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    Bidirectional Forwarding Detection (BFD) in Segment Routing Networks
                         Using MPLS Dataplane
                         draft-ietf-spring-bfd-00

Abstract

   Segment Routing (SR) architecture leverages the paradigm of source
   routing. It can be realized in the Multiprotocol Label Switching
   (MPLS) network without any change to the data plane. A segment is
   encoded as an MPLS label, and an ordered list of segments is encoded
   as a stack of labels. Bidirectional Forwarding Detection (BFD) is
   expected to monitor any existing path between systems. This document
   defines how to use Label Switched Path Ping to bootstrap a BFD
   session, control an SR Policy in the reverse direction of the SR-MPLS
   tunnel, and applicability of BFD Demand mode in the SR-MPLS domain.
   Also, the document describes the use of BFD Echo with BFD Control
   packet payload.

Status of This Memo

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

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   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 March 26, 2021.

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[1](#). Introduction

   [[RFC5880](#)], [[RFC5881](#)], and [[RFC5883](#)] defined the operation of
   Bidirectional Forwarding Detection (BFD) protocol between the two
   systems over IP networks. [[RFC5884](#)] and [[RFC7726](#)] set rules for
   using BFD Asynchronous mode over point-to-point (p2p) Multiprotocol

Label Switching (MPLS) Label Switched Path (LSP). These latter
standards implicitly assume that the remote BFD system, which is at
the egress Label Edge Router (LER), will use the shortest path route
regardless of the path the BFD system at the ingress LER uses to send
BFD Control packets towards it. Throughout this document, references
to ingress LER and egress LER are used, respectively, as a shortened
version of the "BFD system at the ingress/egress LER".

This document defines the use of LSP Ping for Segment Routing
networks over MPLS data plane [RFC8287] to bootstrap and control path
of a BFD session from the egress to ingress LER using Segment Routing
tunnel with MPLS data plane (SR-MPLS).

1.1. Conventions

1.1.1. Terminology

BFD: Bidirectional Forwarding Detection

BSID: Binding Segment Identifier

FEC: Forwarding Equivalence Class

MPLS: Multiprotocol Label Switching

SR-MPLS Segment Routing with MPLS data plane

LSP: Label Switched Path

LER Label Edge Router

p2p Point-to-point

p2mp Point-to-multipoint

SID Segment Identifier

SR Segment Routing

1.1.2. 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.

2. **Bootstrapping BFD Session over Segment Routed Tunnel with MPLS Data Plane**

   Use of an LSP Ping to bootstrap BFD over MPLS LSP is required, as
   documented in [RFC5884], to establish an association between a fault
   detection message, i.e., BFD Control message, and the Forwarding
   Equivalency Class (FEC) of a single label stack LSP in case of
   Penultimate Hop Popping or when the egress LER distributes the
   Explicit NULL label to the penultimate hop router. The Explicit NULL
   label is not advertised as a Segment Identifier (SID) by an SR node
   but, as demonstrated in section 3.1 [RFC8660] if the operation at the
   penultimate hop is NEXT; then the egress SR node will receive an IP
   encapsulated packet. Thus the conclusion is that LSP Ping MUST be
   used to bootstrap a BFD session in an SR-MPLS domain if there are no
   other means to bootstrap the BFD session, e.g., using an extension to
   a dynamic routing protocol as described in
   [I-D.ietf-bess-mvpn-fast-failover] and
   [I-D.ietf-pim-bfd-p2mp-use-case].

   As demonstrated in [RFC8287], the introduction of Segment Routing
   network domains with an MPLS data plane requires three new sub-TLVs
   that MAY be used with Target FEC TLV. Section 6.1 addresses the use
   of the new sub-TLVs in Target FEC TLV in LSP ping and LSP traceroute.
   For the case of LSP ping, the [RFC8287] states that:

      The initiator, i.e., ingress LER, MUST include FEC(s)
      corresponding to the destination segment.

      The initiator MAY include FECs corresponding to some or all of
      segments imposed in the label stack by the ingress LER to
      communicate the segments traversed.

   It has been noted in [RFC5884] that a BFD session monitors for
   defects particular <MPLS LSP, FEC> tuple. [RFC7726] clarified how to
   establish and operate multiple BFD sessions for the same <MPLS LSP,
   FEC> tuple. Because only the ingress LER is aware of the SR-based
   explicit route, the egress LER can associate the LSP ping with BFD
   Discriminator TLV with only one of the FECs it advertised for the
   particular segment. Thus this document clarifies that:

      When LSP Ping is used to bootstrapping a BFD session for SR-MPLS
      tunnel the FEC corresponding to the segment to be associated with
      the BFD session MUST be as the very last sub-TLV in the Target FEC
      TLV.

   If the target segment is an anycast prefix segment
   ([I-D.ietf-spring-mpls-anycast-segments]) the corresponding Anycast
   SID MUST be included in the Target TLV as the very last sub-TLV.

Also, for BFD Control packet the ingress SR node MUST use precisely
the same label stack encapsulation, especially Entropy Label
([RFC6790]), as for the LSP ping with the BFD Discriminator TLV that
bootstrapped the BFD session. Other operational aspects of using BFD
to monitor the continuity of the path to the particular Anycast SID,
advertised by a group of SR-MPLS capable nodes, will be considered in
the future versions of the document.

Encapsulation of a BFD Control packet in Segment Routing network with
MPLS data plane MUST follow Section 7 [RFC5884] when the IP/UDP
header used and MUST follow Section 3.4 [RFC6428] without IP/UDP
header being used.

3. Use BFD Reverse Path TLV over Segment Routed MPLS Tunnel

For BFD over MPLS LSP case, per [RFC5884], egress LER MAY send BFD
Control packet to the ingress LER either over IP network or an MPLS
LSP. Similarly, for the case of BFD over p2p SR-MPLS tunnel, the
egress LER MAY route BFD Control packet over the IP network, as
described in [RFC5883], or transmit over a segment tunnel, as
described in Section 7 [RFC5884]. In some cases, there may be a need
to direct egress LER to use a specific path for the reverse direction
of the BFD session by using the BFD Reverse Path TLV and following
all procedures as defined in [I-D.ietf-mpls-bfd-directed].

4. Use Non-FEC Path TLV

For the case of MPLS data plane, Segment Routing Architecture
[RFC8402] explains that "a segment is encoded as an MPLS label. An
ordered list of segments is encoded as a stack of labels."

This document defines a new optional Non-FEC Path TLV. The format of
the Non-FEC Path TLV is presented in Figure 1

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Non-FEC Path TLV Type      |            Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   ~                          Non-FEC Path                         ~
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
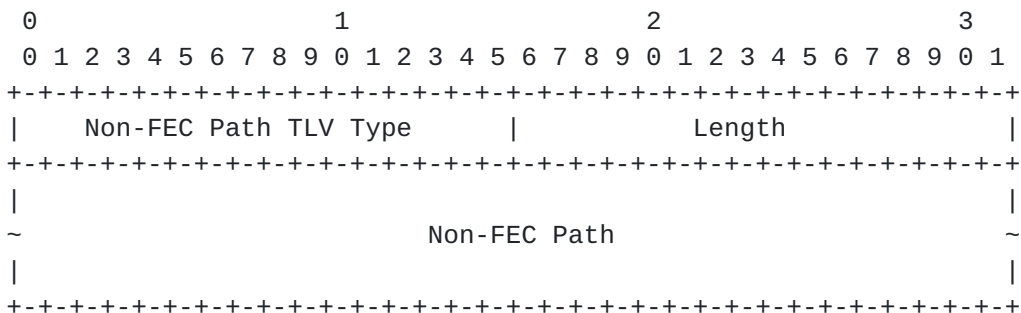
Figure 1: Non-FEC Path TLV Format

Non-FEC Path TLV Type is two octets in length and has a value of TBD1
(to be assigned by IANA as requested in Section 9.1).

Length field is two octets long and defines the length in octets of
the Non-FEC Path field.

Non-FEC Path field contains a sub-TLV. Any Non-FEC Path sub-TLV
(defined in this document or to be defined in the future) for Non-FEC
Path TLV type MAY be used in this field. None or one sub-TLV MAY be
included in the Non-FEC Path TLV. If no sub-TLV has been found in
the Non-FEC Path TLV, the egress LER MUST revert to using the reverse
path selected based on its local policy. If there is more than one
sub-TLV, then the Return Code in echo reply MUST be set to value TBD3
"Too Many TLVs Detected" (to be assigned by IANA as requested in
Table 4).

Non-FEC Path TLV MAY be used to specify the reverse path of the BFD
session identified in the BFD Discriminator TLV. If the Non-FEC Path
TLV is present in the echo request message the BFD Discriminator TLV
MUST be present as well. If the BFD Discriminator TLV is absent when
the Non-FEC Path TLV is included, then it MUST be treated as
malformed Echo Request, as described in [RFC8029].

This document defines the Segment Routing MPLS Tunnel sub-TLV that
MAY be used with the Non-FEC Path TLV. The format of the sub-TLV is
presented 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  SR MPLS Tunnel sub-TLV Type  |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID Entry 1 (Top of Stack)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         SID Entry 2                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 SID Entry N (Bottom of Stack)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
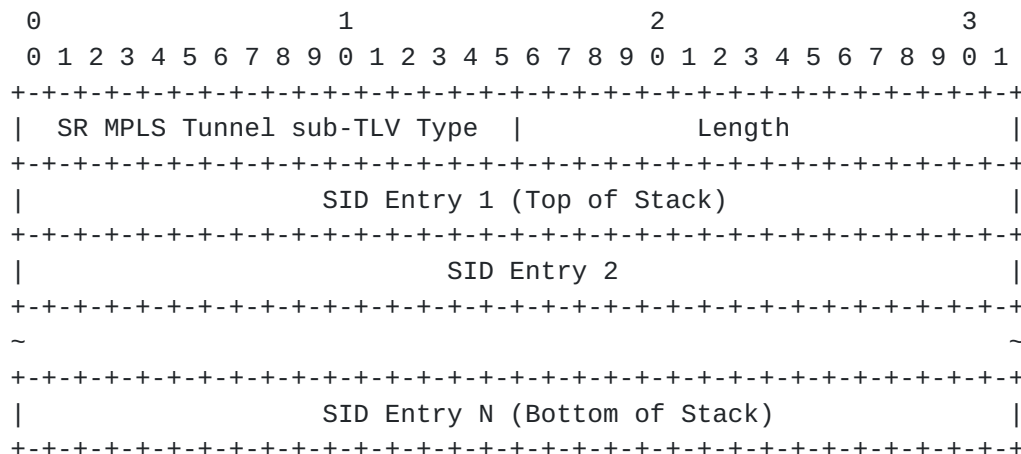
Figure 2: Segment Routing MPLS Tunnel sub-TLV

The Segment Routing MPLS Tunnel sub-TLV Type is two octets in length,
and has a value of TBD2 (to be assigned by IANA as requested in
Section 9.1).

The egress LER MUST use the Value field as label stack for BFD
Control packets for the BFD session identified by the source IP

address of the MPLS LSP Ping packet and the value in the BFD
Discriminator TLV. Label Entries MUST be in network order.

5. **BFD Reverse Path TLV over Segment Routed MPLS Tunnel with Dynamic
     Control Plane**

When Segment Routed domain with MPLS data plane uses distributed
tunnel computation BFD Reverse Path TLV MAY use Target FEC sub-TLVs
defined in [RFC8287].

6. **Applicability of BFD Demand Mode in SR-MPLS Domain**

[I-D.mirsky-bfd-mpls-demand] defines how Demand mode of BFD,
specified in sections 6.6 and 6.18.4 of [RFC5880], can be used to
monitor uni-directional MPLS LSP. Similar procedures can be
following in SR-MPLS to monitor uni-directional SR tunnels:

o an ingress SR node bootstraps BFD session over SR-MPLS in Async
   BFD mode;

o once BFD session is Up, the ingress SR node switches the egress
   LER into the Demand mode by setting D field in BFD Control packet
   it transmits;

o if the egress LER detects the failure of the BFD session, it sends
   its BFD Control packet to the ingress SR node over the IP network
   with a Poll sequence;

o if the ingress SR node receives a BFD Control packet from the
   remote node in a Demand mode with Poll sequence and Diag field
   indicating the failure, the ingress SR node transmits BFD Control
   packet with Final over IP and switches the BFD over SR-MPLS back
   into Async mode, sending BFD Control packets one per second.

7. **Using BFD to Monitor Point-to-Multipoint SR Policy**

[I-D.voyer-spring-sr-p2mp-policy] defined variants of SR Policy to
deliver point-to-multipoint (p2mp) services. For the given P2MP
segment [RFC8562] can be used if, for example, leaves have an
alternative source of the multicast service flow to select. In such
a scenario, a leaf may switch to using the alternative flow after
p2mp BFD detects the failure in the working multicast path. For
scenarios where it is required for the root to monitor the state of
the multicast tree [RFC8563] can be used. The root may use the
detection of the failure of the multicast tree to the particular leaf
to restore the path for that leaf or re-instantiate the whole
multicast tree.

An essential part of using p2mp BFD is the bootstrapping the BFD
session at all the leaves. The root, acting as the MultipointHead,
MAY use LSP Ping with the BFD Discriminator TLV. Alternatively,
extensions to routing protocols, e.g., BGP, or management plane,
e.g., PCEP, MAY be used to associate the particular P2MP segment with
MultipointHead's Discriminator. Extensions for routing protocols and
management plane are for further study.

8. Use of Echo BFD in SR-MPLS

Echo-BFD [RFC5880] can be used to monitor an SR Policy between the
local and the remote BFD peers. As defined in [RFC5880], the remote
BFD system does not process the payload of an Echo BFD. Thus it is
the local system that demultiplexes the Echo BFD packet matching it
to the appropriate BFD session and detects missing Echo BFD packets.
A BFD Control packet MAY be used as the payload of Echo BFD. This
specification defines the use of Echo BFD in SR-MPLS network with BFD
Control packet as the payload. The use of other types of Echo BFD
payload is outside the scope of this document. Because the remote
BFD system does not process Echo BFD, the value of the Your
Discriminator field MUST be set to the discriminator the local BFD
system assigned to the given BFD session. My Discriminator field
MUST be zeroed. Authentication MUST be set according to the
configuration of the BFD session. To ensure that the Echo BFD packet
is returned to the sender without being processed, the sender MAY use
a Binding SID (BSID) [RFC8402] that has been bound with the SR Policy
that ensures the return of a packet to that particular node. A BSID
MAY be associated with the SR Policy that is the reverse to the SR
Policy programmed onto the BFD Echo packet by the sender.

9. IANA Considerations

9.1. Non-FEC Path TLV

IANA is requested to assign new TLV type from the from Standards
Action range of the registry "Multiprotocol Label Switching
Architecture (MPLS) Label Switched Paths (LSPs) Ping Parameters -
TLVs" as defined in Table 1.

Value	TLV Name	Reference
TBD1	Non-FEC Path TLV	This document

Table 1: New Non-FEC Path TLV

IANA is requested to create new Non-FEC Path sub-TLV registry for the
Non-FEC Path TLV, as described in Table 2.

```
+-------------+--------------+-----------------------------------+
| Range       | Registration | Note                              |
|             |  Procedures  |                                   |
+-------------+--------------+-----------------------------------+
| 0-16383     |   Standards  | This range is for mandatory TLVs or |
|             |    Action    | for optional TLVs that require an |
|             |              | error message if not recognized.  |
| 16384-31743 | Specification | Experimental RFC needed          |
|             |   Required   |                                   |
| 32768-49161 |   Standards  | This range is for optional TLVs   |
|             |    Action    | that can be silently dropped if not |
|             |              | recognized.                       |
| 49162-64511 | Specification | Experimental RFC needed          |
|             |   Required   |                                   |
| 64512-65535 |  Private Use |                                   |
+-------------+--------------+-----------------------------------+
```

Table 2: Non-FEC Path sub-TLV registry

IANA is requested to allocate the following values from the Non-FEC
Path sub-TLV registry as defined in Table 3.

```
+-------+--------------------------------------+---------------+
| Value | Description                          | Reference     |
+-------+--------------------------------------+---------------+
| 0     | Reserved                             | This document |
| TBD2  | Segment Routing MPLS Tunnel sub-TLV  | This document |
| 65535 | Reserved                             | This document |
+-------+--------------------------------------+---------------+
```

Table 3: New Segment Routing Tunnel sub-TLV

9.2. Return Code

IANA is requested to create Non-FEC Path sub-TLV sub-registry for the
new Non-FEC Path TLV and assign a new Return Code value from the
"Multi-Protocol Label Switching (MPLS) Label Switched Paths (LSPs)
Ping Parameters" registry, "Return Codes" sub-registry, as follows
using a Standards Action value.

```
           +--------+------------------------+--------------+
           | Value  | Description            | Reference    |
           +--------+------------------------+--------------+
           | X TBD3 | Too Many TLVs Detected. | This document |
           +--------+------------------------+--------------+
```

                        Table 4: New Return Code

10. Implementation Status

   - The organization responsible for the implementation: ZTE
   Corporation.

   - The implementation's name ROSng SW empowers traditional routers,
   e.g., ZXCTN 6000.

   - A brief general description: A list of SIDs can be specified as the
   Return Path for an SR-MPLS tunnel.

   - The implementation's level of maturity: production.

   - Coverage: complete

   - Version compatibility: draft-mirsky-spring-bfd-06.

   - Licensing: proprietary.

   - Implementation experience: Appreciate Early Allocation of values
   for Non-FEC TLV and Segment Routing MPLS Tunnel sub-TLV (using
   Private Use code points).

   - Contact information: Qian Xin qian.xin2@zte.com.cn

   - The date when information about this particular implementation was
   last updated: 12/16/2019

   Note to RFC Editor: This section MUST be removed before publication
   of the document.

11. Security Considerations

   Security considerations discussed in [RFC5880], [RFC5884], [RFC7726],
   and [RFC8029] apply to this document.

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13. Acknowledgments

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   information about the implementation of this specification.

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