## BFD for Geneve
### draft-xiao-nvo3-bfd-geneve-01

Abstract

   This document describes the use of the Bidirectional Forwarding
   Detection (BFD) protocol in point-to-point Generic Network
   Virtualization Encapsulation (Geneve) tunnels forming up an overlay
   network.

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   This Internet-Draft is submitted in full conformance with the
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   This Internet-Draft will expire on April 24, 2020.

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## 1.  Introduction

   "Generic Network Virtualization Encapsulation" (Geneve)
   [I-D.ietf-nvo3-geneve] provides an encapsulation scheme that allows
   building an overlay network by decoupling the address space of the
   attached virtual hosts from that of the network.

   This document describes the use of Bidirectional Forwarding Detection
   (BFD) protocol [RFC5880] to enable monitoring continuity of the path
   between two Geneve tunnel endpoints, which may be NVE (Network
   Virtualization Edge) or other device acting as a Geneve tunnel
   endpoint.  For simplicity, in this document, NVE is used to represent
   Geneve tunnel endpoint, TS (Tenant System) is used to represent the
   physical or virtual device attached to a Geneve tunnel endpoint from
   the outside.  VAP (Virtual Access Point) is the NVE side of the
   interface between the NVE and the TS, and a VAP is a logical network
   port (virtual or physical) into a specific virtual network.  For
   detailed definitions and descriptions of NVE, TS and VAP, please
   refer to [RFC7365] and [RFC8014].

   The use cases and the deployment of BFD for Geneve are consistent
   with what's described in Section 1 and Section 3 of
   [I-D.ietf-bfd-vxlan].  The major difference between Geneve and
   "Virtual eXtensible Local Area Network" (VXLAN) [RFC7348]
   encapsulation is that Geneve supports multi-protocol payload and
   variable length options.

## 2.  Conventions Used in This Document

### 2.1.  Terminology

BFD: Bidirectional Forwarding Detection

CC: Continuity Check

GAL: Generic Associated Channel Label

G-ACh: Generic Associated Channel

Geneve: Generic Network Virtualization Encapsulation

MPLS: Multiprotocol Label Switching

NVE: Network Virtualization Edge

TS: Tenant System

VAP: Virtual Access Point

VNI: Virtual Network Identifier

VXLAN: Virtual eXtensible Local Area Network

### 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.  BFD Packet Transmission over Geneve Tunnel

Concerning whether or not the Geneve data packets include an IP
protocol data unit, and whether or not the Geneve data packets
include an MPLS protocol data unit, this document considers three
options of BFD packet encapsulation in Geneve.

### 3.1.  BFD Encapsulation With Inner Ethernet/IP/UDP Header

If the Protocol Type field (as defined in Section 3.4 of
[I-D.ietf-nvo3-geneve]) of data packets indicates that there exists
an inner Ethernet header, i.e., the Protocol Type equals to 0x6558
(Ethernet frame), then BFD packets are encapsulated in Geneve as
described below.  The Geneve packet format over IPv4 is defined in

Section 3.1 of [I-D.ietf-nvo3-geneve].  The Geneve packet format over
IPv6 is defined in Section 3.2 of [I-D.ietf-nvo3-geneve].  The Outer
IP/UDP and Geneve headers MUST be encoded by the sender as defined in
[I-D.ietf-nvo3-geneve].  Note that the outer IP header and the inner
IP header may not be of the same address family, in other words,
outer IPv6 header accompanied with inner IPv4 header and outer IPv4
header accompanied with inner IPv6 header are both possible.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  Outer Ethernet Header                        ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Outer IPvX Header                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Outer UDP Header                           ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                     Geneve Header                             ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  Inner Ethernet Header                        ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Inner IPvX Header                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Inner UDP Header                           ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                   BFD Control Message                         ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             FCS                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
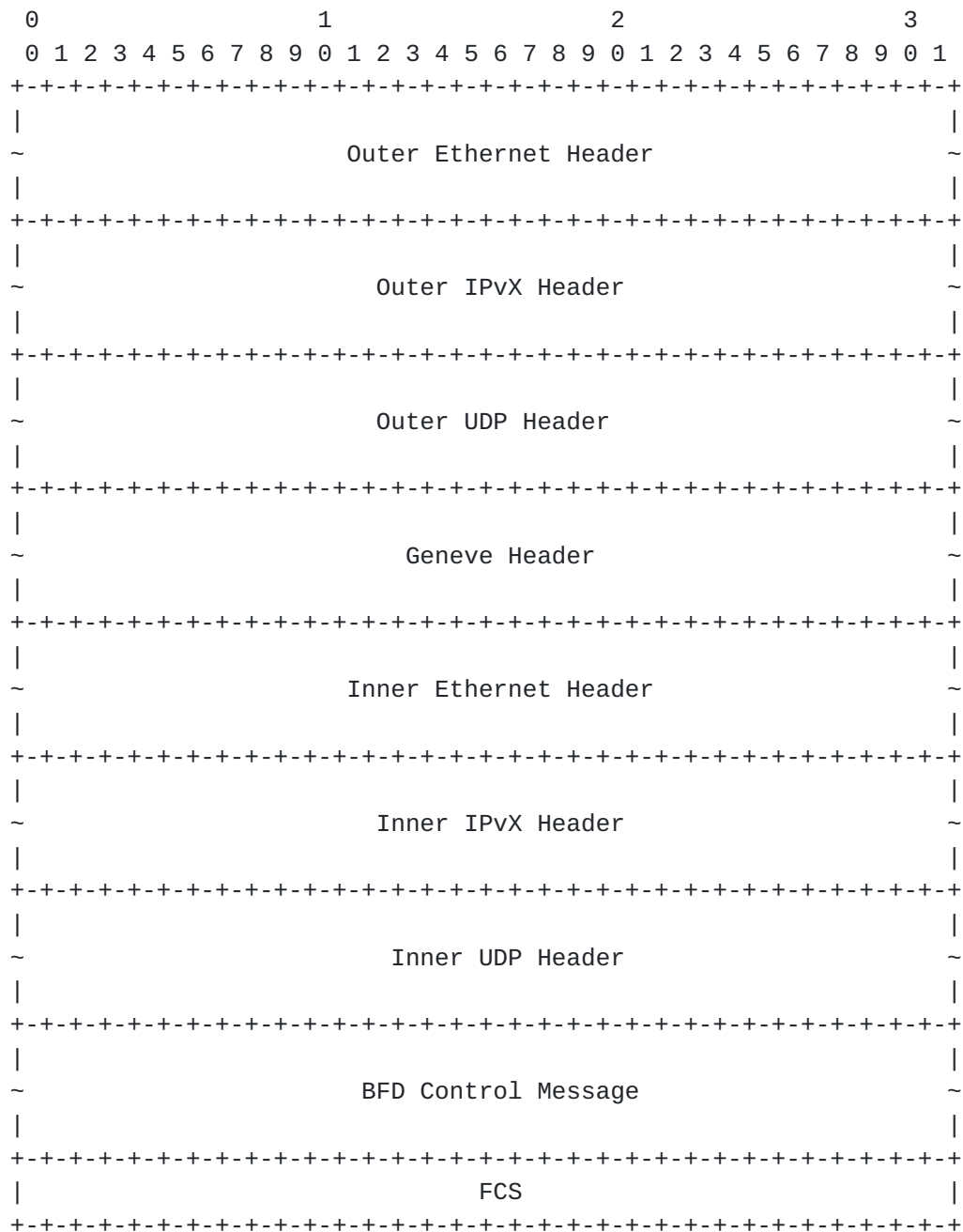
Figure 1: Geneve Encapsulation of BFD Control Message With the Inner
                   Ethernet/IP/UDP Header

The BFD packet MUST be carried inside the inner Ethernet frame of the
Geneve packet, as specified in Section 4 of [I-D.ietf-bfd-vxlan].

When the BFD packets are encapsulated in Geneve in this way, the
Geneve header follows the value set below.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Ver|  Opt Len  |O|C|    Rsvd.  |          Protocol Type        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Virtual Network Identifier (VNI)       |    Reserved   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Variable Length Options                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
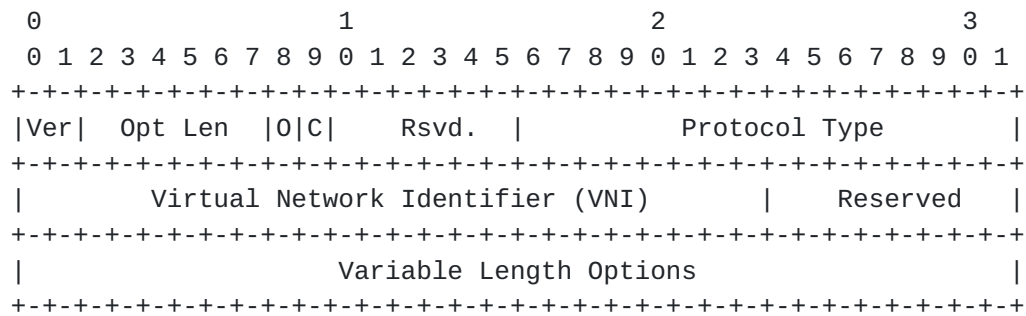
Figure 2: Geneve Header

Opt Len field SHOULD be set to 0, which indicates there isn't any
variable length option.

O bit MUST be set to 1, which indicates this packet contains a
control message.

C bit MUST be set to 0.

Protocol Type field MUST be set to 0x6558 (Ethernet frame).

## 3.2. BFD Encapsulation With Inner IP/UDP Header

If the Protocol Type field (as defined in Section 3.4 of
[I-D.ietf-nvo3-geneve]) of data packets indicates that there exists
an inner IP header, i.e., the Protocol Type equals to 0x0800 (IPv4)
or 0x86DD (IPv6), then BFD packets are encapsulated in Geneve as
described below.  The Geneve packet format over IPv4 is defined in
Section 3.1 of [I-D.ietf-nvo3-geneve].  The Geneve packet format over
IPv6 is defined in Section 3.2 of [I-D.ietf-nvo3-geneve].  The Outer
IP/UDP and Geneve headers MUST be encoded by the sender as defined in
[I-D.ietf-nvo3-geneve].  Note that the outer IP header and the inner
IP header may not be of the same address family, in other words,
outer IPv6 header accompanied with inner IPv4 header and outer IPv4
header accompanied with inner IPv6 header are both possible.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                   Outer Ethernet Header                       ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Outer IPvX Header                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Outer UDP Header                           ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                     Geneve Header                             ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Inner IPvX Header                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                     Inner UDP Header                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                   BFD Control Message                         ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            FCS                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
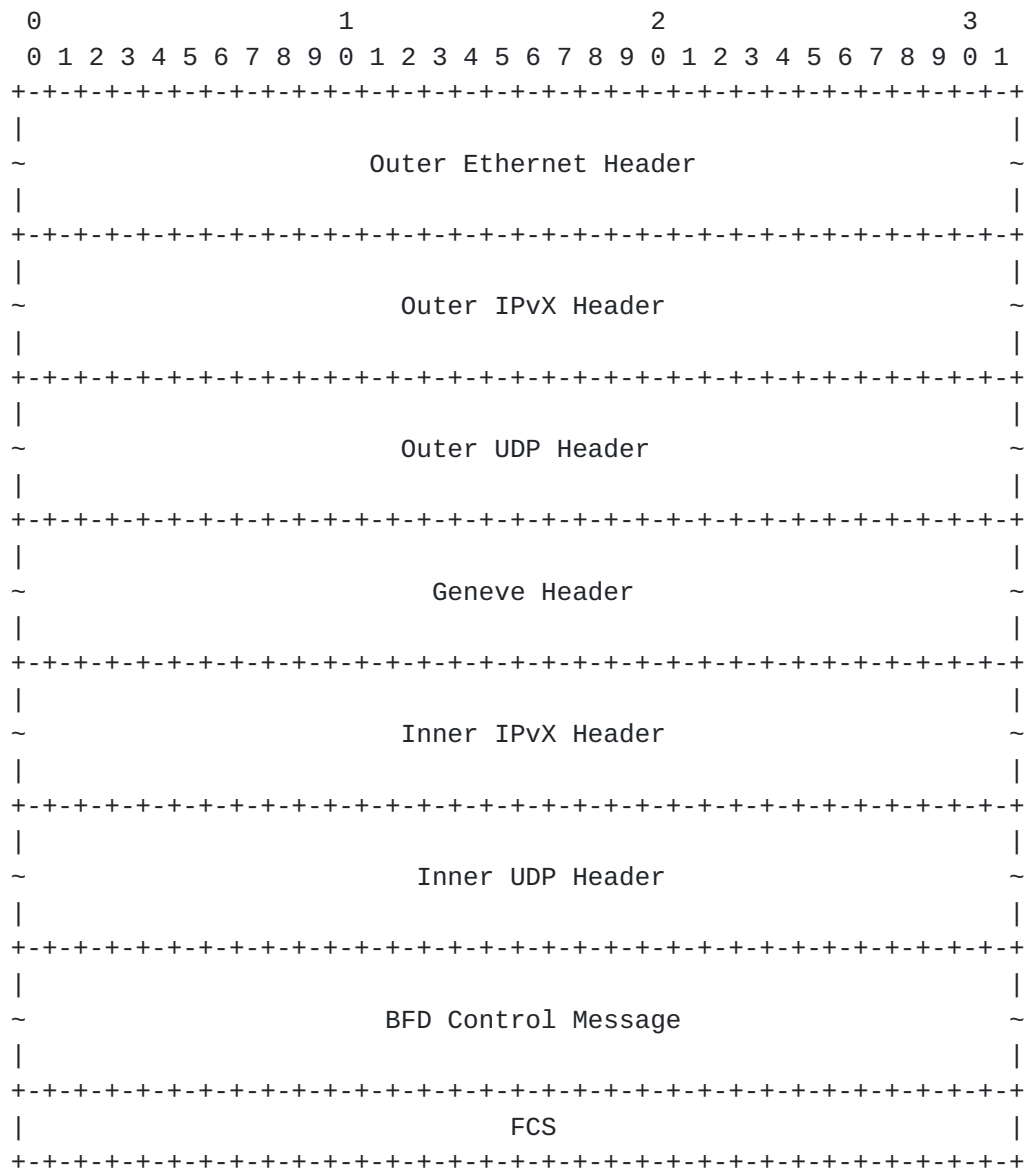
Figure 3: Geneve Encapsulation of BFD Control Message With the Inner
                          IP/UDP Header

The BFD packet MUST be carried inside the inner IP packet of the
Geneve packet.  The inner IP packet carrying the BFD payload has the
following format:

   IP header:

      Source IP: IP address of a VAP of the originating NVE.

      Destination IP: IP address of a VAP of the terminating NVE.

TTL: MUST be set to 1 to ensure that the BFD packet is not
routed within the L3 underlay network.

The fields of the UDP header and the BFD control packet are
encoded as specified in [RFC5881].

When the BFD packets are encapsulated in Geneve in this way, the
Geneve header follows the value set below.

Opt Len field SHOULD be set to 0, which indicates there isn't any
variable length option.

O bit MUST be set to 1, which indicates this packet contains a
control message.

C bit MUST be set to 0.

Protocol Type field MUST be set to 0x0800 (IPv4) or 0x86DD (IPv6),
depending on the address family of the inner IP packet.

## 3.3. BFD Encapsulation With Inner MPLS Header

If the Protocol Type field (as defined in Section 3.4 of
[I-D.ietf-nvo3-geneve]) of data packets indicates that there exists
an inner MPLS header, i.e., the Protocol Type equals to 0x8847 (MPLS)
or 0x8848 (MPLS with the upstream-assigned label), then BFD packets
are encapsulated in Geneve as described below.  The Geneve packet
format over IPv4 is defined in Section 3.1 of [I-D.ietf-nvo3-geneve].
The Geneve packet format over IPv6 is defined in Section 3.2 of
[I-D.ietf-nvo3-geneve].  The Outer IP/UDP and Geneve headers MUST be
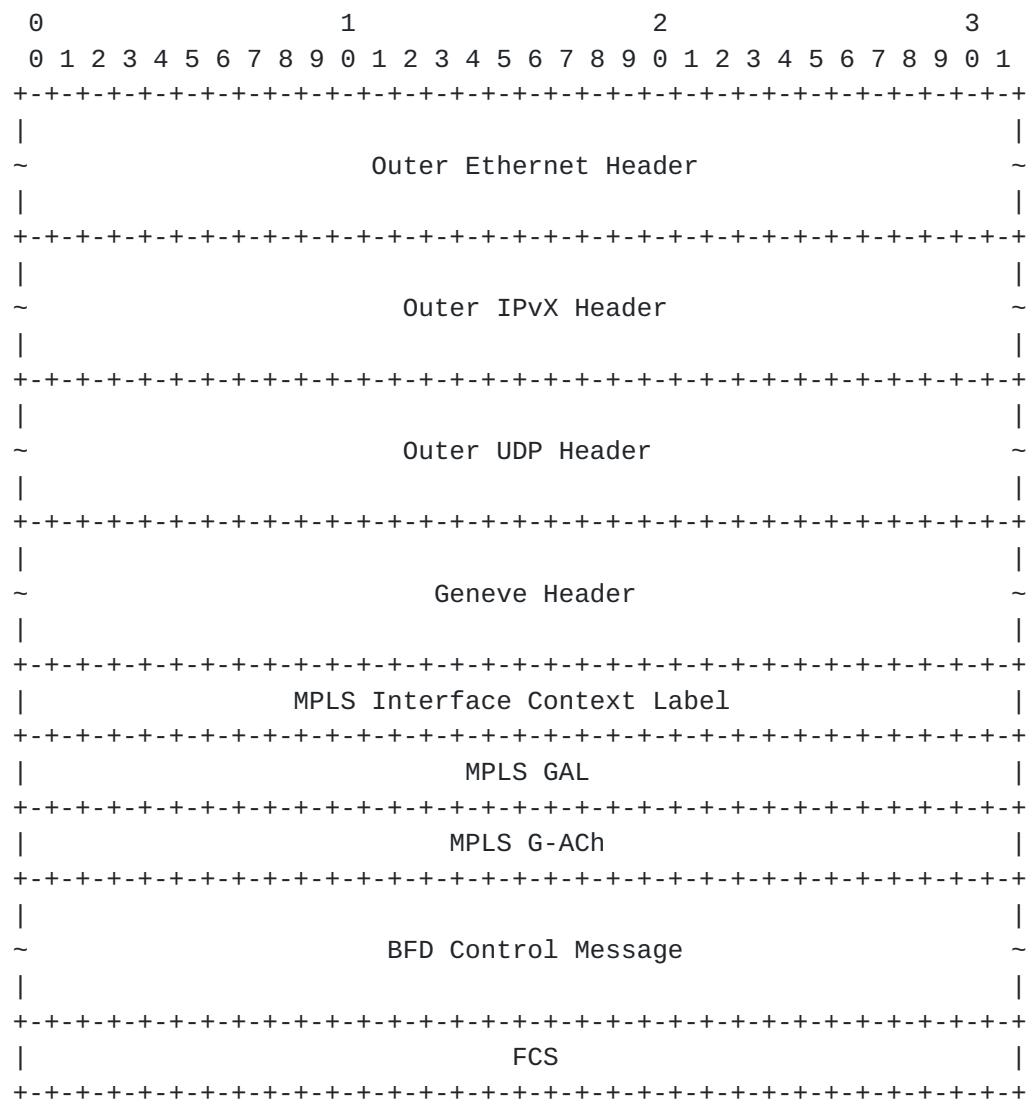encoded by the sender as defined in [I-D.ietf-nvo3-geneve].

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                   Outer Ethernet Header                       ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                    Outer IPvX Header                          ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                    Outer UDP Header                           ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                     Geneve Header                             ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                 MPLS Interface Context Label                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                       MPLS GAL                                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                       MPLS G-ACh                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                   BFD Control Message                         ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                         FCS                                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Figure 4: Geneve Encapsulation of BFD Control Message With the Inner
                         MPLS GAL/G-ACh

   The BFD packet MUST be carried inside the inner MPLS packet of the
   Geneve packet.  The inner MPLS packet carrying the BFD payload has
   the following format:

      MPLS Interface Context Label: This Label would be used to identify
      a VAP of the originating NVE and a VAP of the terminating NVE.

      MPLS GAL (Generic Associated Channel Label):

         Label value: MUST be set to 13, as specified in [RFC5586].

         S bit: MUST be set to 1.

   TTL: MUST be set to 1.

      The fields of the MPLS G-ACh (Generic Associated Channel) and the
      BFD control packet are encoded as specified for MPLS-TP CC
      (Continuity Check) message in [RFC6428].

   When the BFD packets are encapsulated in Geneve in this way, the
   Geneve header follows the value set below.

      Opt Len field SHOULD be set to 0, which indicates there isn't any
      variable length option.

      O bit MUST be set to 1, which indicates this packet contains a
      control message.

      C bit MUST be set to 0.

      Protocol Type field MUST be set to 0x8847 (MPLS).

## 4.  Reception of BFD packet from Geneve Tunnel

   Once a packet is received, NVE MUST validate the packet as described
   in [I-D.ietf-nvo3-geneve].

      If the Protocol Type field equals 0x6558 (Ethernet frame), and the
      Destination MAC of the inner Ethernet frame matches one MAC
      address owned by the NVE, the Destination IP, the UDP destination
      port and the TTL of the inner IP packet MUST be validated to
      determine whether the received packet can be processed by BFD.
      BFD packet with inner MAC set to NVE MUST NOT be forwarded to TSs.

      If the Protocol Type field equals 0x0800 (IPv4) or 0x86DD (IPv6),
      and the Destination IP of the inner IP packet matches a VAP IP
      address of the NVE, the UDP destination port and the TTL of the
      inner IP packet MUST be validated to determine whether the
      received packet can be processed by BFD.  BFD packet with inner IP
      set to NVE MUST NOT be forwarded to TSs.

      If the Protocol Type field equals 0x8847 (MPLS), the MPLS
      Interface Context Label, the MPLS GAL and the MPLS G-ACh of the
      inner MPLS packet MUST be validated to determine whether the
      received packet can be processed by BFD.  BFD packet with MPLS GAL
      MUST NOT be forwarded to TSs.

## 4.1.  Demultiplexing of the BFD packet

In BFD over Geneve, a BFD session is originated and terminated at VAP, usually one NVE owns multiple VAPs, so multiple BFD sessions may be running between two NVEs, there needs to be a mechanism for demultiplexing received BFD packets to the proper session.

If the BFD packet is received with Your Discriminator equals to 0, for different BFD encapsulation, the procedure for demultiplexing the received BFD packets is different.

When the BFD Encapsulation With Inner Ethernet/IP/UDP Header is used, the BFD session MUST be identified using the procedure specified in Section 5.1 of [I-D.ietf-bfd-vxlan].

When the BFD Encapsulation With Inner IP/UDP Header is used, the BFD session MUST be identified using the inner IP/UDP header, i.e., the source IP and the destination IP present in the inner IP/UDP header.

When the BFD Encapsulation With Inner MPLS Header is used, the BFD session MUST be identified using the inner MPLS header, i.e., the MPLS Interface Context Label present in the inner MPLS header.

If the BFD packet is received with non-zero Your Discriminator, then BFD session MUST be demultiplexed only with Your Discriminator as the key.

With respect to BFD for Geneve, the use of the specific VNI would follow the principle as specified in Section 6 of [I-D.ietf-bfd-vxlan].

[Ed.Note]: Currently it's still undetermined whether "BFD for VxLAN" should allow multiple BFD sessions for the same VNI.  The Editor leans to believe "BFD for Geneve" should allow multiple BFD sessions for the same VNI, and it needs further discussion.

## 5.  Security Considerations

This document does not raise any additional security issues beyond those of the specifications referred to in the list of normative references.

## 6.  IANA Considerations

This document has no IANA action requested.

## 7.  Acknowledgements

The authors would like to acknowledge Reshad Rahman, Jeffrey Haas and
Matthew Bocci for their guidance on this work.

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