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A Registry Investigation for IPPM Packet Delay Variation Metrics  
draft-morton-ippm-registry-pdv-00

## Abstract

This memo investigates a scheme to organize registry entries, primarily those defined in RFCs prepared in the IP Performance Metrics (IPPM) Working Group of the IETF. Three aspects make IPPM metric registration difficult: (1) Use of the Type-P notion to allow users to specify their own packet types. (2) Use of Flexible input variables, called Parameters in IPPM definitions, some which determine the quantity measured and others which should not be specified until execution of the measurement. (3) Allowing flexibility in choice of statistics to summarize the results on a stream of measurement packets. Specifically, this memo investigates registry entries that would follow from [RFC 3393](#), the specification IP Packet Delay Variation that allows for many different forms of unique metrics, as a difficult and important test of the registry structure.

## 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](#)].

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## 1. Introduction

This memo investigates a scheme to organize registry entries, primarily those defined in RFCs prepared in the IP Performance Metrics (IPPM) Working Group of the IETF, according to their framework [[RFC2330](#)]. Three aspects make IPPM metric registration difficult: (1) Use of the Type-P notion to allow users to specify their own packet types. (2) Use of Flexible input variables, called Parameters in IPPM definitions, some which determine the quantity measured and others which should not be specified until execution of the measurement. (3) Allowing flexibility in choice of statistics to summarize the results on a stream of measurement packets.

Specifically, this memo investigates registry entries that would follow from [[RFC3393](#)], the specification IP Packet Delay Variation that allows for many different forms of unique metrics, as a difficult and important test of the registry structure.

Although there are several standard templates for organizing specifications of performance metrics (see [[RFC2679](#)] for an example of the traditional IPPM template, based to large extent on the Benchmarking Methodology Working Group's traditional template in [[RFC1242](#)], and [[RFC6390](#)] for a similar template), none of these templates were intended to become the basis for the columns of an IETF-wide registry of metrics. As we examine the aspects of metric specifications which need to appear in the registry, we will see that none of the existing metric templates fully satisfies the needs of a registry.

The authors of [[draft-bagnulo-ippm-new-registry](#)] and

[[draft-bagnulo-ippm-new-registry-independent](#)] made important contributions to this memo in the registry column structure, and the problem of registry development in general. We also acknowledge input from the authors of [[draft-claise-ippm-perf-metric-registry](#)], especially the value of an Element ID and the need for naming conventions.

## [2.](#) Scope

This memo investigates the registry structure that best describes IPPM delay variation metrics based on [[RFC3393](#)] using the conventions of the IPPM framework [[RFC2330](#)].

We find that the flexibility allowed in [[RFC3393](#)] requires further specificity to have a metric worthy of registration, and we refer to [[RFC5481](#)] for the needed definition details.

In this memo, we attempt a combinatoric registry, where all factors

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that can be reasonably specified ARE specified, and changing even one factor would require a new registry entry (row). It is believed that this exercise can also be instructive for a registry based on independent factors, [[draft-bagnulo-ippm-new-registry-independent](#)] but that topic is beyond the scope of this effort.

## [3.](#) List of Registry Columns

This section briefly describes the columns used by this draft, as this is likely to be a topic for discussion and revision. Taken as a whole, the entries in the columns give a registered instance of a metric with sufficient specificity to promote comparable results across independent implementations. In other words, a complete Metric Description.

### [3.1.](#) Element ID

An integer having enough digits to uniquely identify each entry in the Registry.

### [3.2.](#) Metric Name

A metric naming convention is TBD.

The current guidance from [Section 13 of \[RFC2330\]](#), where Type-P is a feature of all IPPM metric names, is:

"... we introduce the generic notion of a "packet of type P", where in some contexts P will be explicitly defined (i.e., exactly what type of packet we mean), partially defined (e.g., "with a payload of B octets"), or left generic. Thus we may talk about generic IP-type-P-connectivity or more specific IP-port-HTTP-connectivity. Some metrics and methodologies may be fruitfully defined using generic type P definitions which are then made specific when performing actual measurements. Whenever a metric's value depends on the type of the packets involved in the metric, the metric's name will include either a specific type or a phrase such as "type-P". ..."

Registry entries are a context where Type-P must be defined.

IPPM Metric names have also included the typically included the stream type, to distinguish between singleton and sample metrics (see [\[RFC2330\]](#) for the definition of these terms).

### [3.3.](#) Run-time Parameters

Run-Time Parameters are input factors that must be determined, configured into the measurement system, and reported with the results for the context to be complete. However, the values of these parameters is not specified in the Registry, rather these parameters are listed as an aid to the measurement system implementor or user (they must be left as variables, and supplied on execution).

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Run-Time Parameters.

### [3.4.](#) Fixed Parameters

Fixed Parameters are input factors that must be determined and embedded in the measurement system for use when needed. The values of these parameters is specified in the Registry.

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Fixed Parameters.

A Parameter which is Fixed for one Registry element may be designated as a Run-time Parameter for another Registry element.

### [3.5.](#) Metric Definition

This entry provides references to relevant sections of the RFC(s) defining the metric, as well as any supplemental information needed to ensure an unambiguous definition for implementations.

### [3.6.](#) Metric Units (and Data Format?)

The results of a metric must be expressed using some standard dimension or units of measure. This column provides the units (and if possible, the data format, whose specification will simplify both measurement implementation and collection/storage tasks).

When a sample of singletons is collected, this entry will include the data format and units of measure for each measured value.

### [3.7.](#) Stream Type and Stream Parameters

Principally, two different streams are used in IPPM metrics, Poisson distributed as described in [[RFC2330](#)] and Periodic as described in [[RFC3432](#)]. Both Poisson and Periodic have their own unique parameters, and the relevant set is specified in as Fixed Parameters

in this column.

### [3.8.](#) Method of Measurement

This entry provides references to relevant sections of the RFC(s) describing the method of measurement, as well as any supplemental information needed to ensure an unambiguous methods for implementations.

### [3.9.](#) Output Statistic

For entries which involve a stream and many singleton measurements, a statistic may be specified in this column to summarize the results to a single value.

### [3.10.](#) Discussion/Remarks

Besides providing additional details which do not appear in other columns, the Discussion/Remarks column allows for unforeseen issues to be addressed by simply updating this Informational column.

## [4.](#) Registry Column Entries for PDV

This is a complete Metric Description for one Packet Delay Variation (PDV) metric.

### [4.1.](#) Element ID

An integer with enough digits to uniquely identify the entry.

### [4.2.](#) Metric Name

A metric naming convention is TBD.

One possibility based on IPPM's framework is:

IP-UDP-One-way-pdv-95th-percentile-Poisson

### [4.3.](#) Run-time Parameters

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Run-Time 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 T1, the wire time of the first packet in a pair, measured at MP(Src) as it leaves for Dst.
- o T2, the wire time of the second packet in a pair, measured at MP(Src) as it leaves for Dst.
- o I(i),I(i+1),  $i \geq 0$ , pairs of times which mark the beginning and ending of the intervals in which the packet stream from which the measurement is taken occurs. Here,  $I(0) = T_0$  and assuming that n is the largest index,  $I(n) = T_f$ .

#### [4.4.](#) Fixed Parameters

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Fixed Parameters.

- o F, a selection function defining unambiguously the packets from the stream selected for the metric. See [section 4.2 of \[RFC5481\]](#) for the PDV form.
- o L, a packet length in bits.  $L = 200$  bits.
- o Tmax, a maximum waiting time for packets to arrive at Dst, set sufficiently long to disambiguate packets with long delays from packets that are discarded (lost).  $T_{max} = 3$  seconds.
- o Type-P, as defined in [\[RFC2330\]](#), which includes any field that may affect a packet's treatment as it traverses the network. The packets are IP/UDP, with DSCP = 0 (BE).

#### [4.5.](#) Metric Definition

See sections [2.4](#) and [3.4](#) of [\[RFC3393\]](#). Singleton delay differences measured are referred to by the variable name "ddT".

#### [4.6.](#) Metric Units (and Data Format?)

See [section 3.3 of \[RFC3393\]](#) for singleton elements.

[\[RFC2330\]](#) recommends that when a time is given, it will be expressed in UTC.

The timestamp format (for T, Tf, etc.) is the same as in [\[RFC5905\]](#) (64 bits) and is as follows: the first 32 bits represent the unsigned integer number of seconds elapsed since 0h on 1 January 1900; the next 32 bits represent the fractional part of a second that has elapsed since then.

The result format for ddT is \*similar to\* the short format in [\[RFC5905\]](#) (32 bits) and is as follows: the first 16 bits represent the \*signed\* integer number of seconds; the next 16 bits represent the fractional part of a second.

#### [4.7.](#) Stream Type and Stream Parameters

Poisson distributed as described in [\[RFC2330\]](#), with the following Parameters.

- o lambda, a rate in reciprocal seconds (for Poisson Streams). lambda = 1 packet per second
- o Upper limit on Poisson distribution (values above this limit will be clipped and set to the limit value). Upper limit = 30 seconds.

#### [4.8.](#) Method of Measurement

See [section 2.6](#) and 3.6 of [\[RFC3393\]](#) for singleton elements.

#### [4.9.](#) Output Statistic

See [section 4.3 of \[RFC3393\]](#) for details on the percentile statistic. The percentile = 95.

Individual results (singletons) should be represented by the following triple

- o T1 and T2, times as described above
- o ddT as defined in [section 2.4 of \[RFC3393\]](#)

if needed.

#### [4.10.](#) Discussion/Remarks

Lost packets represent a challenge for delay variation metrics. See [section 4.1 of \[RFC3393\]](#) and the delay variation applicability statement [\[RFC5481\]](#) for extensive analysis and comparison of PDV and IPDV.

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## [5.](#) Registry Column Entries for IPDV

This is a complete Metric Description for one Inter-Packet Delay Variation (IPDV) metric.

### [5.1.](#) Element ID

An integer with enough digits to uniquely identify the entry.

### [5.2.](#) Metric Name

A metric naming convention is TBD.

One possibility based on IPPM's framework is:

IP-UDP-One-way-ipdv-range-Periodic

### [5.3.](#) Run-time Parameters

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Run-Time Parameters.

- o Src, the IP address of a host
- o Dst, the IP address of a host
- o T, the beginning of a time interval where a periodic sample is desired.
- o T0, a time that MUST be selected at random from the interval [T, T+PdT] to start generating packets and taking measurements (start of test interval)
- o Tf, a time, greater than T0, for stopping generation of packets for a sample (Tf may be relative to T0 if desired).
- o T1, the wire time of the first packet in a pair, measured at MP(Src) as it leaves for Dst.

- o  $T_2$ , the wire time of the second packet in a pair, measured at  $MP(Src)$  as it leaves for  $Dst$ .
- o  $I(i), I(i+1)$ ,  $i \geq 0$ , pairs of times which mark the beginning and ending of the intervals in which the packet stream from which the measurement is taken occurs. Here,  $I(0) = T_0$  and assuming that  $n$  is the largest index,  $I(n) = T_f$ .

#### [5.4.](#) Fixed Parameters

Where metrics supply a list of Parameters as part of their descriptive template, a sub-set of the Parameters will be designated as Fixed Parameters.

- o  $F$ , a selection function defining unambiguously the packets from the stream selected for the metric. See [section 4.1 of \[RFC5481\]](#) for the IPDV form.
- o  $L$ , a packet length in bits.  $L = 200$  bits.
- o  $T_{max}$ , a maximum waiting time for packets to arrive at  $Dst$ , set sufficiently long to disambiguate packets with long delays from packets that are discarded (lost).  $T_{max} = 3$  seconds.
- o Type-P, as defined in [\[RFC2330\]](#), which includes any field that may affect a packet's treatment as it traverses the network. The packets are IP/UDP, with DSCP = 0 (BE).

#### [5.5.](#) Metric Definition

See [section 3.4 of \[RFC3393\]](#).

#### [5.6.](#) Metric Units (and Data Format?)

See [section 3.3 of \[RFC3393\]](#) for singleton elements.

[\[RFC2330\]](#) recommends that when a time is given, it will be expressed in UTC.

The timestamp format (for  $T$ ,  $T_f$ , etc.) is the same as in [\[RFC5905\]](#)

(64 bits) and is as follows: the first 32 bits represent the unsigned integer number of seconds elapsed since 0h on 1 January 1900; the next 32 bits represent the fractional part of a second that has elapsed since then.

The result format for ddT is \*similar to\* the short format in [\[RFC5905\]](#) (32 bits) and is as follows: the first 16 bits represent the \*signed\* integer number of seconds; the next 16 bits represent the fractional part of a second (resolving 15 microseconds).

### [5.7.](#) Stream Type and Stream Parameters

Periodic distributed as described in [\[RFC3432\]](#), with the following Parameters.

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- o incT, the nominal duration of inter-packet interval, first bit to first bit (for Periodic Streams). incT = 1 second (per packet)
- o PdT, the duration of the interval for allowed sample start times. T0 may be drawn from a uniform distribution, such as  $T_0 = T + \text{Unif}(0, \text{PdT})$ , or other distribution for PdT.

### [5.8.](#) Method of Measurement

See [section 2.6](#) and 3.6 of [\[RFC3393\]](#) for singleton elements.

### [5.9.](#) Output Statistic

See sections [5.2](#) and [6.5](#) of [\[RFC5481\]](#) for details on the range statistic, or  $\max(\text{ddT}) - \min(\text{ddT})$ . Note that  $\min(\text{ddT})$  will almost always be a negative value.

Individual results (singletons) should be represented by the following triple

- o T1 and T2, times as described above
- o ddT as defined in [section 2.4 of \[RFC3393\]](#)

if needed.

#### [5.10.](#) Discussion/Remarks

Lost packets represent a challenge for delay variation metrics. See [section 4.1 of \[RFC3393\]](#) and the delay variation applicability statement[RFC5481] for extensive analysis and comparison of PDV and IPDV.

### [6.](#) Security Considerations

#### [6.1.](#) Denial of Service Attacks

The metrics in this memo require 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

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may be cause for immediate rejection or discard of packets or other escalation procedures defined between the affected parties.

#### [6.2.](#) 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.

#### [6.3.](#) 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) in a way 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.

Authentication or encryption techniques, such as digital signatures, MAY be used where appropriate to guard against injected traffic attacks. [[RFC5357](#)] includes both authentication and encryption features.

## [7.](#) IANA Considerations

Metrics previously defined in IETF were registered in the IANA IPPM METRICS REGISTRY, however this process was discontinued when the registry structure was found to be inadequate, and the registry was declared Obsolete [[RFC6248](#)].

Although the metrics in this draft may be considered for some form of registration in the future, no IANA Action is requested at this time.

## [8.](#) Acknowledgements

The author thanks Brian Trammell for suggesting the term "Run-time Parameters", which led to the distinction between run-time and fixed parameters implemented in this memo.

## [9.](#) References

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