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Benchmarking Methodology for IPv6 Routing Extension Headers
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Abstract

This document specifies a test procedure that should be used to evaluate the performance characteristics of a network interconnection device that processes IPv6 routing extension headers. The results of the test procedure can be used to compare the performance of the Compressed Routing Header (CRH) with the performance of other routing extension headers and with the performance of packets that do not include routing extension headers. The routing extension headers that may be compared with the CRH using the test procedure are the Segment Routing Header (SRH) and Routing Header Type 0 (RH0).

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1. Introduction

IPv6 [RFC8200] source nodes use routing extension headers to specify the path that packets follow to reach their destination. The first routing extension header to be defined was Routing Header Type 0 (RH0) [RFC2460]. This header was deprecated [RFC5095] and removed from current IPv6 implementations because it introduced security vulnerabilities.

Two replacements to RH0 have been proposed, the Segment Routing Header (SRH) [RFC8754] and the Compressed Routing Header (CRH) [I-D.draft-bonica-6man-comp-rtg-hdr]. Both of these routing extension headers provide a superset of the functionality that was previously provided by RH0, and both address the security vulnerabilities of RH0.

Both RH0 and the SRH specify intermediate nodes in the routing extension header as a list of 128-bit IPv6 addresses. The disadvantage of this is that routing headers may become very large, which may impose data transmission overhead and degrade router performance (see section 1 of [I-D.draft-bonica-6man-comp-rtg-hdr]). For this reason, in the CRH, intermediate nodes are specified using 16-bit or 32-bit short identifiers which are mapped to IPv6 addresses by intermediate routers.

For a given router, it is possible that either the SRH or the CRH would result in better performance. Processing a packet that uses the SRH requires the router to copy a larger header; however, processing a packet that uses the CRH requires the router to perform a lookup to translate the short identifier into an IPv6 address.

This document defines a procedure that can be used to compare the performance of the CRH against other routing extension headers, namely: the SRH, RH0, and packets without routing extension headers.

2. 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].

3. Test Procedure

The performance characteristics of routing extension headers on a given device under test (DUT) SHOULD be measured following the guidelines in [RFC2544], except as specified in the following sections. The set of tests that is run SHOULD include a throughput test, and MAY also include other tests that are specified in [RFC2544].

3.1. DUT Setup

The DUT to be tested MUST be able to process each of the routing extension headers whose performance will be compared. To get the most useful results, both the CRH and the SRH SHOULD be included. If possible, both 16-bit and 32-bit versions of the CRH SHOULD be included. RH0 and packets without a routing extension header MAY be included as well for comparison.

The CRH has limited support in current IPv6 implementations, so the requirement to support the CRH is likely to be the most difficult to fulfill. Juniper Networks has produced implementations of the CRH in the Linux kernel and in the MX-series router (see section 11 of [I-D.draft-bonica-6man-comp-rtg-hdr]). However, these implementations currently support only the 16-bit version of the CRH.

If the CRH is included in tests, then the router MUST have at least one SID configured to map to the tester's IP address. This SID MUST be used in the CRH to cause the router to forward the packet back to the tester (or receiver, if separate transmitting and receiving devices are used).

As per [RFC2544], configuration changes MUST NOT be made to the router between different tests.

3.2. Independent Variables

The performance characteristics of routing extension header processing may be affected by several factors, which SHOULD be used as independent variables in the test procedure:

- The type of routing extension header in use (the CRH, the SRH, RH0, or none).
- For the CRH, whether 16-bit or 32-bit short identifiers are used.
- For the CRH, the SRH, and RH0, the number of addresses (or, for the CRH, short identifiers) specified in the header. This variable SHOULD range at least from 1 to 15, but MAY include higher values if desired.
- The number of data bytes included in the packets that are sent. This variable SHOULD take on the same set of values for each permutation of the other independent variables. See the discussion of frame sizes below.

Each test SHOULD be run for every possible combination of the independent variables.

3.3. Header Contents

No extension headers should be used except for the routing extension headers being tested. Only one extension header at a time should be used.

The next segment in the SRH and RH0 MUST be the IP address of the tester (or, when using separate transmitting and receiving devices, the receiver). The next segment in the CRH MUST be an SID that the DUT has been configured to map to the IP address of the tester (or receiver). This configuration MUST be done before starting any tests.

Apart from the next segment for the SRH and RH0, the IP addresses used in the CRH, the SRH, and RH0 should be selected randomly as outlined in appendix C of [RFC2544] from the ranges reserved for this purpose by IANA.

3.4. Frame Sizes

The performance characteristics of routing extension headers may vary depending on frame size. Section 9 of [RFC2544] provides guidelines for selecting frame sizes. However, different routing extension headers use different amounts of space to encode the same information. In particular, the CRH uses less space to encode information about intermediate nodes than the SRH and RH0. For this reason, a fair comparison between two routing extension headers uses the same payload size for each rather than the same frame size for each.

The set of payload sizes for the tests SHOULD be chosen so that the resulting set of frame sizes for each routing extension header and each number of addresses follows the guidelines set out in [RFC2544] as closely as possible.

4. IANA Considerations

No IANA actions required.

5. Security Considerations

No security considerations.

6. References

6.1. Normative References

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6.2. Informative References

[I-D.draft-bonica-6man-comp-rtg-hdr] Bonica, R., Kamite, Y., Niwa, T., Alston, A., and L. Jalil, "The IPv6 Compressed Routing Header (CRH)", draft-bonica-6man-comp-rtg-hdr-14 (work in progress), April 2020.

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