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In Situ Operations, Administration, and Maintenance (IOAM) Extension for Bit Error Rate Measurement
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Abstract

Networks may experience transmission bit errors due to various factors, such as poor fiber quality, thereby corrupting packets. Merely measuring the end-to-end bit error rate makes it difficult to locate the exact link wich poor quality. Therefore, a measurement method is needed to collect bit error rate information along the entire path to locate the specific linke with poor quality.

This document extends IOAM with a new Trace-Type and "Interface Bit Error Rate" field to collect the interface error rate along the path. This new Trace-Type is applicable to Pre-allocated Trace, Incremental Trace, and Direct Exporting Option-Type.

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1. Introduction

In situ Operations, Administration, and Maintenance (IOAM)[RFC9197] collects OAM information within the packet while the packet traverses a particular network domain. IOAM is used to complement mechanisms, such as Ping or Traceroute.

Networks may experience transmission bit errors due to various factors, such as poor fiber quality, thereby corrupting packets. Although,the bit errors in the received packets can be detected using Cyclic Redundancy Check (CRC) and may be dropped or corrected using Forward Error Correction(FEC). But even with efficient CRC and FEC mechanisms, some bit errors may escape detection and correction (called residual bit error rate), and result in upper-layer checksum failures and packet drops.

[I-D.gandhi-ippm-stamp-ber] arguments the STAMP extensions in [RFC8972] to enable the measurement of end-to-end residual bit error rate within the "Extra Padding" TLV of STAMP packets.

However, merely measuring the end-to-end bit error rate makes it difficult to locate the exact link with poor quality. Therefore, a measurement method is needed to collect bit error rate information along the entire path to locate the specific linke with poor quality.

This document extends IOAM with a new Trace-Type and "Interface Bit Error Rate" field to collect the interface error rate along the path. This new Trace-Type is applicable to Pre-allocated Trace, Incremental Trace, and Direct Exporting Option-Type.

1.1. 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.

1.2. Terminology

The abbreviations used in this document are:

IOAM: In situ Operations, Administration, and Maintenance

2. IOAM extension

2.1. Extension to Pre-allocated and Incremental Trace-Option

2.1.1. Extension to Pre-allocated and Incremental Trace-Option Header

The format of IOAM Pre-allocated and Incremental Trace-Option header defined in [RFC9197] is shown as follows:

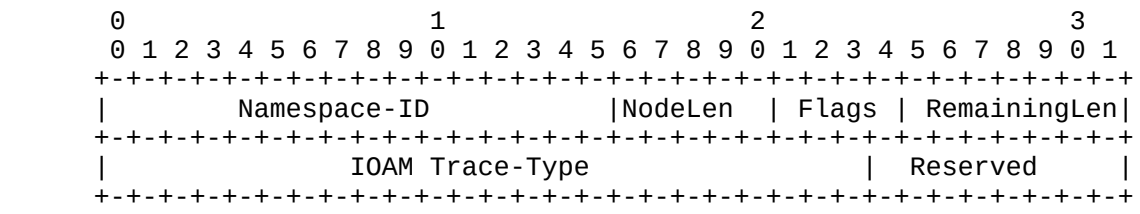

Figure 1: IOAM Pre-allocated and Incremental Trace-Option Header

The IOAM Trace-Type filed is a 24-bit identifier that specifies which data types are used in this node data list. Currently, bit 0 to bit 11 are already occupied, and bit 12 to 21 are not allocated.

This document requires to allocate a new bit X in the IOAM Trace-Type field:

Bit X: When set, indicates the presence of bit error rate of the ingress interface in the node data.

2.1.2. Extension to IOAM Node Data Fields

This document defines a new IOAM node data field, which is called "Interface Bit Error Rate". The format of this field is shown as follows:

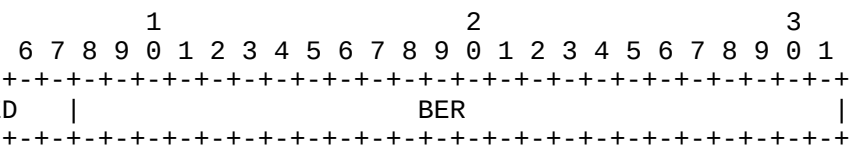

Figure 2: Interface bit error rate field

where:

A bit: This field represents the Anomalous (A) bit. The A bit is set when the measured value of this parameter exceeds its configured maximum threshold. The A bit is cleared when the measured value falls below its configured reuse threshold. If the A bit is cleared, the sub-TLV represents steady-state link performance.

RESERVED: This field is reserved for future use. It MUST be set to 0 when sent and MUST be ignored when received.

Link Bit Error Ratio: This 24-bit field carries Link Bit Error Ratio as a percentage of the total traffic sent over a configurable interval. The basic unit is 0.000003%, where (2^24 - 2) is 50.331642%. This value is the highest link bit error percentage that can be expressed. Therefore, measured values that are larger than the field maximum SHOULD be encoded as the maximum value.

2.2. Extension for Direct Exporting Option

As described in Section 3.2 of [RFC9326], the format of this IOAM-Trace-Type of Direct Exporting Option is the same as defined in [RFC9197]. Therefore, the new bit defined in Section 2.1.1 is also valid in Direct Exporting Option.

3. IANA Considerations

This document requests IANA to allocate a bit from the "IOAM Trace-Type" registry:

Value	Description	Reference
Bit X	Bit error rate of ingress interface	This document

Table 1

4. Security Considerations

TBD

5. References

5.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/rfc/rfc2119>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

5.2. Informative References

[RFC9197] Brockners, F., Ed., Bhandari, S., Ed., and T. Mizrahi, Ed., "Data Fields for In Situ Operations, Administration, and Maintenance (IOAM)", RFC 9197, DOI 10.17487/RFC9197, May 2022, <https://www.rfc-editor.org/rfc/rfc9197>.

[I-D.gandhi-ippm-stamp-ber] Gandhi, R., Schoenmaker, P., and R. F. Foote, "Simple Two-Way Active Measurement Protocol (STAMP) Extensions for Residual Bit Error Rate Measurement", Work in Progress, Internet-Draft, draft-gandhi-ippm-stamp-ber-04, 14 November 2025, <https://datatracker.ietf.org/doc/html/draft-gandhi-ippm-stamp-ber-04>.

[RFC8972] Mirsky, G., Min, X., Nydell, H., Foote, R., Masputra, A., and E. Ruffini, "Simple Two-Way Active Measurement Protocol Optional Extensions", RFC 8972, DOI 10.17487/RFC8972, January 2021, <https://www.rfc-editor.org/rfc/rfc8972>.

[RFC9326] Song, H., Gafni, B., Brockners, F., Bhandari, S., and T. Mizrahi, "In Situ Operations, Administration, and Maintenance (IOAM) Direct Exporting", RFC 9326, DOI 10.17487/RFC9326, November 2022, <https://www.rfc-editor.org/rfc/rfc9326>.

Acknowledgements

TBD

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