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## Segment Routing for Unaffiliated BFD Echo Function

### Abstract

This document describes how to leverage Segment Routing (SR) to ensure that the Unaffiliated BFD (U-BFD) Echo packets must reach the remote system before being looped back to the local system. This enables that U-BFD works not only for one hop scenario but for multiple hops scenario as well.

In addition, this document also defines a way to explicitly specify the loop back path of the U-BFD Echo packets. This is useful in the case where the forward and reverse path of the Echo packets are required to follow the same path.

### 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 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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### 1. Introduction

BFD Echo function was originally defined in [RFC5880] and [RFC5881], where the remote system is required to loop the BFD Echo packets back to the local system. To support BFD Echo Function, some negotiations between the local system and remote system are needed, and both the local and remote system need to maintain the BFD session state.

Unaffiliated BFD Echo Function (U-BFD) is defined in [I-D.ietf-bfd-unaffiliated-echo]. Where the destination IP address of the BFD Echo packets is set to one of the IP addresses of the local system. Therefore, the Echo packets can be automatically looped back (through normal IP forwarding) by the remote system to the local system. With U-BFD, the remote system does not need to support any BFD related functions and maintain any session states. This further simplifies the BFD Echo Function process at the remote system hence greatly increases scalability.

But, the U-BFD works when there is only one hop between the local system and remote system. Otherwise, the Echo packets will be prematurely looped back by an intermediate node, and the Echo packets will not reach the remote system. This may result in false negative issue. Take the following figure (Figure 1) as an example, if the U-BFD is expected to monitor the path between node A and node C, node A (as the local system) sets the destination IP to itself and sends the Echo packets to node B. Since node B has the route to node A, the Echo packets will be directly forwarded back to node A. If there is a failure on the path between node B and node C, obviously, the U-BFD session cannot detect it.

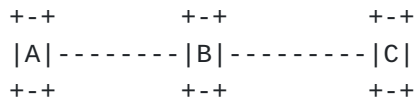


Figure 1, Multi-hop Scenario

In addition, in some scenarios, for example, mobile backhaul network, where the forward and reverse direction of a path are required to along the same path. When apply BFD in mobile backhaul network, it also expects that the BFD control packets in both directions follow the same path, otherwise, it may result in false positive issue. Take the following figure (Figure 2) as an example, there are two paths (A-B-C, A-D-C) between node A and node C. Assuming that it expects to monitor the path A-B-C by using BFD, where node A is the local system and node C is the remote system. If node C chooses path C-D-A to send the Echo packets, when a failure occurs on path C-D-A, node A (the local system) may not receive the BFD packets and consider that path A-B-C is failed. But actually path A-B-C is working.

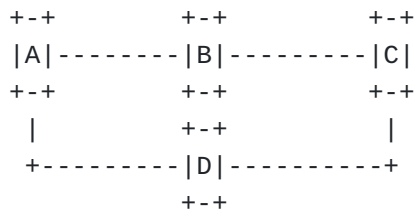


Figure 2, Multi-hop, Multi-path Scenario

To solve the above issues, this document describes how to leverage the Segment Routing (SR) [[RFC8402](#)] to ensure that the U-BFD Echo packets must reach the remote system before being looped back. This enables that U-BFD Echo Function works not only for one hop scenario but for multiple hops scenario. In addition, by using SR policy [[I-D.ietf-spring-segment-routing-policy](#)], the loop back path of the Echo packets can be specified as required. This is useful in the case where the forward and loop back path of the Echo packets are required to follow the same path.

## 2. Tunnel U-BFD Packets to Remote System

When using U-BFD to monitor a path, the U-BFD echo packets are constructed as specified in [[I-D.ietf-bfd-unaffiliated-echo](#)], then the U-BFD echo packets are encapsulated in an SR tunnel and sent to the remote system. It needs to make sure that the SR tunnel and the path being monitored follow the same path and share the same fate, otherwise the UP/Down state can not reflect the health of the path being monitored. This can be satisfied if the path itself is an SR path, where the U-BFD echo packets, just as other data traffic, are transmitted over the SR tunnel to the remote system. When the packet arrives the remote system, the SR encapsulation (e.g, MPLS Label Stack, or IPv6 Header with/without SRH) is removed, the inner IP header is exposed. Since the destination IP address of the inner header is one of the routable IP addresses of the local system, the echo packet will be forwarded back to the local system via IP routing.

If the path is an pure IP path, SR over IP [[RFC8663](#)] or SRv6 Best Effort (BE) can be used to tunnel the U-BFD echo packets to the remote system. Once the packet reaches the remote system, the remote system decapsulates the echo packet and forwards it back to the local system based on the inner header.

## 3. Specify Reverse Path of U-BFD Echo Packets

In some cases, for example, mobile backhaul network, bidirectional paths are often used. And in general, the forward and reverse direction of the bidirectional path are required to follow the same path hence to share the same fate. Therefore, when apply U-BFD to monitor such a bidirectional path, the forward and reserve path the U-BFD echo need to follow the same path as well.

In the case of SR, [[I-D.ietf-spring-segment-routing-policy](#)] is normally used to implement bidirectional path. To ensure that the U-BFD Echo packets can reach the remote system before looping back to the local system, the SR policy MUST have a candidate path that is associated with a Segment-List, and the Segment-List MUST include a SID that identifies the remote system. That means the U-BFD Echo packets will be tunneled by the SR policy to the remote system, and then looped back.

To specify the loopback path, a series of SIDs or a Binding SID (BSID) that is associated with the loopback path MUST be added to the SID stack of the U-BFD Echo packets. This can be done through the following ways:

Given the topology in Figure 2, the SR policy can be modeled as below:

1. Not explicitly specify the reserve path:

```
SR policy POL1 <headend = A, color = 1, endpoint = C>
Candidate-path CP1 <protocol-origin = 20, originator =
    100:1.1.1.1, discriminator = 1>
Preference 200
Weight W1, SID-List <B,C>
```

The U-BFD Echo packets are transmitted to the remote system according the SR policy. When the Echo packets reach the remote system, they will be decapsulated and then forwarded back to the local system according to inner IP header.

2. Specify the reverse path by carrying a Reverse Binding Segment Identifier (R-BSID):

```
SR policy POL2 <headend = A, color = 1, endpoint = C>
Candidate-path CP1 <protocol-origin = 20, originator =
    100:1.1.1.1, discriminator = 2>
Preference 200
Weight W1, SID-List <B, C>, L-BSID, R-BSID
```

Two new attributes, which are referred to as Local BSID (L-BSID) and Remote BSID (R-BSID), are introduced to a candidate path. Here, the L-BSID or R-BSID is a BSID that correlates to a specific SID List rather a candidate path. The L-BSID is a local BSID on the headend, in the above example, it identifies the SID-List <B, C>. The R-BSID identifies another corresponding SID list <B, A> that is deployed on the endpoint (Node C) and has the same path and share the same fate with SID-list <B, C>. SID List <B, C> and SID List <B, A> form a bidirectional SR path. With this, a SID stack <B, C, R-BSID> will be attached to the U-BFD echo packets, the SID B and C will take the echo packets to the remote system, the R-BSID will bring the echo packets back to the local system.

3. Specify the reverse path by explicitly carrying the SID list of the reverse path:

```
SR policy POL2 <headend = A, color = 1, endpoint = A>
Candidate-path CP1 <protocol-origin = 20, originator =
    100:1.1.1.1, discriminator = 3>
Preference 200
Weight W1, SID-List <B, C>, Reverse SID-List <B, A>
```

A new attribute, Reverse SID-List, is introduced to a candidate path, it corresponds to a SID-List of the candidate path. In the above example, the SID-List <B, C> and Reverse SID-List <B, A> form a bidirectional path. With this, a SID stack <B, C, B, A> will be attached to the U-BFD echo packets, the SID B and C will take the echo packets to the remote system, and the SID B and A will bring the back to the local system.

#### 4. Binding SID for Segment-List

With the current SR policy, a BSID corresponds to a candidate path that may have multiple SID Lists. In the case of bidirectional SR path, the forward or reverse path corresponds to a specific SID List. In order to identify a SID List with a SID, the straightforward idea is to define a BSID to for SID list. A bidirectional SR path correlates to two SID Lists: the forward SID List and the reverse SID List. Therefore, two BSIDs (L-BSID and R-BSID) need to be defined for a bidirectional SR path to identify the corresponding SID list.

An information model of a SR policy with the L-BSID and R-BSID is as follows:

```
SR policy POL1 <headend = H1, color = 1, endpoint = E1>
  Candidate-path CP1 <protocol-origin = 20, originator =
    100:1.1.1.1, discriminator = 1>
    Preference 100
    Weight W1, SID-List1 <SID11...SID1i>, L-BSID-1, R-BSID-1

  Candidate-path CP2 <protocol-origin = 20, originator =
    100:1.1.1.1, discriminator = 2>
    Preference 200
    Weight W2, SID-List2 <SID21...SID2j>, L-BSID-2, R-BSID-2
```

The POL1 has two candidate paths, CP1 and CP2. Each has a SID-List, a Local BSID (L-BSID) and a Reverse BSID (R-BSID). The L-BSID corresponds to the SID List (e.g., L-BSID-1 corresponds to SID-List <SID11...SID1i>). The R-BSID corresponds a SID List of a candidate path of a policy that is deployed on the endpoint (E1), as following. Assume that the SID-List1 of POL1 and the SID-List1 of POL2 form a bidirectional SR path. For policy POL1, the R-BSID-1 is the same as the L-BSID-1' of policy POL2; and the R-BSID-1' of POL2 is the same as the L-BSID-1 of policy POL1.

```
SR policy POL2 <headend = E1, color = 1, endpoint = H1>
  Candidate-path CP1 <protocol-origin = 20, originator =
    200:1.1.1.1, discriminator = 1>
    Preference 100
    Weight W1, SID-List1 <SID11...SID1i>, L-BSID-1', R-BSID-1'

  Candidate-path CP2 <protocol-origin = 20, originator =
    200:1.1.1.1, discriminator = 2>
    Preference 200
    Weight W2, SID-List2 <SID21...SID2j>, L-BSID-2', R-BSID-2'
```

Therefore, to deploy such a policy, it needs to know the R-BSID of the corresponding reverse SID List. It assumes that a controller will learn the L-BSID of each SID list and is responsible for the configuration of SR policy on both the headend and endpoint of the SR policies.

The corresponding BGP or PECP extensions in support of SR policy with BSID for SID List will be defined in future version.

## 5. IANA Considerations

This document makes no request of IANA.

## 6. Security Considerations

This document does not introduce additional security requirements and mechanisms other than the ones described in [[I-D.ietf-bfd-unaffiliated-echo](#)] and [[I-D.ietf-spring-segment-routing-policy](#)].

## 7. Acknowledgements

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