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EVPN Network Layer Fault Management  
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Abstract

This document specifies **proactive, in-band network layer OAM mechanisms** to detect loss of continuity faults that affect unicast and multi-destination paths (used by Broadcast, Unknown Unicast, and Multicast traffic) in an Ethernet VPN (**EVPN, RFC 7432bis**) network. The mechanisms specified in the **draft-document** use the widely adopted Bidirectional Forwarding Detection (RFC 5880) protocol **and other protocols as necessary**.

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- Commenté [BMI1]:** I fail to find this defined in RFC7432 or 7432bis. I think that you are referring to the layering in 2.1 of 9062.
- I'm not asking to make a change here, but for the readers convenience, you can consider adding a sentence in the introduction about 2.1 of 9062 to poision the layer you are considering.
- Commenté [BMI2]:** This is the only mention in the document. I would delete or elaborate on this aspect in the main text.
- Commenté [BMI3]:** Any reason why the bis is cited explicitly here? Are there parts of the spec that are not applicable to 7432?  
Please clarify in the doc.
- Commenté [BMI4]:** Unless you cite those, I'm not sure this adds much to the readers.

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## 1. Introduction

[RFC9062] outlines the OAM requirements of Ethernet VPN networks (EVPN) [rfc7432bis]. This document specifies mechanisms for proactive fault detection at the network (overlay) layer of EVPN, that is to say between PEs (Provider Edge (PE) nodes). The mechanisms proposed-specified in this document use the widely adopted

### Bidirectional

Forwarding Detection (BFD) [RFC5880] protocol, which is a lightweight protocol using fixed length messages suitable for implementation in hardware, and other protocols as necessary. EVPN restoration mechanisms (redundancy and recovery/convergence) are the most logical clients for BFD sessions specified herein.

EVPN fault detection mechanisms need to consider unicast traffic separately from Broadcast, Unknown Unicast, and Multicast (BUM) traffic since they map to different Forwarding Equivalency Classes (FECs) in EVPN. Hence this document proposes-specifies somewhat different

continuity fault detection mechanisms depending on the type of traffic and the type of tunnel used as follows:

\* Using BFD [RFC5880] for unicast traffic and BUM traffic via Multipoint to Point (MP2P) tunnels.

\* Using BFD Multipoint [RFC8562] or BFD Multipoint Active Tails

Commenté [BMI5]: "networks" is redundant with "N"

Commenté [BMI6]: To be consistent in the doc about expanding terms.

Commenté [BMI7]: Wouldn't you need 5881-5884 as well?

Commenté [BMI8]: I don't parse what is meant here as "client" has a specific meaning in BFD.

Commenté [BMI9]: Can we back this with a requirement in rfc9062?

Commenté [BMI10]: ?

Commenté [BMI11]: Pointing to 2.3 of 9062 would be helpful to digest these cases.

[RFC8563] [ietf-mp-ls-p2mp-bfd] for BUM traffic via a Point to Multipoint (P2MP) tunnel.

Packet loss and packet delay measurement are out of scope for this document. See [ietf-bmwg-evpn-test] for EVPN benchmarking guidance.

### 1.1. Terminology

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.

The following acronyms are used in this document.

BFD - Bidirectional Forwarding Detection-~~[RFC5880]~~

BUM - Broadcast, ~~Unknown-unknown~~ Unicast, and ~~Multicast~~ Multicast

Commenté [BMI12]: Per 7432

CC - Continuity Check

CE - Customer Edge

EVI - EVPN Instance

EVPN - Ethernet VPN-~~[rfe7432bis]~~

FEC - Forwarding Equivalency Class

GAL - Generic Associated Channel Label [RFC5586]

Commenté [BMI13]: This is used only once in the doc.

LSM - Label Switched Multicast-~~(P2MP)~~

LSP - Label Switched Path

~~MP2MP~~ - Multi-~~P~~oint-to-Multi-~~P~~oint

Commenté [BMI14]: Used only once in the doc.

MP2P - ~~Multipoint to Point~~ Multi-~~Point~~-to-Point

Commenté [BMI15]: For consistency with 9062

OAM - Operations, Administration, and Maintenance

P2MP - ~~Point to Multipoint~~ Point-to-Multi-Point (LSM)

Commenté [BMI16]: For consistency with 9062

P2P - Point to Point

PE - Provider Edge ~~node~~

Commenté [BMI17]: Please check rfc4026

VXLAN - Virtual eXtensible Local Area Network-~~[RFC7348]~~

### 2. Scope of this Document

This document specifies ~~BFD~~-based mechanisms for proactive fault detection for EVPN as specified in [rfc7432bis] and also for EVPN using VXLAN encapsulation [RFC8365]. Specifically, the document ~~it~~ covers the following:

- \* Unicast traffic using Point-to-Point (P2P) and Multi-Point-to-Point (MP2P) tunnels.
- \* BUM traffic using ingress replication via Point-to-Point (P2P) and Multi-Point-to-Point (MP2P) tunnels.
- \* BUM traffic using Point-to-Multi-Point (P2MP) tunnels (Label Switched Multicast (LSM)).
- \* MPLS and VXLAN encapsulation.

This document does not discuss BFD mechanisms for:

- \* The PBB-EVPN [RFC7623] EVPN variant. It is intended to address this in future versions of this document.
- \* Integrated Routing and Bridging (IRB) solution based on EVPN [RFC9135]. It is intended to address this in future versions of this document.
- \* EVPN using other encapsulations such as NVGRE or MPLS over GRE [RFC8365].
- \* BUM traffic using MP2MP tunnels.

This document specifies procedures for BFD asynchronous mode. BFD demand mode is outside the scope of this specification except as it is used in [RFC8563]. The use of the BFD Echo function is outside the scope of this specification.

### 3. Motivation for Running BFD at the EVPN Network Layer

The choice of running BFD at the network layer of the OAM model for EVPN [RFC9062] was made after considering the following:

- \* In addition to detecting link failures in the an EVPN network, BFD sessions at the network layer can be used to monitor the successful setup, such as label programming, of MP2P and P2MP EVPN tunnels transporting Unicast and BUM traffic. The scope of reachability detection covers the ingress and the egress EVPN PE (Provider Edge) nodes and the network connecting them.
- \* Monitoring a representative set of path(s) or a particular path among multiple paths available between two EVPN PEs nodes could be done by exercising entropy mechanisms such as entropy labels, when they are used, or VXLAN source port numbers. However, paths that cannot be realized by entropy variations cannot be monitored. The fault monitoring requirements outlined by [RFC9062] are addressed by the mechanisms proposed-defined-by-in this draftdocument.

BFD testing between EVPN PEs nodes does not guarantee that the EVPN service is functioning. (This can be, e.g., monitored at the service level, that is CE (Customer Edge) to CE.) For example, an egress EVPN PE could understand EVPN labeling received but could switch data to an

**Commenté [BMI18]:** I guess you meant other documents?

**Commenté [BMI19]:** Is it the intent to cover this here or leave this to a separate document?

I would simply delete the sentence

**Commenté [BMI20]:** May be call out specific sections, e.g., 5.2 of 8365?

**Commenté [BMI21]:** Please clarify as I don't see any BFD discussion in that RFC.

**Commenté [BMI22]:** This smells like an operational recommendation, while I think that "choice" is up to the operators. The spec should reason about describing how BFD can be used + provided features.

I would reword accordingly.

**Commenté [BMI23]:** Consider adding pointers/RFCs.

**Commenté [BMI24]:** Which specific requirements are you referring to? Please explicit it in the text. Thanks.

**Commenté [BMI25]:** Please point to th 9062 for the service layer matters.

**Commenté [BMI26]:** For consistency with rfc9062

**Commenté [BMI27]:** What does that mean technically? Maintain a state?

Please reword.

incorrect interface. However, BFD testing in the EVPN Network Layer does provide additional confidence that data transported using those tunnels will reach the expected egress node. When BFD testing in the EVPN overlay fails, that can be used as an indication of a Loss-of-Connectivity defect in the EVPN underlay that would cause EVPN service failure.

#### 4. Fault Detection for Unicast Traffic

The mechanisms specified in BFD for MPLS LSPs [RFC5884] [RFC7726] and BFD for VXLAN [RFC8971] are, **except as otherwise provided herein**, applied to test loss of continuity for unicast EVPN traffic. The MPLS control plane can be verified against the data plane as specified in [RFC8029]. When the discriminators required for de-multiplexing the BFD sessions are **not otherwise available**, they can be advertised through BGP using the BFD Discriminator Attribute [RFC9026]. Discriminators are needed for MPLS since the label stack does not contain enough information to identify the sender of **thea** packet.

The usage of MPLS entropy labels [RFC6790] or **various** VXLAN source **Portport numbers** **takes care** of the requirement to monitor various paths of the **multi-path server layer network**. Each unique realizable path between the participating PE **s routers** **MAY** be monitored separately when such entropy is used. At least one path of multi-path connectivity between two PE **s routers** **MUST** be tracked with BFD, but in that case the granularity of fault-detection will be coarser.

To support unicast fault management to a PE **node**, that PE **MUST** allocate or be configured with a BFD discriminator to be used as Your

Discriminator (**Section 4.1 of [RFC5880]**) in the BFD messages to it. **By default, it-a PE** advertises this discriminator with BGP using the BFD Discriminator Attribute [RFC9026] with BFD Mode TBD2 in an EVPN Ethernet Autodiscovery Route [rfc7432bis] or MAC/IP Advertisement Route as long as it advertises it in at least one route. **It-A PE** extracts its peer's discriminator from such an attribute. However, these discriminators **MAY** be exchanged out-of-band or through some other mechanism outside the scope of this document.

Once a PE knows a unicast route and discriminator for another PE and if **it is the higher priority** of the two PEs to initiate BFD and is configured to do so, it endeavors to bring UP and maintain a BFD session to that other PE.

Once the BFD session is UP, the ends of the BFD session **MUST NOT** change the local discriminator values of the BFD Control packets they generate, unless they first bring down the session as specified in [RFC5884]. **The BFD session is brought down if a PE is no longer configured to maintain it or if a route and discriminator are no longer available.**

#### 5. Fault Detection for BUM Traffic

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Commenté [BMI28]: Such as?

I wonder if you can cite an example of such case.

Commenté [BMI29]: Not sure what is meant here.

Commenté [BMI30]: Not sure what is meant here. Please reword. Thanks.

Commenté [BMI31]: Which server? Do you meant service layer? If son, why network is also cited?

Please clarify in the text.

Commenté [BMI32]: Not sure the normative language is justified here. Please check

Commenté [BMI33]: This text and the sentence right after smell like a SHOULD. Wonder if it is clearer to use a normative language here.

a mis en forme : Surlignage

Commenté [BMI34]: I guess your are referring to this part of Section 7 of 5884:

"Note that once the BFD session for the MPLS LSP is UP, either end of the BFD session **MUST NOT** change the source IP address and the local discriminator values of the BFD Control packets it generates, unless it first brings down the session. "

I would add an explicit pointer to that specific section.

Also, the use of the normative language here is redundant with the first sentence in this section:

" The mechanisms specified in BFD for MPLS LSPs [RFC5884] [RFC7726] and BFD for VXLAN [RFC8971] are ... applied to test loss of continuity for unicast EVPN traffic. "

Section 5.1 ~~below~~ discusses BUM traffic fault detection for P2P and MP2P tunnels using ingress replication and Section 5.2 discusses such fault detection for P2MP tunnels.

### 5.1. Ingress Replication

Ingress replication uses separate P2P or MP2P tunnels for transporting BUM traffic from the ingress PE (head) to a set of one or more egress PEs (tails). The fault detection mechanism specified by this document takes advantage of the fact that the head makes a unique copy for each tail.

**Commenté [BMI35]:** Any reference to cite here? Maybe rfc7432#section-11?

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Another key aspect to be considered in EVPN is the advertisement of the Inclusive Multicast Ethernet Tag Route [rfc7432bis]. The BUM traffic flows from a head node to a particular tail only after the head receives such an inclusive multicast route from the tail. This route contains the BUM EVPN MPLS label (downstream allocated) corresponding to the MP2P tunnel for MPLS encapsulation and contains the IP address of the PE originating the inclusive multicast route for use in VXLAN encapsulation. It also contains a BFD Discriminator Attribute [RFC9026] with BFD Mode TDB4 giving the BFD discriminator that will be used by the tail. This is the P2P mode BFD Discriminator Attribute since a P2P BFD session is used in both the P2P and MP2P cases with ingress replication.

**Commenté [BMI36]:** Please help readers and cite the exact section to look at. Thanks

**Commenté [BMI37]:** Internal consistency: Previous sections state that 9026 is not mandatory and other mechanisms can be used. This text seems to assume that it is always used.

**Commenté [BMI38]:** To be fixed

**a mis en forme :** Surlignage

**Commenté [BMI39]:** Not sure the normative language is justified here.

There MAY exist multiple BFD sessions between a head PE and an individual tail due to (1) the usage of MPLS entropy labels [RFC6790] or VXLAN source port numbers for an inclusive multicast FEC and (2)

due to

multiple MP2P tunnels indicated by different tail labels for MPLS or different IP addresses for VXLAN encapsulation. If a PE is configured to do so, once a PE

knows a multicast route and discriminator for another PE it endeavors to bring UP and maintain a BFD session to that other PE. Once a BFD session for a path is UP, the ends of the BFD session MUST NOT change the local discriminator values of the BFD Control packets they generate, unless they first bring down the session as specified in [RFC5884]. The BFD session is brought down if a PE is no longer configured to maintain it or if a route and discriminator are no longer available.

### 5.2. P2MP Tunnels (Label Switched Multicast)

Fault detection for BUM traffic distributed using a P2MP tunnel uses BFD Multipoint Active Tails [RFC8563] in one of the three methods providing head notification. Which method is used depends on the local configuration. Sections 5.2.2 and 5.2.3 of [RFC8563] describe two of these methods ("Head Notification and Tail Solicitation with Multipoint Polling" and "Head Notification with Composite Polling"). The third method ("Head Notification without Polling") is touched on in Section 5.2.1 of [RFC8563] and fully specified in [ietf-mpls-p2mp-bfd]. All ~~three of these~~ three modes assume the existence of a

unicast

return path from each tail to the head. In addition, Head Notification with Composite Polling assumes a head to tail unicast path disjoint from the path used by the P2MP tunnel.

The BUM traffic flows from a head node to the tails after the head transmits an Inclusive Multicast Tag Route [rfc7432bis] if local configuration so directs. This route contains the BUM EVPN MPLS label (upstream allocated) corresponding to the P2MP tunnel for MPLS encapsulation. **The route also includes a BFD Discriminator Attribute** [RFC9026] with the BFD Mode set to 1 and a Source IP Address TLV, which gives the address associated with the MultiPoint Head of the P2MP session. This BFD discriminator advertised by the head in the Inclusive Multicast route or otherwise configured at or communicated to a tail MUST be used in any reverse BFD control message as Your Discriminator so the head can determine the tail of which P2MP BFD session is responding. If **a PE is** configured to do so, once a PE

Commenté [BMI40]: Idem as a previous comment

knows a P2MP multicast route and the needed discriminators, it brings UP and maintains a P2MP BFD active tails session to the tails. The BFD session is brought down if a PE is no longer configured to maintain it or the multicast route and discriminators are no longer available.

For MPLS encapsulation of the head to tails BFD, Label Switched Multicast is used. For VXLAN encapsulation, BFD is delivered to the tails through underlay multicast using an outer multicast IP address.

## 6. BFD Packet Encapsulation

The **following subsections below** discuss the MPLS and VXLAN encapsulations of BFD for EVPN network layer fault management.

### 6.1. MPLS Encapsulation

This section describes use of the Generic Associated Channel Label (GAL) for BFD encapsulation in ~~MPLS-MPLS~~-based EVPN network layer fault management. Since the use of BFD specified in this document is encapsulated between PEs, it is treated as single hop and uses the single hop BFD port **number [RFC5881]**.

#### 6.1.1. Unicast MPLS Encapsulation

As shown in Figure 1, ~~the-a~~ packet **initially** contains the following labels: LSP label (transport), the optional entropy label, the EVPN Unicast label, and then the Generic Associated Channel label with the G-ACh type set to TBD1. The G-ACh payload of the packet MUST contain the destination ~~L2-Layer 2~~ header (in overlay space) followed by the

Commenté [BMI41]: What does mean initially here?

IP header that encapsulates the BFD packet. The **MAC address of the inner packet** is used to validate the <EVI, MAC> in the receiving node.

Commenté [BMI42]: Which one? Src?

\* The destination MAC **address** MUST be the **dedicated unicast MAC address TBD3** (see Section 8) or the MAC address of the destination PE.

a mis en forme : Surlignage

Commenté [BMI43]: There is no such requested value in IANA section

\* The destination IP address MUST be 127.0.0.1/32 for IPv4 **[RFC1812]** or ::1/128 for IPv6 [RFC4291].

Commenté [BMI44]: I would use rfc6890, instead

\* The destination UDP port **number** MUST be 3784 [RFC5881].

- \* The source UDP port number MUST be in the range 49152 through 65535.
- \* The discriminator values for BFD are obtained as discussed in Section 4.
- \* IPv4 TTL or IPv6 Hop Limit MUST be set to 255 according to [RFC5082].

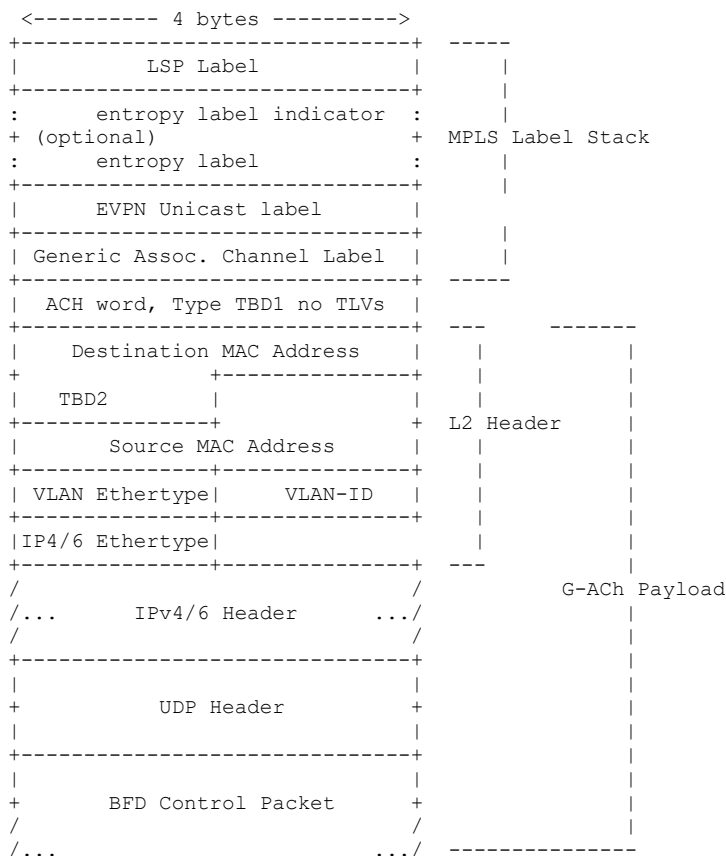


Figure 1: MPLS Unicast Encapsulation

### 6.1.2. MPLS Ingress Replication

~~The A~~ packet initially contains the following labels: LSP label (transport), optionally the entropy label, the BUM label, and the split horizon label [rfc7432bis] (where applicable). The G-ACh type is set to TBD1. The G-ACh payload of the packet is as described in Section 6.1.1 except that the destination MAC address is the dedicated multicast MAC address TBD2.

**Commenté [BMI45]:** Idem as above.

**Commenté [BMI46]:** But TBD2 is about "P2P BFD Session". Please double check.

**a mis en forme :** Surlignage



### 6.1.3. MPLS LSM (Label Switched Multicast, P2MP)

The encapsulation is the same as in Section 6.1.2 for ingress replication except that the transport label identifies the P2MP tunnel, in effect the set of tail PEs, rather than identifying a single destination PE at the end of an MP2P tunnel.

## 6.2. VXLAN Encapsulation

This section describes the use of the VXLAN [RFC7348] [RFC8365] for BFD encapsulation in VXLAN based EVPN fault management.

### 6.2.1. Unicast VXLAN Encapsulation

Figure 2 below shows the unicast VXLAN encapsulation on the wire on an Ethernet link. The outer and inner IP headers have a unicast source and destination IP addresses that are the addresses of the PEs that are the BFD message source and destination. If the BFD source has multiple IP addresses, entropy MAY be further obtained by using any of those addresses assuming the source is prepared for responses directed to the IP address used.

**a mis en forme : Surlignage**

**Commenté [BMI47]:** Independent of the address family?

- \* The outer destination UDP port number MUST be 4789 [RFC7348].
- \* The inner destination UDP port number MUST be 3784 [RFC5881].
- \* The outer and inner source UDP port numbers MUST each be in the range 49152 through 65535.
- \* The inner destination MAC address MUST be the MAC address of the destination PE or the dedicated unicast MAC TBD3 (see Section 8).

**Commenté [BMI48]:** There is no such requested value in IANA section

```

<----- 4 bytes ----->
+-----+-----+
| Destination MAC Address |
+-----+-----+
|                               |
+-----+-----+
| Source MAC Address |
+-----+-----+
| VLAN Ethertype | VLAN-ID |
+-----+-----+
| IP4/6 Ethertype |
+-----+-----+
/                               /
/... IP4/6 Header .../
/                               /
+-----+-----+
|                               |
+-----+-----+
| UDP Header |
+-----+-----+
|                               |
+-----+-----+
| VXLAN Header |
+-----+-----+

```

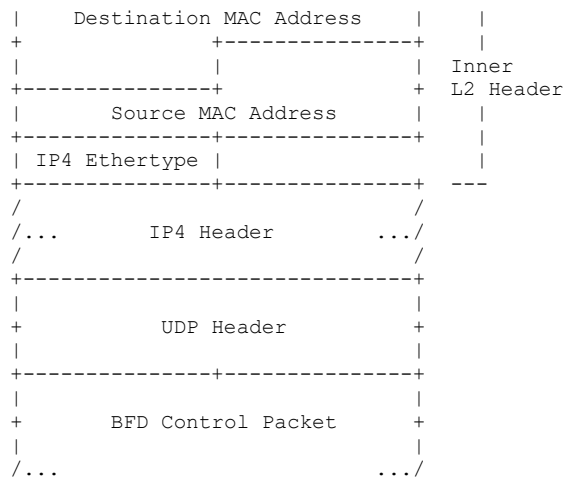


Figure 2: VXLAN Unicast Encapsulation

#### 6.2.2. VXLAN Ingress Replication

The BFD packet construction is as given in Section 6.2.1 except ~~as follows~~ the following:

1. The destination IP address used by the BFD message source is that advertised by the destination PE in its Inclusive Multicast EVPN route for the MP2P tunnel in question; and
2. The Your BFD discriminator used is the one advertised by the BFD destination using BGP as discussed in Section 5.1 for the MP2P tunnel.

#### 6.2.3. VXLAN P2MP

The VXLAN encapsulation for the head-to-tails BFD packets uses the multicast destination IP address corresponding to the VXLAN VNI.

The destination UDP port number MUST be 3784. For entropy purposes, the source UDP port number ~~can may~~ vary but MUST be in the range 49152 through 65535

[RFC5881]. If the head PE has multiple IP addresses, entropy MAY be further obtained by using any of those addresses.

The Your BFD discriminator is the value distributed for this multicast fault management purpose as discussed in Section 5.2.

#### 7. Scalability Considerations

The mechanisms ~~proposed by this draft~~ defined in this document could affect the packet load on the network and its elements especially when supporting configurations involving a large number of EVIs. The option of slowing down or speeding up BFD timer values can be used by an

**Commenté [BMI49]:** Independent of the address family or for a given address family?

**Commenté [BMI50]:** Do you mean increase/decrease? If so, please reword.

administrator or a network management entity to maintain the overhead incurred due to fault monitoring at an acceptable level.

## 8. IANA Considerations

~~The following IANA Actions are requested.~~

### 8.1. Pseudowire Associated Channel Type

IANA is requested to assign a channel type from the "Pseudowire Associated Channel Types" registry in [RFC4385] as follows.

Value	Description	Reference
-----	-----	-----
TBD1	BFD-EVPN OAM	[this document]

### 8.2. BFD Discriminator Attribute Mode

IANA is requested to assign a value from the IETF Review range in the BFD Mode sub-registry on the Border Gateway Protocol Parameters Registry web page as follows:

Value	Description	Reference
-----	-----	-----
TBD2	P2P BFD Session	[this document]

## 9. Security Considerations

Security considerations discussed in [RFC5880], [RFC5883], and [RFC8029] apply.

MPLS security considerations [RFC5920] apply to BFD Control packets encapsulated in a MPLS label stack. When ~~BFD~~-BFD Control packets are routed, the authentication considerations discussed in [RFC5883] should be followed.

VXLAN BFD security considerations in [RFC8971] apply to BFD packets encapsulate in VXLAN.

## 10. Normative References

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