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SRv6 In-situ Active Measurement

Abstract

This draft describes a data-plane in-band active measurement method for SRv6. A packet containing an SRH uses a flag bit to indicate it is an active probing packet. The measurement information, such as the IOAM header and data, is encapsulated in UDP payload. The probing packet originates from a segment source node and terminates at a configured segment endpoint node. Each segment node on the path, when detecting the flag, parses the UDP header and the payload. In case of IOAM, the node adds data to the IOAM node data fields. The method avoids the performance and encapsulation issues for applying IOAM as well as other measurement techniques in SRv6 networks. Multiple applications can be supported by the method.

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.

Status of This Memo

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1. Introduction

To support SRv6 network operation, we need various means to collect data and measure the performance of SRv6 network. [I-D.ietf-6man-spring-srv6-oam] provides some mechanisms for SRv6 OAM. Some other general methods for performance measurement such as [RFC8762] can also be applied for SRv6. However, these methods have limited data coverage and measurement capability.

[I-D.ietf-ippm-ioam-data] supports extensible data collection for user traffic. It is beneficial for SRv6 network monitor and measurement. [I-D.ali-spring-ioam-srv6] proposes to encapsulate IOAM in SRH TLV. However, when applying to user packets, IOAM's overhead may cause packet fragmentation and its processing may affect the packet forwarding throughput. Moreover, due to the extension header limitations asserted by [RFC8200], it is not easy to come up with a scheme to encapsulate the IOAM header and data in other locations in SRv6 user packets.

Fortunately, the forwarding behavior in SRv6 networks is determined by the SRH. To conduct in-band measurement, the IOAM header and data do not need to be added to user packets. Instead, they can be encapsulated in an independent packet dedicated for measurement. As long as this packet has the same SRH as the user packet, the data collected can faithfully reflect the user packet's forwarding experience, so the result is similar to that by applying IOAM on SRv6 user packets. This approach retains the benefits of in-situ measurement but avoids the aforementioned issues.

In this case, the IOAM header and data processing can even be done in slow path, without worrying about delaying the user traffic. Because of this, the potential limitation of the forwarding hardware's header processing capability (e.g., the header parsing depth) is no longer an issue.

This SR-based active measurement approach also supports some other applications. For example, it can be used to support network-wide telemetry coverage by using pre-planned paths [I-D.tian-bupt-inwt-mechanism-policy]; it can be used to actively measure the backup paths for SRv6 traffic engineering; and by setting the path end as the path head in SRH, it can naturally support two-way or round-trip measurement.

The approach is built on existing protocol components with limited extra requirements.

2. In-situ Active Measurement for SRv6

As specified by [RFC8754], the Segment Routing Header (SRH) contains an 8-bit "Flags" field. This document defines the following flag bit 'T' to designate the packet as a dedicated probing packet for active measurement.

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
| |T|           |
+-+-+-+-+-+-+-+-+
```

Figure 1: A Hierarchical Edge Network

The O-bit defined in [I-D.ietf-6man-spring-srv6-oam] servers for user traffic OAM, so the T-bit and O-bit are mutual exclusive. When T-bit is set, O-bit must be cleared, and vice versa.

The Next Header of SRH is set to UDP. A destination UDP port is reserved to encode the type of the payload. For example, a port number is reserved for IOAM. If the destination port number is of the IOAM type, the UDP payload would encapsulate the IOAM header and data as specified in [I-D.ietf-ippm-ioam-data]. The source UDP port can be used as sequence number to track the probing packets on a specific SR path.

The complete active probing packet format for IOAM is shown in Figure 2.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|Ver (6)| Traffic Class |           Flow Label                  |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|         Payload Length        |  NH : SRH     |   Hop Limit   |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               Source Address (128 bits)                       | RFC
|                                                               +  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               Destination Address (128 bits)                  |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|  NH : UDP     |  Hdr Ext Len  | Routing Type  | Segments Left |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|  Last Entry   | |1|  Flags    |              Tag              |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ RFC
|                                                               |  |
|                   Segment List (m * 128 bits)                 |  |
|                                                               |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|   Source Port (TBD)           |     Destination Port (TBD)    |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ RFC
|   Length                      |     Checksum                  |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|        Namespace-ID           |NodeLen  | Flags | RemainingLen|  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               IOAM-Trace-Type                 |  Reserved     |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ IOA
|                                                               |  |
|                   Node Data List (n * 32 bits)                |  |
|                                                               |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
```

Figure 2: The active probing packet format for IOAM

3. Network Operation

The SR source node constructs the probing packets. The source address is the address of the SR source node and the destination address is the address of first SR segment endpoint node. The SRH lists all the SR segment endpoint nodes for which IOAM data will be collected.

Each SR node on the path, when detecting the T-flag, in addition to normal SRH processing, will further parse the UDP header and IOAM header, and as directed by the IOAM header, add data to the IOAM node data list.

The last SR segment endpoint node will terminate the probing packet. The collected data can be exported and analyzed according to configuration.

If an SR segment endpoint node on the path is incapable of processing the probing packet, it should ignore the T-flag and continue forwarding the packet.

4. Applications

This section summarizes a list of applications of the SRv6 In-situ Active Measurement (SIAM) approach.

* As described in Section 1, this is an easy way to apply IOAM in SRv6. In order to collect the on-path data for a specific flow, all we need is to copy the SRH from the flow packet and construct the probing packets. The probing packet rate can match the original flow or arbitrarily configured. The edge of the SR domain must terminate the probing packets to avoid leakage.

* To support SRv6 traffic engineering, some alternative paths may be pre-computed. It is desirable to measure the performance of these paths so the best path can be picked when a flow is swapped. Since each path can be represented by an SRH, we can construct the probing packets with these SRHs to actively measure their status and performance.

* In an SRv6 network, it is easy to conduct round trip measurement by setting the starting node and the end node of a path to the same segment source node, and setting the destination node as an intermediate node on the path.

* To collect the network wide telemetry data and gain global visibility within a SRv6 domain, we can apply the algorithm described in [I-D.tian-bupt-inwt-mechanism-policy] to calculate the optimal SR paths, and construct probing packets on these paths.

5. Probing Packet Type Extension

The same scheme is also suitable for other types of probing packets. For example, The probing packets can carry IOAM E2E option header and data, IOAM DEX option header, and other OAM headers and data. It is easy to use different reserved UDP port numbers to differentiate the payload types.

6. Security Considerations

7. IANA Considerations

An SRH Flag bit 'T'. The bit position TBD

Optional UDP destination port numbers indicating different IOAM options (TBD)

8. Acknowledgments

9. References

9.1. Normative References

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