                        Round-trip Loss Metrics
                      draft-morton-ippm-rt-loss-01

Abstract

   Many user applications and the transport protocols that make them
   possible require two-way communications. To address this need, and
   also for system simplicity, round-trip loss measurements are
   frequently conducted in practice. The Two-Way Active Measurement
   Protocol specified in RFC 5357 establishes a round-trip loss
   measurement capability for the Internet. However, there is currently
   no metric specified according to the RFC 2330 framework.

   This memo proposes/adds round-trip loss to the set of IP Performance
   Metrics (IPPM).

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 RFC 2119 [RFC2119].

Status of this Memo

   This Internet-Draft is submitted in full conformance with the
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1. Introduction

   This memo defines a metric for round-trip loss on Internet paths. It
   builds on the notions and conventions introduced in the IP
   Performance Metrics (IPPM) framework [RFC2330]. Also, the
   specifications of the One-way Loss metric [RFC2680] and the Round-
   trip Delay metric [RFC2681] are frequently referenced and modified to
   match the round-trip circumstances addressed here. However, this
   memo assumes that the reader is familiar with the references, and
   does not repeat material as was done in [RFC2681].

   This memo uses the terms "two-way" and "round-trip" synonymously.

1.1. Motivation

   Many user applications and the transport protocols that make them
   possible require two-way communications. For example, the TCP SYN->,
   <-SYN-ACK, ACK-> three-way handshake attempted billions of times each
   day cannot be completed without two-way connectivity in a near-
   simultaneous time interval. Thus, measurements of Internet round-
   trip loss performance provide a basis to infer application
   performance more easily.

   Measurement system designers have also recognized advantages of
   system simplicity when one host simply echoes or reflects test
   packets to the sender. Round-trip loss measurements are frequently
   conducted and reported in practice. The Two-Way Active Measurement
   Protocol specified in [RFC5357] establishes a round-trip loss
   measurement capability for the Internet. However, there is currently
   no round-trip loss metric specified according to the [RFC2330]
   framework.

   [RFC2681] indicates that round-trip measurements may sometimes
   encounter "asymmetric" paths. When loss is observed using a round-
   trip measurement, there is often a desire to ascertain which of the
   two directional paths "lost" the packet. Under some circumstances,
   it is possible to make this inference. The round-trip measurement
   method raises a few complications when interpreting the embedded one-
   way results, and the user should be aware of them.

   [RFC2681] also points out that loss measurement conducted
   sequentially in both directions of a path and reported as a round-
   trip result may be exactly the desired metric. On the other hand, it
   may be difficult to derive the state of round-trip loss from one-way
   measurements conducted in each direction unless a method to match the
   appropriate one-way measurements has pre-arranged.

   Finally, many measurement systems report statistics on a conditional

delay distribution, where the condition is packet arrival at the destination. This condition is encouraged in [RFC3393], [RFC5481], and [draft-ietf-ippm-reporting-metrics]. As a result, lost packets need to be reported separately, according to a standardized metric. This memo defines such a metric.

See Section 1.1 of[RFC2680] for additional motivation of the packet loss metric.

2. Scope

This memo defines a round-trip loss metric using the conventions of the IPPM framework [RFC2330].

The memo defines a singleton metric, a sample metric, and a statistic, as per [RFC2330].

The memo also investigates the topic of one-way loss inference from a two-way measurement, and lists some key considerations.

3. Common Specifications for Round-trip Metrics

To reduce the redundant information presented in the detailed metrics sections that follow, this section presents the specifications that are common to two or more metrics. The section is organized using the same subsections as the individual metrics, to simplify comparisons.

3.1. Name: Type-P-*

All metrics use the Type-P convention as described in [RFC2330]. The rest of the name is unique to each metric.

3.2. Metric Parameters

o Src, the IP address of a host

o Dst, the IP address of a host

o T, a time (start of test interval)

o Tf, a time (end of test interval)

o lambda, a rate in reciprocal seconds (for Poisson Streams)

o incT, the nominal duration of inter-packet interval, first bit to
   first bit (for Periodic Streams)

o T0, a time that MUST be selected at random from the interval [T,
   T+dT] to start generating packets and taking measurements (for
   Periodic Streams)

o TstampSrc, the wire time of the packet as measured at MP(Src) as
   it leaves for Dst.

o TstampDst, the wire time of the packet as measured at MP(Dst),
   assigned to packets that arrive within a "reasonable" time.

o Tmax, a maximum waiting time for packets to arrive, set
   sufficiently long to disambiguate packets with long delays from
   packets that are discarded (lost).

o M, the total number of packets sent between T0 and Tf

o N, the total number of packets received at Dst (sent between T0
   and Tf)

o Type-P, as defined in [RFC2330], which includes any field that may
   affect a packet's treatment as it traverses the network

3.3. Metric Definition

This section is specific to each metric.

3.4. Metric Units

The metric units are logical (1 or 0) when describing a single
packet's loss performance, where a 0 indicates successful packet
transmission and a 1 indicates packet loss.

Units of time are as specified in [RFC2330].

Other units used are defined in the associated section.

4. A Singleton Round-trip Loss Metric

4.1. Name: Type-P-Round-trip-Loss

4.2. Metric Parameters

   See section 3.2.

4.3. Definition and Metric Units

   Type-P-Round-trip-Loss SHALL be represented by the binary logical
   values (or their equivalents) when the following conditions are met:

   Type-P-Round-trip-Loss = 0:

   o Src sent the first bit of a Type-P packet to Dst at wire-time
      TstampSrc,

   o that Dst received that packet,

   o the Dst immediately sent a Type-P packet back to the Src, and

   o that Src received the last bit of the reflected packet at wire-
      time TstampSrc + Tmax.

   Type-P-Round-trip-Loss = 1:

   o Src sent the first bit of a Type-P packet to Dst at wire-time
      TstampSrc,

   o that Src did not receive the last bit of the reflected packet
      before the waiting time lapsed at TstampSrc + Tmax

   o (possibly because that Dst did not receive that packet,

   o the Dst did not immediately sent a Type-P packet back to the Src,
      or

   o the Src did not receive a reflected Type-P packet sent from the
      Dst).

   Following the precedent of[RFC2681], we make the simplifying
   assertion:

   Type-P-Round-trip-Loss(Src->Dst) = Type-P-Round-trip-Loss(Dst->Src)

   (and agree with the rationale, that the ambiguity introduced is a
   small price to pay for measurement efficiency).

   Therefore, each singleton can be represented by pairs of elements as
   follows:

   o TstampSrc, the wire time of the packet at the Src (beginning the
      round-trip journey).

   o L, either zero or one (or some logical equivalent), where L=1
      indicates loss and L=0 indicates successful round-trip arrival
      prior to TstampSrc + Tmax.

4.4. Discussion and other details

   See [RFC2680] and [RFC2681] for extensive discussion, methods of
   measurement, errors and uncertainties, and other fundamental
   considerations that need not be repeated here.

5. A Sample Round-trip Loss Metric

   Given the singleton metric Type-P-Round-trip-Loss, we now define one
   particular sample of such singletons. The idea of the sample is to
   select a particular binding of the parameters Src, Dst, and Type-P,
   then define a sample of values of parameter TstampSrc. This can be
   done in several ways, including:

   1. Poisson: a pseudo-random Poisson process of rate lambda, whose
       values fall between T and Tf. The time interval between
       successive values of TstampSrc will then average 1/lambda, as per
       [RFC2330].

   2. Periodic: a periodic stream process with pseudo-random start time
       T0 between T and dT, and nominal inter-packet interval incT, as
       per [RFC3432].

   In the metric name, the variable <Stream> should be replaced with the
   process used to define the sample, using one of the above processes
   (or other process, the details of which MUST be specified if used).

5.1. Name: Type-P-Round-trip-Loss-<Sample>-Stream

5.2. Metric Parameters

   See section 3.2.

5.3. Definition and Metric Units

   Given one of the methods for defining the test interval, the sample
   of times (TstampSrc) and other metric parameters, we obtain a
   sequence of Type-P-Round-trip-Loss singletons as defined in section
   4.3.

Type-P-Round-trip-Loss-<Sample>-Stream SHALL be a sequence of pairs
with elements as follows:

o TstampSrc, as above

o L, either zero or one (or some logical equivalent), where L=1
   indicates loss and L=0 indicates successful round-trip arrival
   prior to TstampSrc + Tmax.

where <Sample> SHALL be replaced with "Poisson", "Periodic", or an
appropriate term to designate another sample method meeting the
criteria of [RFC2330].

5.4. Discussion and other details

   See [RFC2680] and [RFC2681] for extensive discussion, methods of
   measurement, errors and uncertainties, and other fundamental
   considerations that need not be repeated here.

6. Round-trip Loss Statistic

   This section gives the primary and overall statistic for loss
   performance. Additional statistics and metrics originally prepared
   for One-way loss MAY also be applicable.

6.1. Type-P-Round-trip-Loss-<Sample>-Ratio

   Given a Type-P-Round-trip-Loss-<Sample>-Stream, the average of all
   the logical values, L, in the Stream is the Type-P-Round-trip-Loss-
   <Sample>-Ratio. This ratio is in units of lost packets per round-
   trip transmissions attempted.

   In addition, the Type-P-Round-trip-Loss-<Sample>-Ratio is undefined
   if the sample is empty.

7. Round-trip Testing and One-way Reporting

   This section raises considerations for results collected using a
   round-trip measurement architecture, such as in TWAMP [RFC5357].

   The sampling process for the return path (Dst->Src) is a conditional
   process that depends on successful packet arrival at the Dst and
   correct operation at the Dst to generate the reflected packet.
   Therefore, the sampling process for the return path will be
   significantly affected when appreciable loss occurs on the Src->Dst
   path, making an attempt to assess the return path performance invalid

(for loss or possibly any metric).

Further, the sampling times for the return path (Dst->Src) are a
random process that depends on the original sample times (TstampSrc),
the one-way-delay for successful packet arrival at the Dst, and time
taken at the Dst to generate the reflected packet. Therefore, the
sampling process for the return path will be significantly affected
when appreciable delay variation occurs on the Src->Dst path, making
an attempt to assess the return path performance invalid (for loss or
possibly any metric).

8. Security Considerations

8.1. Denial of Service Attacks

   This metric requires a stream of packets sent from one host (source)
   to another host (destination) through intervening networks, and back.
   This method could be abused for denial of service attacks directed at
   the destination and/or the intervening network(s).

   Administrators of source, destination, and the intervening network(s)
   should establish bilateral or multi-lateral agreements regarding the
   timing, size, and frequency of collection of sample metrics. Use of
   this method in excess of the terms agreed between the participants
   may be cause for immediate rejection or discard of packets or other
   escalation procedures defined between the affected parties.

8.2. User Data Confidentiality

   Active use of this method generates packets for a sample, rather than
   taking samples based on user data, and does not threaten user data
   confidentiality. Passive measurement must restrict attention to the
   headers of interest. Since user payloads may be temporarily stored
   for length analysis, suitable precautions MUST be taken to keep this
   information safe and confidential. In most cases, a hashing function
   will produce a value suitable for payload comparisons.

8.3. Interference with the metrics

   It may be possible to identify that a certain packet or stream of
   packets is part of a sample. With that knowledge at the destination
   and/or the intervening networks, it is possible to change the
   processing of the packets (e.g. increasing or decreasing delay) that
   may distort the measured performance. It may also be possible to
   generate additional packets that appear to be part of the sample
   metric. These additional packets are likely to perturb the results
   of the sample measurement.

   To discourage the kind of interference mentioned above, packet
   interference checks, such as cryptographic hash, may be used.

9. IANA Considerations

   Metrics defined in IETF are typically registered in the IANA IPPM
   METRICS REGISTRY as described in initial version of the registry
   [RFC4148]. However, areas for improvement of this registry have been
   identified, and the registry structure has to be revisited when there
   is consensus to do so.

   Therefore, the metrics in this draft may be considered for
   registration in the future, and no IANA Action is requested at this
   time.

10. Acknowledgements

11. References

11.1. Normative References

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11.2. Informative References

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Author's Address

   Al Morton
   AT&T Labs
   200 Laurel Avenue South
   Middletown,, NJ 07748
   USA

   Phone: +1 732 420 1571
   Fax: +1 732 368 1192
   Email: acmorton@att.com
   URI: http://home.comcast.net/~acmacm/