IPv6 Option for DetNet Data Fields

Abstract

The DetNet data fields defined in Deterministic Latency Action (DLA)
can be used in enhanced Deterministic Networking (DetNet) to provide
QoS treatment to achieve deterministic latency.

This document defines how DetNet data fields are encapsulated in
IPv6 option.

Status of This Memo

This Internet-Draft is submitted in full conformance with the
provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering
Task Force (IETF). Note that other groups may also distribute
working documents as Internet-Drafts. The list of current Internet-
Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six
months and may be updated, replaced, or obsoleted by other documents
at any time. It is inappropriate to use Internet-Drafts as reference
material or to cite them other than as "work in progress."

This Internet-Draft will expire on 14 April 2024.

Copyright Notice

Table of Contents

1. Introduction

According to [RFC8655], Deterministic Networking (DetNet) operates
at the IP layer and delivers service which provides extremely low
data loss rates and bounded latency within a network domain. DetNet
data planes has been specified in [RFC8938]. The existing
deterministic technologies are facing large-scale number of nodes
and long-distance transmission, traffic scheduling, dynamic flows,
and other controversial issues in large-scale networks. The enhanced
DetNet Data plane is required to support a data plane method of flow
identification and packet treatment.
[I-D.liu-detnet-large-scale-requirements] has described the
enhancement requirements for DetNet data plane, it is required to
support information used by functions ensuring Deterministic
Latency. [I-D.xiong-detnet-large-scale-enhancements] has proposed
the overall framework of DetNet enhancements for large-scale
deterministic networks. The packet treatment should schedule the
resources and indicate the behaviour to ensure the deterministic
latency. Moreover, new functions and related metadata should be
supported in enhanced DetNet. [I-D.xiong-detnet-data-fields-edp] has
proposed a common DetNet data fields and option types for enhanced
DetNet data plane and defined a Deterministic Latency Action (DLA)
option to carry queuing-based metadata.

This document defines how DetNet data fields are encapsulated in
IPv6 option such as Deterministic Latency Action (DLA) data fields.

2. Conventions used in this document

2.1. Terminology

The terminology is defined as [RFC8655].

2.2. 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.

3. The DetNet Options

[I-D.xiong-detnet-data-fields-edp] has proposed a common DetNet data fields and option types for enhanced DetNet data plane. This document defines new IPv6 options for DetNet to signal DetNet data fields. The DetNet options helps to discriminate the types of mechanisms and specify the related parameters.

The format of the DetNet options follow the generic definition in section 4.2 of [RFC8200]. The DetNet options may be placed either in an HbH or a DoH EH. Multiple options with the same option type MAY appear in the same hop-by-hop options or destination options header with distinct data.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Option Type  |  Opt Data Len | DetNet-Type   | DetNet-Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+           DetNet Options Data(variable)                       +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
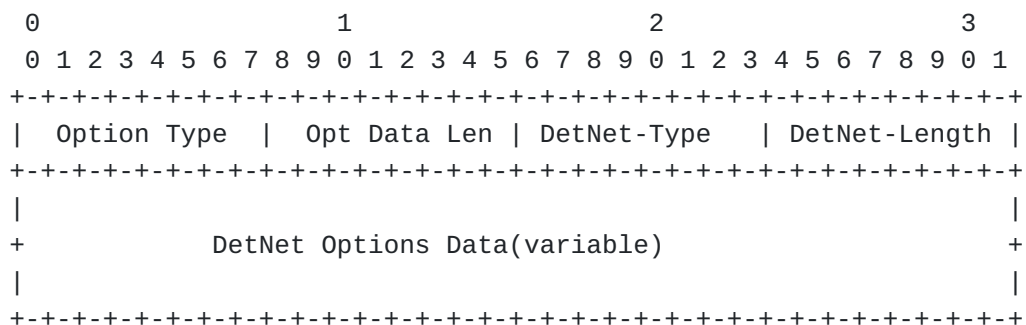
Figure 1: DetNet Options Format

[I-D.xiong-detnet-data-fields-edp] has defined a Deterministic Latency Action (DLA) option to carry queuing-based metadata. The DetNet DLA option data can be provided as follows:

Option Type: TBD1, 8-bit option type identifier indicates the DetNet Options.

Opt Data Len: 8-bit unsigned integer. Length of this option, in
octets, not including the first 2 octets.

Reserved: 8-bit field MUST be set to zero.

DetNet-Length: 16-bit field indicates the DetNet option length.

DetNet-Type: 16-bit field indicates the DetNet option type.

DetNet Options Data: Variable-length field and Option-Type-specific
data. [I-D.xiong-detnet-data-fields-edp] has defined a Deterministic
Latency Action (DLA) option to carry queuing-based metadata. The
DetNet option data can be provided as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Option Type   | Opt Data Len  | DetNet-Type   | DetNet-Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          DLA Type             |   Data len    | Ancillary Len |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|DLA option data(list) field determined by DLA Q-Type(variable) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|DLA ancillary data(list) field determined by DLA Type(variable)|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
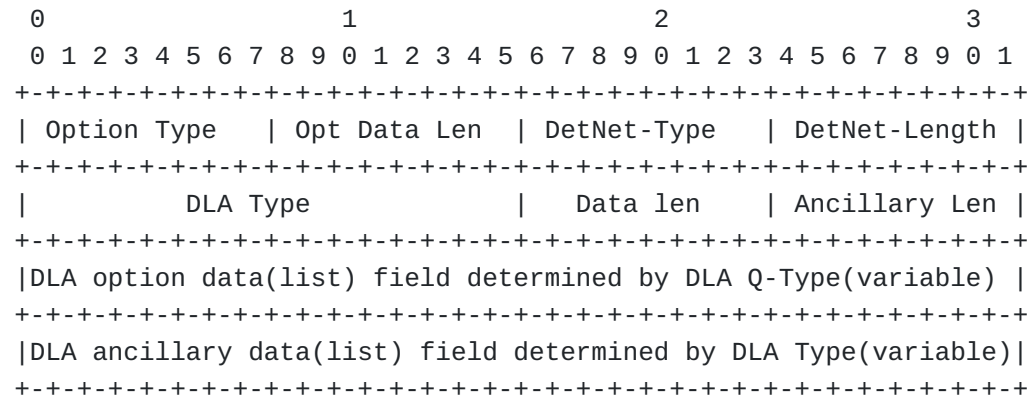
Figure 2: DetNet DLA Option Format

The definition of the value can be referred as
[I-D.xiong-detnet-data-fields-edp]. The DetNet option data and
Ancillary data can be provided one time or in list.

4. Encapsulation of DetNet Options

4.1. IPv6 Networks

The DetNet Options is intended to be placed in an IPv6 HbH EH since
it must be processed by every DetNet forwarding node along the path.
For the DetNet DLA option, all DetNet forwarding nodes can use the
queuing information to achieve the packet forwarding and scheduling.
The format of DetNet DLA option in IPv6 is as follows.

```
              +----------------------------------+
              |           DetNet App-Flow         |
              |         (original IP) Packet      |
              +----------------------------------+
              |              other EHs            |
              +----------------------------------+--\
              |        IPv6 Hop-by-Hop Ex Hdr    |    |
              |         (DetNet DLA Option)      | DetNet Options
              |                                   |    |
              +----------------------------------+--/
              |             IPv6 Header           |
              +----------------------------------+
              |              Data-Link            |
              +----------------------------------+
              |              Physical             |
              +----------------------------------+
```
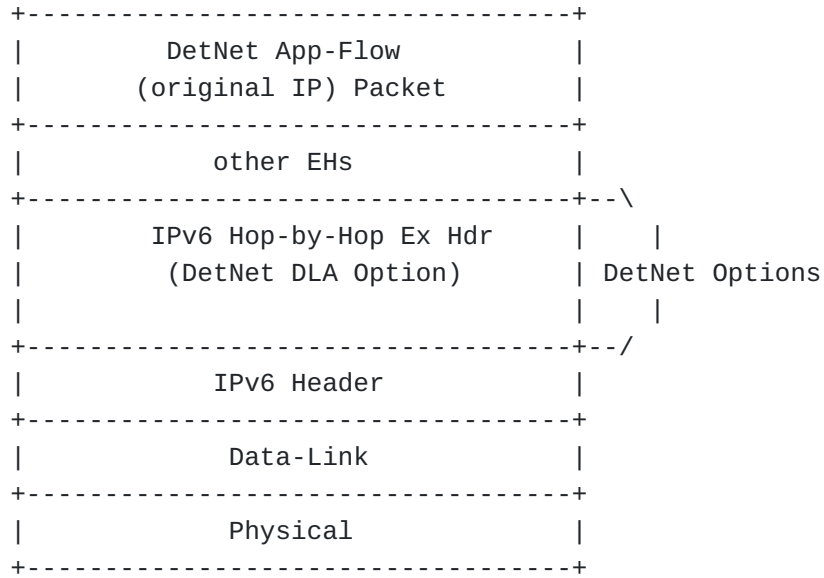
            Figure 3: DetNet DLA Option Format in IPv6

4.2. SRv6 Networks

   The DetNet Options is intended to be placed in an DOH EH before an
   SRH since it must be processed by the DetNet forwarding nodes of the
   SRv6 segment list. For the DetNet DLA option, the DetNet forwarding
   nodes among SRv6 segment list can use the queuing-based information
   to achieve the packet forwarding and scheduling. The format of
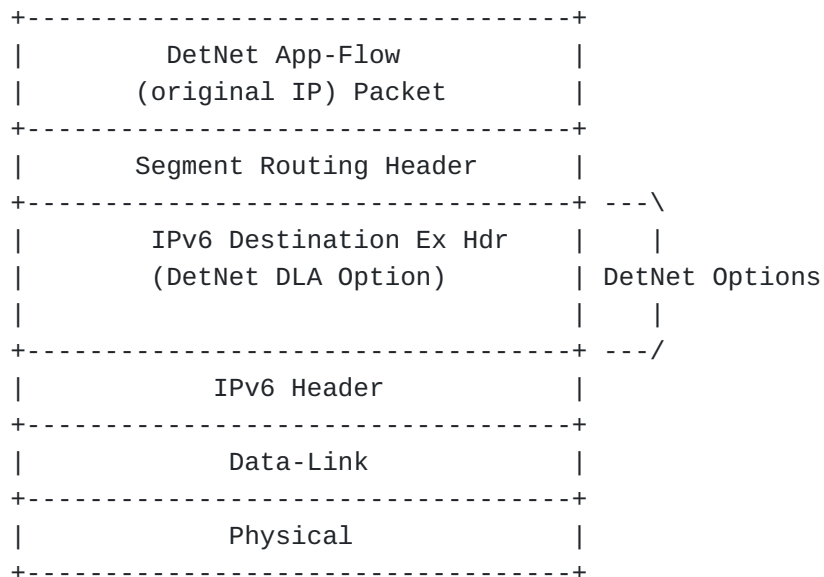   DetNet DLA option in SRv6 is as follows.

```
              +----------------------------------+
              |           DetNet App-Flow         |
              |         (original IP) Packet      |
              +----------------------------------+
              |        Segment Routing Header     |
              +----------------------------------+ ---\
              |        IPv6 Destination Ex Hdr    |    |
              |         (DetNet DLA Option)      | DetNet Options
              |                                   |    |
              +----------------------------------+ ---/
              |             IPv6 Header           |
              +----------------------------------+
              |              Data-Link            |
              +----------------------------------+
              |              Physical             |
              +----------------------------------+
```

Figure 4: DetNet DLA Option Format in SRv6

5. Security Considerations

TBA

6. IANA Considerations

6.1. New Option for IPv6

This specification updates the "Destination Options and Hop-by-Hop
Options" under the "Internet Protocol Version 6 (IPv6) Parameters"
registry with the values below:

Type	Description	Reference
TBD1	DetNet DLA Option	[this document]

Table 1

7. Acknowledgements

The authors would like to thank Aihua Liu, Peng Liu, Bin Tan, Shaofu
Peng for their review, suggestions and comments to this document.

8. Normative References

[I-D.dang-queuing-with-multiple-cyclic-buffers] Liu, B. and J. Dang,
         "A Queuing Mechanism with Multiple Cyclic Buffers", Work
         in Progress, Internet-Draft, draft-dang-queuing-with-
         multiple-cyclic-buffers-00, 22 February 2021, <https://
         www.ietf.org/archive/id/draft-dang-queuing-with-multiple-
         cyclic-buffers-00.txt>.

[I-D.ietf-detnet-bounded-latency]
         Finn, N., Boudec, J. L., Mohammadpour, E., Zhang, J.,
         and B. Varga, "DetNet Bounded Latency", Work in Progress,
         Internet-Draft, draft-ietf-detnet-bounded-latency-10, 8
         April 2022, <https://www.ietf.org/archive/id/draft-ietf-
         detnet-bounded-latency-10.txt>.

[I-D.joung-detnet-asynch-detnet-framework] Joung, J., Ryoo, J.,
         Cheung, T., Li, Y., and P. Liu, "Asynchronous
         Deterministic Networking Framework for Large-Scale
         Networks", Work in Progress, Internet-Draft, draft-joung-
         detnet-asynch-detnet-framework-00, 26 June 2022,
         <https://www.ietf.org/archive/id/draft-joung-detnet-
         asynch-detnet-framework-00.txt>.

[I-D.liu-detnet-large-scale-requirements] Liu, P., Li, Y., Eckert,
         T., Xiong, Q., and J. Ryoo, "Requirements for Large-Scale
         Deterministic Networks", Work in Progress, Internet-

Draft, draft-liu-detnet-large-scale-requirements-02, 10
April 2022, <https://www.ietf.org/archive/id/draft-liu-
detnet-large-scale-requirements-02.txt>.

[I-D.peng-6man-deadline-option] Peng, S. and B. Tan, "Deadline
Option", Work in Progress, Internet-Draft, draft-
peng-6man-deadline-option-00, 11 January 2022, <https://
www.ietf.org/archive/id/draft-peng-6man-deadline-
option-00.txt>.

[I-D.peng-detnet-deadline-based-forwarding] Peng, S., Tan, B., and
P. Liu, "Deadline Based Deterministic Forwarding", Work
in Progress, Internet-Draft, draft-peng-detnet-deadline-
based-forwarding-01, 1 March 2022, <https://www.ietf.org/
archive/id/draft-peng-detnet-deadline-based-
forwarding-01.txt>.

[I-D.stein-srtsn] Stein, Y. (., "Segment Routed Time Sensitive
Networking", Work in Progress, Internet-Draft, draft-
stein-srtsn-01, 29 August 2021, <https://www.ietf.org/
archive/id/draft-stein-srtsn-01.txt>.

[I-D.xiong-detnet-data-fields-edp] Xiong, Q. and D. Yang, "Data
Fields for DetNet Enhanced Data Plane", Work in Progress,
Internet-Draft, draft-xiong-detnet-data-fields-edp-00, 10
March 2023, <https://datatracker.ietf.org/api/v1/doc/
document/draft-xiong-detnet-data-fields-edp/>.

[I-D.xiong-detnet-large-scale-enhancements] Xiong, Q. and Z. Du,
"DetNet Enhancements for Large-Scale Deterministic
Networks", Work in Progress, Internet-Draft, draft-xiong-
detnet-large-scale-enhancements-00, 24 February 2022,
<https://www.ietf.org/archive/id/draft-xiong-detnet-
large-scale-enhancements-00.txt>.

[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>.

[RFC2212]   Shenker, S., Partridge, C., and R. Guerin, "Specification
of Guaranteed Quality of Service", RFC 2212, DOI

10.17487/RFC2212, September 1997, <https://www.rfc-editor.org/info/rfc2212>.

[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>.

[RFC8200]   Deering, S. and R. Hinden, "Internet Protocol, Version 6
            (IPv6) Specification", STD 86, RFC 8200, DOI 10.17487/
            RFC8200, July 2017, <https://www.rfc-editor.org/info/
            rfc8200>.

[RFC8655]   Finn, N., Thubert, P., Varga, B., and J. Farkas,
            "Deterministic Networking Architecture", RFC 8655, DOI
            10.17487/RFC8655, October 2019, <https://www.rfc-editor.org/info/rfc8655>.

[RFC8938]   Varga, B., "Deterministic Networking (DetNet) Data Plane
            Framework", RFC 8938, DOI 10.17487/RFC8938, November
            2020, <https://www.rfc-editor.org/info/rfc8938>.

Authors' Addresses

   Quan Xiong
   ZTE Corporation
   No.6 Huashi Park Rd
   Wuhan
   Hubei, 430223
   China

   Email: xiong.quan@zte.com.cn

   Junfeng Zhao
   CAICT
   China

   Email: zhaojunfeng@caict.ac.cn

   Rakesh Gandhi
   Cisco Systems, Inc.
   Canada

   Email: rgandhi@cisco.com