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SRv6 Midpoint Protection

Abstract

The current local repair mechanism, e.g., TI-LFA, allows the upstream neighbor of the failed node or link to fast re-route traffic around the failure. This mechanism does not work properly for SRv6 TE path after the failure happens in an endpoint node and IGP converges on the failure. This document defines midpoint protection for SRv6 TE path, which enables the upstream endpoint node of the failed node to perform the endpoint behavior for the faulty node and fast re-route traffic around the failure after IGP converges on the failure.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD 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

The current local repair mechanism, e.g., Topology-Independent Loop-Free Alternate (TI-LFA) ([\[I-D.ietf-rtgwg-segment-routing-ti-lfa\]](#)), allows the upstream neighbor of the failed node or link to fast re-route traffic around the failure. This mechanism does not work properly after the failure happens in an endpoint node and IGP converges on the failure.

In SRv6, the IPv6 destination address (DA) in the outer IPv6 header could be a segment endpoint node (or endpoint for short) of an SRv6 TE path (or SRv6 path for short) rather than the destination of the SRv6 path ([\[RFC8986\]](#)). After the endpoint fails and IGP converges on the failure, the packet with the failed endpoint as DA will be dropped since there is no FIB entry for DA (i.e., no route to this endpoint). The upstream non-endpoint neighbor of the failed endpoint will not receive the packet for the SRv6 path. [\[I-D.ietf-spring-segment-protection-sr-te-paths\]](#) and [\[I-D.hu-spring-segment-routing-proxy-forwarding\]](#) propose midpoint

protection for SR-MPLS TE path after IGP converges on the failure of a node along the path.

This document defines midpoint protection for SRv6 path after IGP converges on the failure of an endpoint on the path, which enables the upstream endpoint of the failed endpoint to perform the endpoint behavior for the failed endpoint and fast re-route traffic around the failure after IGP converges on the failure.

2. SRv6 Midpoint Protection Mechanism

When an endpoint node fails, the packet needs to bypass the failed endpoint node and be forwarded to the next endpoint node of the failed endpoint. Only endpoint node can process SRH, so, only endpoint nodes can perform midpoint protection. There are two stages or time periods after an endpoint node fails. The first is the time period from the failure until the IGP converges on the failure. The second is the time period after the IGP converges on the failure.

During the first time period, the packet will be sent to the upstream neighbor of the failed endpoint node. After detecting the failure of its interface to the failed endpoint node, the neighbor forwards the packet around the failed endpoint node using TI-LFA.

During the second time period, there is no FIB entry for the failed endpoint. When a upstream/previous endpoint of the failed endpoint has no FIB entry for the failed endpoint, it changes the DA of the packet to the IPv6 address of the next endpoint (of the failed endpoint) and forwards the packet using the FIB entry for the next endpoint. Note that the upstream/previous endpoint node may not be the upstream neighbor of the failed endpoint.

3. SRv6 Midpoint Protection Example

[Figure 1](#) illustrates an example of network topology with SRv6 enabled on each node. The cost of each link is 1 by default, except for the costs of the links indicated by numbers on the links.

In this document, an end SID at node N_i with locator block B is represented as B:i. A SID list is represented as $\langle S_1, S_2, S_3 \rangle$ where S_1 is the first SID to visit, S_2 is the second SID to visit and S_3 is the last SID to visit along the SRv6 TE path.

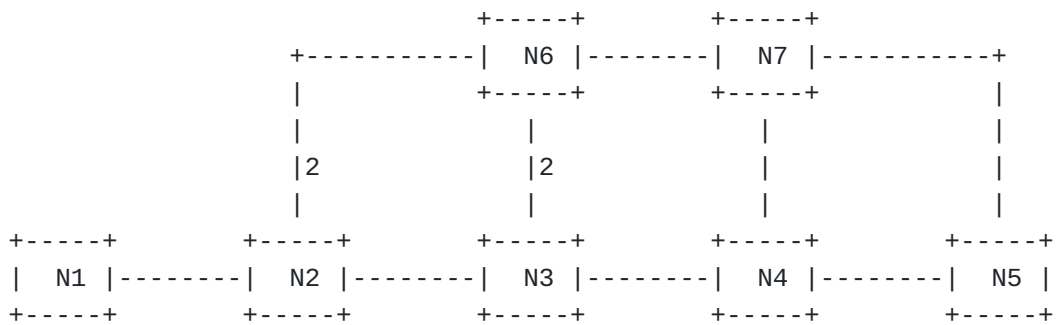


Figure 1: An example of network for midpoint protection

In the reference topology, suppose that there are two SRv6 paths having node N1 as ingress. The first path is from N1 through endpoint nodes N4 and N5, which is represented by SID list <B:4, B:5>. The second path is from N1 through endpoint nodes N2, N4 and N5, which is represented by SID list <B:2, B:4, B:5>. For a packet to be transported by the first path, N1 encapsulates the packet with <B:4, B:5>. For a packet to be transported by the second path, N1 encapsulates the packet with <B:2, B:4, B:5>.

When N4 fails, the packet on each of the two paths needs to bypass the failed endpoint N4 and be forwarded to the next endpoint N5 after the failed endpoint.

During the first time period (i.e., after N4 fails and before IGP converges on the failure), N3 (upstream neighbor of N4) as a Repair Node receives the packet for each of the two SRv6 paths. It forwards the packet around the failed endpoint N4 after detecting the failure of the outbound interface/link to the endpoint B:4. It uses the TI-LFA to forward the packet through encapsulating the packet with SID list <B:6, B:7> as a TI-LFA repair path.

During the second time period (i.e., after N4 fails and after IGP converges on the failure):

*For the first path, N3 (upstream endpoint neighbor of N4) as a Repair Node receives the packet, N3 has no FIB entry for the failed endpoint N4. N3 forwards the packet around the failed endpoint N4 to the next endpoint (e.g., N5) using the FIB entry for the next endpoint. N3 changes the DA of the packet to the next SID B:5 and forwards the packet using the FIB entry for DA = B:5 (i.e., using IGP SPF path to B:5).

*For the second path, N3 (upstream non-endpoint neighbor of N4) will not receive any packet for the path. The upstream endpoint N2 of the failed endpoint N4 will not send any packet for the path to N3. N2 has no FIB entry for the failed N4. N2, as a Repair Node, sends the packet around N4 to the next endpoint

(e.g., N5) using the FIB entry for the next endpoint. N2 changes the DA of the packet to the next SID B:5 and sends the packet using the FIB entry for DA = B:5 (i.e., using IGP SPF path to B:5).

4. SRv6 Midpoint Protection Behavior

[Figure 2](#) shows the procedure of a upstream (endpoint) node of an endpoint node on an SRv6 path for midpoint protection in pseudo code.

When the endpoint (e.g., N4) fails and before IGP converges on the failure (i.e., in the first period), if the upstream node (e.g., neighbor N3) of the failed endpoint detects the failure of the link used to send the packet for the path and the FIB entry for the DA of the packet exists, then it uses TI-LFA to fast re-route the packet around the failure (refer to line 1 and 2 of the procedure); otherwise, the link used to send the packet works (i.e., no failure) or no FIB entry for DA of the packet (i.e., after the failure and IGP converges on the failure, or say in the second period).

If the upstream node (e.g., endpoint N2 for the second path) has no FIB entry for the DA of the packet, then it changes the DA to the next SID and sends the packet using the FIB entry for DA = next SID when the packet has a SRH with SIDs as a next header (refer to lines 3 to 6). When the packet has no SRH with SIDs as a next header, the packet is dropped (refer to line 7 to 8).

When the upstream node has a FIB entry for the DA of the packet (i.e., no failure or there is a failure and before IGP converges on the failure which is in the first time period), it sends the packet using the FIB entry for the DA (refer to line 9 to A).

```
1: IF link for sending packet failed and FIB entry for DA exists THEN
2:   use TI-LFA to re-route packet around failure; // in 1st period
3: ELSE IF no FIB entry for DA of packet (i.e., in 2nd period) THEN
4:   IF NH = SRH && SL != 0 THEN // if next header is SRH with SIDs
5:     SL--; DA = SRH[SL]; // change DA of packet to next SID/endpoint
6:     forward packet using FIB entry for DA;//send packet to next SID
7:   ELSE // next header is not SRH with SIDs
8:     drop the packet;
9: ELSE //has FIB entry for DA of packet(i.e.,normal or in 1st period)
A:   forward packet accordingly to FIB entry for DA;
```

Figure 2: Procedure of Upstream Node for Midpoint Protection

5. Determining whether the Endpoint could Be Bypassed

SRv6 Midpoint Protection provides a mechanism to bypass a failed endpoint. But in some scenarios, some important functions may be implemented in the bypassed failed endpoints that should not be bypassed, such as firewall functionality or In-situ Flow Information Telemetry of a specified path. Therefore, a mechanism is needed to indicate whether an endpoint can be bypassed or not.

[[I-D.li-rtgwg-enhanced-ti-1fa](#)] provides method to determine whether enable SRv6 midpoint protection or not by defining a "no bypass" flag for the SIDs in IGP.

6. Security Considerations

To ensure that the Repair node does not modify the SRH header Encapsulated by nodes outside the SRv6 Domain, the segment within the SRH needs to be in the same domain as the repair node. So it is necessary to check the skipped segment has the same block as the repair node.

7. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

8. References

8.1. Normative References

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