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SRv6 In-situ Active Measurement with IOAM

Abstract

This draft describes an active measurement method for SRv6 which can support hop-by-hop and end-to-end measurement on any SRv6 path using existing protocols such as IOAM. A packet containing an SRH uses a flag bit to indicate the packet is an active probing packet. The measurement information, such as the IOAM header and data, is encapsulated in UDP payload, indicated by a dedicated port number. The probing packet originates from a segment source node, traverses an arbitrary segment path, and terminates at a segment endpoint node, as configured by the segment list in SRH. Each segment node on the path, when detecting the flag, shall parse the UDP header and the payload. In the case of IOAM, the node shall process the IOAM option conforming to the standard procedures defined in the IOAM documents. The method is compatible with some other SRv6 active measurement proposals and support multiple applications.

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

This Internet-Draft will expire on 5 September 2022.

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1. Introduction

SRv6 network OAM needs various means to collect data, detect issues, and measure its performance. [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. More mechanisms should be provided to enrich the OAM coverage.

IOAM [I-D.ietf-ippm-ioam-data] can support extensible hop-by-hop data collection for user traffic. It is beneficial for SRv6 network monitor and measurement. Since it is designed for user-packet measurement, [I-D.ali-spring-ioam-srv6] proposes to encapsulate IOAM in SRH TLV options.

However, with its well-defined structure and functions, IOAM can also be used for active measurement (i.e., in dedicated probing packets without user payload) to fulfill many measurement tasks that are inconvenient or infeasible to be applied on user traffic. For active measurement, we can directly encapsulate the IOAM header and data in the UDP-based probing packet payload. The similar method has been proposed in [I-D.ietf-spring-stamp-srpm] to support STAMP for SRv6 measurement. IOAM is complement to STAMP by providing hop-by-hop measurement capability. The high-level method can be generalized and extended to support other performance measurement protocols under the same framework.

Fully built on exiting protocol components, the SR-based active measurement method using IOAM can support some useful 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.

2. An Active Measurement Framework 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 has been proposed to be reserved for STAMP in [I-D.ietf-spring-stamp-srpm]. Similarly, another port number should be reserved for IOAM trace option. If the destination port number matches the reserved values, the UDP payload would encapsulate the corresponding protocol header. The source UDP port can be used or ignored depending on each use case. The UDP checksum processing procedure conforms to [RFC6936].

3. SRv6 In-Situ Active Measurement with IOAM

We focus on a specific use case of the framework: using IOAM trace option for hop-by-hop measurement. The IOAM header and data format are specified in [I-D.ietf-ippm-ioam-data]. The complete active probing packet format for IOAM is shown in Figure 2. The source UDP port can be used as sequence number to track the probing packets on a specific SR path.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|Ver (6)| Traffic Class |           Flow Label                  |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|         Payload Length        |  NH : SRH     |   Hop Limit   |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               Source Address (128 bits)                       | RFC
|                                                               + 8200
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               Destination Address (128 bits)                  |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|  NH : UDP     |  Hdr Ext Len  | Routing Type  | Segments Left |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|  Last Entry   | |1|  Flags    |              Tag              |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ RFC
|                                                               | 8754
|                   Segment List (m * 128 bits)                 |  |
|                                                               |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|   Source Port (TBD)           |     Destination Port (TBD)    |  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+RFC768
|   Length                      |     Checksum                  |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
|        Namespace-ID           |NodeLen  | Flags | RemainingLen|  ^
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+  |
|               IOAM-Trace-Type                 |  Reserved     |  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ IOAM
|                                                               |  |
|                   Node Data List (n * 32 bits)                |  |
|                                                               |  |
|                                                               |  V
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ---
```

Figure 2: The active probing packet format for IOAM trace option

4. Network Operation

To initiate an IOAM active measurement on a path, the probing packets are generated at the SR source node. 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 including the source node, 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 according to the specifications for IOAM data export.

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. The last SR segment endpoint node MUST be able to process and terminate the probing packets.

5. Applications

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

* The method can be used as an alternative way for applying IOAM on user traffic in SRv6, because the forwarding behavior in SRv6 networks is determined by the SRH. As long as a probing packet has the same SRH as the user packet, the data collected can faithfully reflect the user packet's forwarding experience along the same path. In this case, 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 constantly 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.

* In order to detect or prevent gray network failures for SLA guarantee, it is necessary to collect network-wide telemetry data to gain full visibility within a SRv6 domain. We can apply the algorithm described in [I-D.tian-bupt-inwt-mechanism-policy] to calculate the minimum number of optimal SR paths to acheive the full coverage, and construct probing packets on these paths.

6. Probing Packet Type Extension

The same framework can support other OAM protocols. In addition to STAMP [I-D.ietf-spring-stamp-srpm], the active probing packets can carry IOAM E2E option header and data[I-D.ietf-ippm-ioam-data], IOAM DEX option header [I-D.ietf-ippm-ioam-direct-export], and other OAM options. It is easy to use different reserved UDP port numbers to differentiate the payload types.

7. Security Considerations

TBD

8. IANA Considerations

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

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

9. Acknowledgments

We acknowledge the comments and suggestions from Greg Mirsky and Tianran Zhou which help to improve this document.

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