybrid
performance measurement method, per [[RFC7799](#)] classification of
measurement methods. This method is based on marking consecutive
batches of packets and it can be used to measure packet loss,
latency, and jitter on live traffic.

The [IPv6 AltMark Option](#) [[I-D.ietf-6man-ipv6-alt-mark](#)] applies the
Alternate Marking Method to IPv6, and defines an Extension Header
Option to encode the Alternate Marking Method for both the Hop-by-
Hop Options Header and the Destination Options Header. Similarly,
[SRv6 AltMark](#) [[I-D.fz-spring-srv6-alt-mark](#)] defines how Alternate
Marking data is carried as a TLV in the Segment Routing Header.

While the IPv6 AltMark Option implements the basic alternate marking
methodology, this document defines extended data fields for the
AltMark Option and provides enhanced capabilities to overcome some
challenges and enable future proof applications.

It is worth mentioning that the enhanced capabilities are intended
for further use and are optional.

Some possible enhanced applications MAY be:

1. thicker packet loss measurements: the single marking method of
   the base AltMark Option can be extended with additional marking
   bits in order to get shortest marking periods under the same
   timing conditions.

2. more dense delay measurements: than double marking method of
   the base AltMark Option can be extended with additional marking
   bits in order to identify down to each packet as delay sample.

3. increase the number of concurrent flows under monitoring: if the 20-bit FlowMonID is set independently and pseudo randomly, there is a 50% chance of collision for 1206 flows. The size of FlowMonIDcan can be extended to raise the entropy and therefore to increase the number of concurrent flows that can be monitored.

1.1. 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.

2. Data Fields Format

The Data Fields format is represented in Figure 1. An 4-bit NH(NextHeader) field is allocated from the Reserved field of IPv6 AltMark Option [I-D.ietf-6man-ipv6-alt-mark]. It is worth highlighting that remaining bits of the former Reserved field continue to be reserved.

```
 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
+---------------------------------------+-+-+-----------+-------+
|              FlowMonID                |L|D|  Reserved |  NH   |
+---------------------------------------+-+-+-----------+-------+
```

Figure 1: Figure 1: Data fields indicator for enhanced capabilities

The NH (NextHeader) field is used to indicate the extended data fields which are used for enhanced capabilities:

NextHeader value of 0x00 is reserved for backward compatibility. It means that there is no extended data field attached.

NextHeader values of 0x01-0x08 are reserved for private use or for experimentation.

NextHeader value of 0x09 indicates the extended data fields. The format is showed in Figure 2.

```
 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
+---------------------------------------+-------+-------+-------+
|            FlowMonID Ext              | Flag  |  Len  |   R   |
+---------------------------------------+-------+-------+-------+
|            MetaInfo          |          Padding (variable)    |
+------------------------------+--------------------------------+
//                      Padding (variable)                     //
+------------------------------+--------------------------------+
```
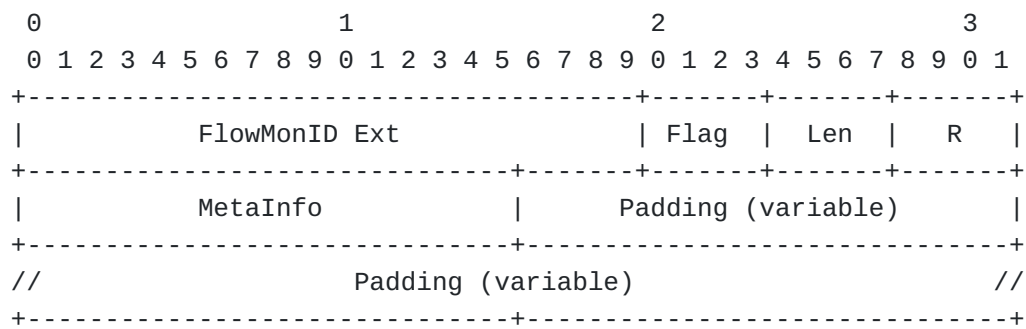
Figure 2: Figure 2: Data fields extension for enhanced alternate
marking

where:

*FlowMonID Ext - 20 bits unsigned integer. This is used to extend
 the FlowMonID to reduce the conflict when random allocation is
 applied. The disambiguation of the FlowMonID field is discussed
 in IPv6 AltMark Option [I-D.ietf-6man-ipv6-alt-mark].

*Flag - A 4-bit flag to indicate the special purpose usage (see
 below).

*Len - Length. It indicates the length of the enhanced alternate
 marking extension in bytes.

*R - Reserved for further use. These bits MUST be set to zero on
 transmission and ignored on receipt.

*MetaInfo - A 16-bit Bitmap to indicate more meta data attached
 for the enhanced function (see below).

*Padding - These bits MUST be set to zero when not being used.

The Flag is defined in Figure 3 as:

*bit 0 - Measurement mode, M bit. M=0, indicates that it is for
 hop-by-hop monitoring. M=1, indicates that it is for end-to-end
 monitoring.

*bit 2 - Flow direction identification, F bit. This flag is used
 in the case backward direction flow monitoring is requested to be
 set up automatically. F=1, indicates that the flow direction is
 forward. F=0, indicates the flow direction is backward.

*others (shown as R) - Reserved. MUST be set to zero and ignored
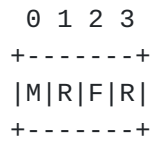 on receipt.

```
                0 1 2 3
                +-------+
                |M|R|F|R|
                +-------+
```

Figure 3: Figure 3: Flag data field

The MetaInfo is defined in Figure 4 as a bit map as follows:

```
                0 1 2 3 4 5 6 7
                +---------------+
                |    MetaInfo   |
                +---------------+
```
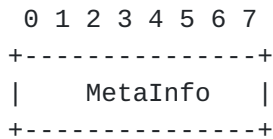
Figure 4: Figure 4: MetaInfo data field

*bit 0: indicates a 6 bytes Timestamp is attached after the
 MetaInfo. Timestamp(s) stands for the number of seconds in the
 timestamp. It will overwrite the Padding after MetaInfo.
 Timestamp(ns) stands for the number of subseconds in the
 timestamp with the unit of nano second. This Timestamp is filled
 by the encapsulation node, and is taken all the way to the
 decapsulation node. So that all the intermediate nodes could
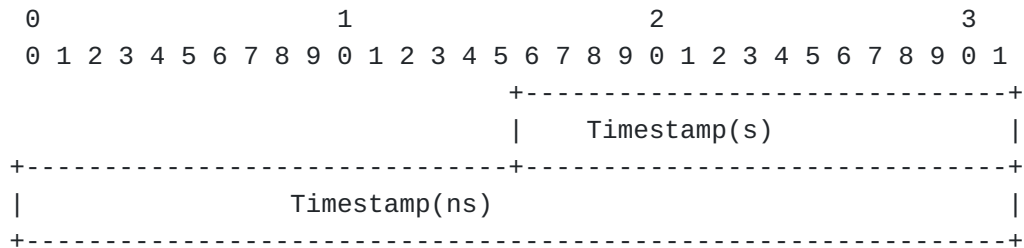 compare it with its local time, and measure the one way delay.

```
 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
                                +------------------------------+
                                |          Timestamp(s)        |
 +------------------------------+------------------------------+
 |                    Timestamp(ns)                            |
 +-------------------------------------------------------------+
```

Figure 5: Figure 5: Timestamp data field

*bit 1: indicates the control information with the following data
 format is attached:

```
 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
 +---------------+---------------+-----------+------------------+
 |  DIP Mask     | SIP Mask      | Control   |    Period        |
 +---------------+---------------+-----------+------------------+
```
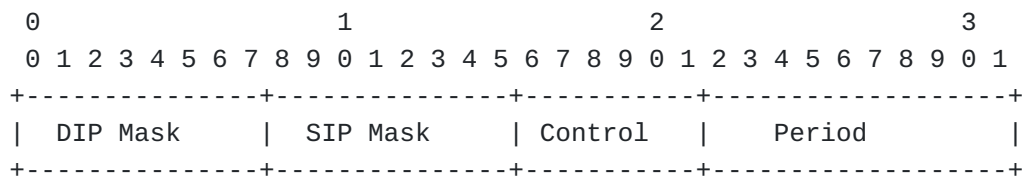
Figure 6: Figure 6: Control words for backward direction flow
                          monitoring

This is used to set up the backward direction flow monitoring.
Where:

   -DIP Mask: is the length of the destination IP prefix.

   -SIP Mask: is the length of the source IP prefix.

   -Control: indicates more match fields to set up the backward
    direction flow monitoring.

   -Period: indicates the alternate marking period with the unit
    of second.

 *bit 2: indicates a 4 bytes Sequence number with the following
  data format is attached after the MetaInfo. Sole Sequence cound
  be used to detect the out-of-order packets, in addition to the
  normal loss measurement. More over, the Sequence can be used
  together with the latency measurement, so as to get the per
  packet timestamp.

```
 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
+---------------------------------------------------------------+
|                           Sequence                            |
+---------------------------------------------------------------+
```
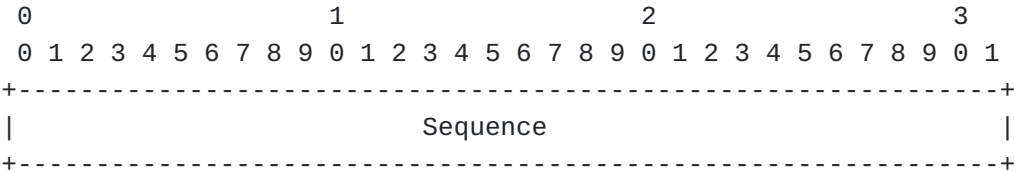
Figure 7: Figure 7: Sequence number data field

It is worth noting that the meta data information specified above in
Figure 5, Figure 6 and Figure 7 must be ordered according to the
order of the MetaInfo bits.

3. Security Considerations

IPv6 AltMark Option [I-D.ietf-6man-ipv6-alt-mark] analyzes different
security concerns and related solutions. These aspects are valid and
applicable also to this document. In particular the fundamental
security requirement is that Alternate Marking MUST only be applied
in a specific limited domain, as also mentioned in [RFC8799].

4. IANA Considerations

This document has no request to IANA.

5. References

5.1. Normative References

[I-D.fz-spring-srv6-alt-mark] Fioccola, G., Zhou, T., and M.
          Cociglio, "Segment Routing Header encapsulation for

Alternate Marking Method", Work in Progress, Internet-
Draft, draft-fz-spring-srv6-alt-mark-03, 5 August 2022,
<https://datatracker.ietf.org/api/v1/doc/document/draft-
fz-spring-srv6-alt-mark/>.

[I-D.ietf-6man-ipv6-alt-mark] Fioccola, G., Zhou, T., Cociglio, M.,
           Qin, F., and R. Pang, "IPv6 Application of the Alternate
           Marking Method", Work in Progress, Internet-Draft, draft-
           ietf-6man-ipv6-alt-mark-16, 1 July 2022, <https://
           datatracker.ietf.org/api/v1/doc/document/draft-ietf-6man-
           ipv6-alt-mark/>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
           Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/
           RFC2119, March 1997, <https://www.rfc-editor.org/info/
           rfc2119>.

[RFC7799] Morton, A., "Active and Passive Metrics and Methods (with
           Hybrid Types In-Between)", RFC 7799, DOI 10.17487/
           RFC7799, May 2016, <https://www.rfc-editor.org/info/
           rfc7799>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC
           2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174,
           May 2017, <https://www.rfc-editor.org/info/rfc8174>.

5.2. Informative References

[RFC8321]
           Fioccola, G., Ed., Capello, A., Cociglio, M.,
           Castaldelli, L., Chen, M., Zheng, L., Mirsky, G., and T.
           Mizrahi, "Alternate-Marking Method for Passive and Hybrid
           Performance Monitoring", RFC 8321, DOI 10.17487/RFC8321,
           January 2018, <https://www.rfc-editor.org/info/rfc8321>.

[RFC8799] Carpenter, B. and B. Liu, "Limited Domains and Internet
           Protocols", RFC 8799, DOI 10.17487/RFC8799, July 2020,
           <https://www.rfc-editor.org/info/rfc8799>.

[RFC8889] Fioccola, G., Ed., Cociglio, M., Sapio, A., and R. Sisto,
           "Multipoint Alternate-Marking Method for Passive and
           Hybrid Performance Monitoring", RFC 8889, DOI 10.17487/
           RFC8889, August 2020, <https://www.rfc-editor.org/info/
           rfc8889>.

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