Network Working Group
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Reporting IP Performance Metrics to Users
draft-shalunov-ippm-reporting-03.txt

Status of this Memo

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Abstract

The aim of this document is to define a small set of metrics that are robust, easy to understand, orthogonal, relevant, and easy to compute. The IPPM WG has defined a large number of richly parameterized metrics because network measurement has many purposes. Often, the ultimate purpose is to report a concise set of metrics describing a network's state to an end user. It is for this purpose that the present set of metrics is defined.

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1. Requirements Notation

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].

2. Goals and Motivation

The IPPM working group has defined many richly parameterized performance metrics with a number of variants (one-way delay, one-way loss, delay variation, reordering, etc.) and a protocol for obtaining the measurement data needed to compute these metrics (OWAMP). It would be beneficial to define a standard way to report a set of performance metrics to end users. Parameterization might be acceptable in such a set, but there must still be defaults for everything. It is especially important to get these defaults right. Such a set would enable different tools to produce results that can be compared against each other.

Existing tools already report statistic about the network. This is done for varying reasons: network testing tools, such as the ping program available in UNIX-derived operating systems as well as in Microsoft Windows, report statistics with no knowledge of why the user is running the program; networked games might report statistics of the network connection to the server so users can better understand why they get the results they get (e.g., if something is slow, is this because of the network or the CPU?), so they can compare their statistics to those of others (``you're not lagged any more than I am'') or perhaps so that users can decide whether they need to upgrade the connection to their home; IP telephony hardware and software might report the statistics for similar reasons. While existing tools report statistics all right, the particular set of metrics they choose is ad hoc; some metrics are not statistically robust, some are not relevant, and some are not easy to understand; more important than specific shortcomings, however, is the incompatibility: even if the sets of metrics were perfect, they would still be all different, and, therefore, metrics reported by different tools would not be comparable.

The set of metrics of this document is meant for human consumption. It must therefore be small. Anything greater than half-dozen numbers is certainly too confusing.

Each of the metrics must be statistically robust. Intuitively, this means that having a small number of bad data points and a small amount of noise must not dramatically change the metric.

Each metric in the set must have, qualitatively, an immediate intuitive meaning that has to be obvious for an advanced end user without consulting documentation (that is, it has to be clear what rough meaning, intuitively, the larger values of a given metric have).

To be small, the set has to be orthogonal: each of the metrics has to

express a property not covered by other metrics (otherwise, there's redundancy).

The metrics in the set must be relevant. Partly, being easy to understand will help achieve this, but additional constraint may be placed by relevancy.

Finally, while this set will most frequently be computed for small data sets, where efficiency is not a serious consideration, it must be possible to compute for large data sets, too. In particular, it must be possible to compute the metrics in a single pass over the data using a limited amount of memory (i.e., it must be possible to take a source of measurement data with a high data rate and compute the metrics on the fly, discarding each data point after it is processed).

3. Reportable Metrics Set

The following metrics comprise the set:

1. delay;

2. loss;

3. jitter;

4. duplication;

5. reordering.

Each of the above is represented by a single numeric quantity, computed as described below.

3.1. Delay

The reported delay is the median of all delays in the sample. When a packet is lost, its delay is to be considered +infinity for the purposes of this computation; therefore, if more than half of all packets are lost, the delay is +infinity.

FIXME: References.

3.2. Loss

Loss is the fraction, expressed as a percentage, of packets that did not arrive intact within a given number of seconds (timeout value) after being sent. Since this set of metrics often has to be reported to a waiting human user, the default timeout value has to be small. By default, 2 seconds MUST be the timeout value.

FIXME: References.

3.3. Jitter

Jitter is the interquartile spread of delay. In other words, jitter is equal to the difference of the 75th and 25th percentiles of delay. When both percentiles are +infinity, the value of jitter is undefined. Therefore, if less than 25% of packets are lost, jitter is defined and finite; if between 75% and 25% of packets are lost, jitter is +infinity; finally, if more than 75% of packets are lost, jitter is undefined.

FIXME: References.

3.4. Duplication

Duplication is the fraction of packets for which more than a single copy of the packet was received within the timeout period (same timeout as in the definition of loss), expressed in percentage points.

Note: while most received packets can be ones previously seen, duplication can never exceed 100%.

FIXME: References (tough one---IPPM hasn't defined duplication).

3.5. Reordering

Reordering is the fraction of sent packets for which the sequence number of the packet received immediately before the first copy of the given packet is not the decrement of the sequence number of the given packet. For the purposes of determining the sequence number of the preceding packet in this definition, assuming sequence numbers starting with 1, an extra packet at the start of the stream of received packets, with a sequence number of 0, is considered to be present (this extra packet, of course, is not counted for the purposes of computing the fraction).

FIXME: References.

4. Sample Source

Section 3 describes the metrics to compute on a sample of measurements. The source of the sample in not discussed there, and, indeed, the metrics discussed (delay, loss, etc.) are simply estimators that could be applied to any sample whatsoever. For the names of the estimators to be applicable, of course, the measurements need to come from a packet delivery network.

The data in the samples for the set of metrics discussed in this document can come from the following sources: one-way active measurement, round-trip measurement, and passive measurement. There infrequently is a choice between active and passive measurement, as, typically, only one is available; consequently, no preference is given to one over the other. In cases where clocks can be expected to be synchronized, in general, one-way measurements are preferred over round-trip measurements (as one-way measurements are more informative). When one-way measurements cannot be obtained, or when clocks cannot be expected to be synchronized, round-trip measurement MAY be used.

4.1. One-Way Active Measurement

The default duration of the measurement interval is 10 seconds.

The default sending schedule is a Poisson stream.

The default sending rate is 10 packets/second on average. The default sending schedule is a Poisson stream. When randomized schedules, such as a Poisson stream, are used, the rate MUST be set with the distribution parameter(s). With a randomized schedule, the default sample size is 100 packets and the measurement window duration can vary to some extent depending on the values of the (pseudo-)random deviates.

The default packet size is the minimum necessary for the measurement.

Values other than the default ones MAY be used; if they are used, their use, and specific values used, MUST be reported.

A one-way active measurement is characterized by the source IP address, the destination IP address, the time when measurement was taken, and the type of packets (e.g., UDP with given port numbers and a given DSCP) used in the measurement. For the time, the middle of the measurement interval MUST be reported.

4.2. Round-Trip Active Measurement

The same default parameters and characterization apply to round-trip measurement as to one-way measurement (Section 4.1).

4.3. Passive Measurement

Passive measurement use whatever data it is natural to use. For example, an IP telephony application or a networked game would use the data that it sends. An analysis of performance of a link might use all the packets that traversed the link in the measurement interval. An analysis of performance of an Internet service provider's network might use all the packets that traversed the network in the measurement interval. An analysis of performance of a specific service from the point of view of a given site might use an appropriate filter to select only the relevant packets. In any case, the source needs to be reported.

The same default duration applies to passive measurement as to one-way active measurement (Section 4.1).

When the passive measurement data is reported in real time, a sliding window SHOULD be used as a measurement period, so that recent data become more quickly reflected.

5. Security Considerations

The reporting per se, not being a protocol, does not raise security considerations.

An aspect of reporting relevant to security is how the reported metrics are used and how they are collected. If it is important that the metrics satisfy certain conditions (e.g., that the ISP whose network is being measured be unable to make the metrics appear better than they are), the collection mechanism MUST ensure that this is, indeed, so. The exact mechanisms to do so our outside of scope of this document and belong with discussion of particular measurement data collection protocols.

6. Internationalization Considerations

The reported metrics, while they might occasionally be parsed by machine, are primarily meant for human consumption. As such, they MAY be reported in the language preferred by the user, using an encoding suitable for the purpose, such as UTF-8.

7. IANA Considerations

This document requires no action from the IANA.

8. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

Appendix A. Acknowledgments

The author gratefully acknowledges discussion with, encouragement from, and contributions of Lawrence D. Dunn, Reza Fardid, Ruediger Geib, Matt Mathis, Al Morton, Carsten Schmoll, Henk Uijterwaal, and Matthew J. Zekauskas.

Appendix B. TODO

FIXME: This section needs to be removed before publication.

- Add references
- Add non-normative code for illustration
- Add examples (code output)

Appendix C. Revision History

FIXME: This section needs to be removed before publication.

$Log: draft-shalunov-ippm-reporting.xml,v $
Revision 1.5 2006/05/02 20:25:44 shalunov
Version 03: Various refinements and clarifications based on feedback
from Reza Fardid, Ruediger Geib, and Al Morton.

Revision 1.4 2006/04/25 22:38:58 shalunov
Version 02: Address comments from Carsten Schmoll, sent in message
70524A4436C03E43A293958B505008B61B9CFB@EXCHSRV.fokus.fraunhofer.de.
My response, with clarifications and diffs, is in message
8664kxwazk.fsf@abel.internet2.edu.

Revision 1.3 2006/04/11 22:09:47 shalunov
Version 01: Wording changes based on discussion with Matt Zekauskas
(reordering, loss). Rewrite abstract a bit. Add TODO list.

Revision 1.2 2006/04/04 21:39:20 shalunov
Convert to xml2rfc 1.30 and RFC 3978 IPR statement.

Revision 1.1.1.1 2006/04/02 17:07:36 shalunov
Initial import into CVS.

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