Workgroup: MPLS Working Group
Internet-Draft: draft-ietf-mpls-p2mp-bfd-00
Published: 9 February 2022
Intended Status: Standards Track
Expires: 13 August 2022
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BFD for Multipoint Networks over Point-to-Multi-Point MPLS LSP

Abstract

This document describes procedures for using Bidirectional Forwarding Detection (BFD) for multipoint networks to detect data plane failures in Multiprotocol Label Switching (MPLS) point-to-multipoint (p2mp) Label Switched Paths (LSPs) and Segment Routing (SR) point-to-multipoint policies with SR-MPLS data plane.

It also describes the applicability of LSP Ping, as in-band, and the control plane, as out-band, solutions to bootstrap a BFD session.

It also describes the behavior of the active tail for head notification.

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1. Introduction

[RFC8562] defines a method of using Bidirectional Detection (BFD) [RFC5880] to monitor and detect unicast failures between the sender (head) and one or more receivers (tails) in multipoint or multicast networks.

[RFC8562] added two BFD session types - MultipointHead and MultipointTail. Throughout this document, MultipointHead and MultipointTail refer to the value of the bfd.SessionType is set on a BFD endpoint.

This document describes procedures for using such modes of BFD protocol to detect data plane failures in Multiprotocol Label Switching (MPLS) point-to-multipoint (p2mp) Label Switched Paths (LSPs) and Segment Routing (SR) point-to-multipoint policies with SR-MPLS data plane

The document also describes the applicability of out-band solutions to bootstrap a BFD session in this environment.

It also describes the behavior of the active tail for head notification.

2. Conventions used in this document

2.1. Terminology

MPLS: Multiprotocol Label Switching

LSP: Label Switched Path

BFD: Bidirectional Forwarding Detection

p2mp: Point-to-Multipoint

FEC: Forwarding Equivalence Class

G-ACh: Generic Associated Channel

ACH: Associated Channel Header

GAL: G-ACh Label

LSR: Label Switching Router

SR: Segment Routing

SR-MPLS: SR with MPLS data plane

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. Multipoint BFD Encapsulation

[RFC8562] uses BFD in the Demand mode from the very start of a point-to-multipoint (p2mp) BFD session. Because the head doesn't receive any BFD Control packet from a tail, the head of the p2mp BFD session transmits all BFD Control packets with the value of Your Discriminator field set to zero. As a result, a tail cannot demultiplex BFD sessions using Your Discriminator, as defined in [RFC5880]. [RFC8562] requires that to demultiplex BFD sessions, the tail uses the source IP address, My Discriminator, and the identity of the multipoint tree from which the BFD Control packet was received. If the BFD Control packet is encapsulated in IP/UDP, then the source IP address MUST be used to demultiplex the received BFD Control packet as described in Section 3.1. The non-IP encapsulation case is described in Section 3.2.

3.1. IP Encapsulation of Multipoint BFD

[RFC8562] defines IP/UDP encapsulation for multipoint BFD over p2mp MPLS LSP:

- *UDP destination port MUST be set to 3784;

- *destination IP address MUST be set to the loopback address 127.0.0.1/32 for IPv4, or the loopback address ::1/128 for IPv6 [RFC4291]. Note that that is different from how the destination IP address selection is defined in Section 7 [RFC5884]. Firstly, because only one loopback address ::1/128 is defined in IPv6. And also, it is recommended to use the Entropy Label [RFC6790] to discover multiple alternate paths in an MPLS network. Using a single loopback address both for IPv4 and IPv6 encapsulation makes it consistent and more straightforward for an implementation.

The Motivation section [RFC6790] lists several advantages of generating the entropy value by an ingress Label Switching Router (LSR) compared to when a transit LSR infers entropy using the information in the MPLS label stack or payload. Thus this specification further clarifies that:

> if multiple alternative paths for the given p2mp LSP Forwarding Equivalence Class (FEC) exist, the MultipointHead SHOULD use Entropy Label [RFC6790] used for LSP Ping [RFC8029] to exercise those particular alternative paths;
>
> or the MultipointHead MAY use the UDP port number as discovered by LSP Ping traceroute [RFC8029] as the source UDP port number to possibly exercise those particular alternate paths.

3.2. Non-IP Encapsulation of Multipoint BFD

In some environments, the overhead of extra IP/UDP encapsulations may be considered burdensome, making the use of more compact G-ACh encapsulation attractive. Also, the validation of the IP/UDP encapsulation of a BFD Control packet in a p2mp BFD session may fail because of a problem related to neither the MPLS label stack nor to BFD. Avoiding unnecessary encapsulation of p2mp BFD over an MPLS LSP improves the accuracy of the correlation of the detected failure and defect in MPLS LSP. Non-IP encapsulation for multipoint BFD over p2mp MPLS LSP MUST use Generic Associated Channel (G-ACh) Label (GAL) (see [RFC5586]) at the bottom of the label stack followed by an Associated Channel Header (ACH). If a BFD Control packet in PW-ACH encapsulation (without IP/UDP Headers) is to be used in ACH, an implementation would not be able to verify the identity of the MultipointHead and, as a result, will not properly demultiplex BFD packets. Hence, a new channel type value is needed. The Channel Type

field in ACH MUST be set to TBA1 value Section 7. To provide the identity of the MultipointHead for the particular multipoint BFD session, a Source Address TLV [RFC7212] MUST immediately follow a BFD Control message.

4. Bootstrapping Multipoint BFD

4.1. LSP Ping

LSP Ping is the part of the on-demand OAM toolset used to detect and localize defects in the data plane and verify the control plane against the data plane by ensuring that the LSP is mapped to the same FEC at both egress and ingress endpoints.

LSP Ping, as defined in [RFC6425], MAY be used to bootstrap MultipointTail. If LSP Ping is used, it MUST include the Target FEC TLV and the BFD Discriminator TLV defined in [RFC5884]. For the case of p2mp MPLS LSP, the Target FEC TLV MUST use sub-TLVs defined in Section 3.1 [RFC6425]. For the case of p2mp SR policy with SR-MPLS data plane, an implementation of this specification MUST follow procedures defined in [RFC8287]. Setting the value of Reply Mode field to "Do not reply" [RFC8029] for the LSP Ping to bootstrap MultipointTail of the p2mp BFD session is RECOMMENDED. Indeed, because BFD over a multipoint network uses BFD Demand mode, the LSP echo reply from a tail has no useful information to convey to the head, unlike in the case of the BFD over a p2p MPLS LSP [RFC5884]. A MultipointTail that receives an LSP Ping that includes the BFD Discriminator TLV:

- MUST validate the LSP Ping;
- MUST associate the received BFD Discriminator value with the p2mp LSP;
- MUST create a p2mp BFD session and set bfd.SessionType = MultipointTail as described in [RFC8562];
- MUST use the source IP address of LSP Ping, the value of BFD Discriminator from the BFD Discriminator TLV, and the identity of the p2mp LSP to properly demultiplex BFD sessions.

Besides bootstrapping a BFD session over a p2mp LSP, LSP Ping SHOULD be used to verify the control plane against the data plane periodically by checking that the p2mp LSP is mapped to the same FEC at the MultipointHead and all active MultipointTails. The rate of generation of these LSP Ping Echo request messages SHOULD be significantly less than the rate of generation of the BFD Control packets because LSP Ping requires more processing to validate the consistency between the data plane and the control plane. An

implementation MAY provide configuration options to control the rate of generation of the periodic LSP Ping Echo request messages.

4.2. Control Plane

The BGP-BFD Attribute [RFC9026] MAY be used to bootstrap multipoint BFD session on a tail.

5. Operation of Multipoint BFD with Active Tail over P2MP MPLS LSP

[RFC8562] defined how the BFD Demand mode can be used in multipoint networks. When applied in MPLS, procedures specified in [RFC8562] allow an egress LSR to detect a failure of the part of the MPLS p2mp LSP from the ingress LSR. The ingress LSR is not aware of the state of the p2mp LSP. [RFC8563], using mechanisms defined in [RFC8562], defined an "active tail" behavior. An active tail might notify the head of the detected failure and responds to a poll sequence initiated by the head. The first method, referred to as Head Notification without Polling, is mentioned in Section 5.2.1 [RFC8563], is the simplest of all described in [RFC8563]. The use of this method in BFD over MPLS p2mp LSP is discussed in this document. Analysis of other methods of a head learning of the state of an MPLS p2mp LSP is outside the scope of this document.

As specified in [RFC8563] for the active tail mode, BFD variables MUST be as follows:

On an ingress LSR:

- *bfd.SessionType is MultipointHead;

- *bfd.RequiredMinRxInterval is set to nonzero, allowing egress LSRs to send BFD Control packets.

On an egress LSR:

- *bfd.SessionType is MultipointTail;

- *bfd.SilentTail is set to zero.

In Section 5.2.1 [RFC8563] is noted that "the tail sends unsolicited BFD packets in response to the detection of a multipoint path failure" but without the specifics on the information in the packet and frequency of transmissions. This document defines below the procedure of an active tail with unsolicited notifications for p2mp MPLS LSP.

Upon detecting the failure of the p2mp MPLS LSP, an egress LSR sends BFD Control packet with the following settings:

- *the Poll (P) bit is set;
- *the Status (Sta) field set to Down value;
- *the Diagnostic (Diag) field set to Control Detection Time Expired value;
- *the value of the Your Discriminator field is set to the value the egress LSR has been using to demultiplex that BFD multipoint session;
- *BFD Control packet MAY be encapsulated in IP/UDP with the destination IP address of the ingress LSR and the UDP destination port number set to 4784 per [RFC5883]. If non-IP encapsulation is used, then a BFD Control packet is encapsulated using PW-ACH encapsulation (without IP/UDP Headers) (0x0007) [RFC5885];
- *these BFD Control packets are transmitted at the rate of one per second until either it receives a control packet valid for this BFD session with the Final (F) bit set from the ingress LSR or the defect condition clears; however to improve the likelihood of notifying the ingress LSR of the failure of the p2mp MPLS LSP, the egress LSR SHOULD initially transmit three BFD Control packets defined above in short succession.

An ingress LSR that has received the BFD Control packet, as described above, sends the unicast IP/UDP encapsulated BFD Control packet with the Final (F) bit set to the egress LSR.

6. Security Considerations

This document does not introduce new security aspects but inherits all security considerations from [RFC5880], [RFC5884], [RFC7726], [RFC8562], [RFC8029], and [RFC6425].

Also, BFD for p2mp MPLS LSP MUST follow the requirements listed in section 4.1 [RFC4687] to avoid congestion in the control plane or the data plane caused by the rate of generating BFD Control packets. An operator SHOULD consider the amount of extra traffic generated by p2mp BFD when selecting the interval at which the MultipointHead will transmit BFD Control packets. The operator MAY consider the size of the packet the MultipointHead transmits periodically as using IP/UDP encapsulation, which adds up to 28 octets, more than 50% of the BFD Control packet length, comparing to G-ACh encapsulation.

7. IANA Considerations

IANA is requested to allocate value (TBA1) from its MPLS Generalized Associated Channel (G-ACh) Types registry.

Value	Description	Reference
TBA1	Multipoint BFD Session	This document

Table 1: Multipoint BFD Session G-ACh Type

8. Acknowledgements

The authors sincerely appreciate the comments received from Andrew Malis, Italo Busi, Shraddha Hegde, and thought stimulating questions from Carlos Pignataro.

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