               **Active and Passive Metrics and Methods (and everything in-between, or
                                     Hybrid)**
                      draft-ietf-ippm-active-passive-00

Abstract

   This memo provides clear definitions for Active and Passive
   performance assessment. The construction of Metrics and Methods can
   be described as Active or Passive. Some methods may use a subset of
   both active and passive attributes, and we refer to these as Hybrid
   Methods.

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1. Introduction

   The adjectives "active" and "passive" have been used for many years
   to distinguish two different classes of Internet performance
   assessment. The first Passive and Active Measurement (PAM)
   Conference was held in 2000, but the earliest proceedings available
   on-line are from the second PAM conference in 2001
   [https://www.ripe.net/ripe/meetings/pam-2001].

   The notions of "active" and "passive" are well-established. In
   general:

      An Active metric or method depends on a dedicated measurement
      packet stream and observations of the stream.

      A Passive metric or method depends *solely* on observation of one
      or more existing packet streams. The streams only serve
      measurement when they are observed for that purpose, and are
      present whether measurements take place or not.

As new techniques for assessment emerge it is helpful to have clear
definitions of these notions. This memo provides more detailed
definitions, defines a new category for combinations of traditional
active and passive techniques, and discusses means to evaluate new
techniques as they emerge.

This memo provides definitions for Active and Passive Metrics and
Methods based on long usage in the Internet measurement community,
and especially the Internet Engineering Task Force.

1.1. 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].

2. Purpose and Scope

The scope of this memo is to define and describe Active and Passive
versions of metrics and methods which are consistent with the long-
time usage of these adjectives in the Internet measurement community
and especially the Internet Engineering Task Force. Since the
science of measurement is expanding, we provide a category for
combinations of the traditional extremes, treating Active and Passive
as a continuum and designating combinations of their attributes as
Hybrid methods.

Further, this memo's purpose includes describing multiple dimensions
in which to evaluate methods as they emerge.

3. Terms and Definitions

This section defines the key terms of the memo. Some definitions use
the notion of "stream of interest" which is synonymous with
"population of interest" defined in clause 6.1.1 of ITU-T
Recommendation Y.1540. The definitions are consistent with
[I-D.zheng-ippm-framework-passive].

3.1. Performance Metric

The standard definition of a quantity, produced in an assessment of
performance and/or reliability of the network, which has an intended
utility and is carefully specified to convey the exact meaning of a
measured value. (This definition is consistent with that of
Performance Metric in RFC 2330 and RFC 6390).

3.2. Method of Measurement

   The procedure or set of operations having the object of determining a
   Measured Value or Measurement Result.

3.3. Observation Point

   See section 2 of [RFC7011] for this definition (a location in the
   network where packets can be observed), and related definitions. The
   comparable term defined in IETF literature on Active measurement is
   Measurement Point, see section 4.1 of [RFC5835]. Two terms have come
   into use describing similar actions at the identified point in the
   network path.

3.4. Active Methods

   Active measurement methods have the following attributes:

   1. Commonly, the packet stream of interest is generated as the basis
       of measurement. Another packet stream may be generated to
       increase traffic load, but the loading stream itself may not be
       measured.

   2. The packets in the stream of interest have fields (or are
       augmented or modified to include fields) which are dedicated to
       measurement. Since measurement usually requires determining the
       corresponding packets at multiple measurement points, a sequence
       number is the most common information dedicated to measurement.

   3. The Source and Destination of the packet stream of interest are
       usually known a' priori.

   4. The characteristics of the packet stream of interest are known at
       the Source at least, and may be communicated to Destination as
       part of the method.

   When adding traffic to the network for measurement, Active Methods
   influence the quantities measured to some degree, and those
   performing tests should take steps to quantify the effect(s) and/or
   minimize such effects.

3.5. Active Metric

   An Active Metric incorporates one or more of the aspects of Active
   Methods in the metric definition.

   For example, IETF metrics for IP performance (developed according to
   the [RFC2330] framework) include the Source packet stream

characteristics as metric input parameters, and also specify the
packet characteristics (Type-P) and Source and Destination IP
addresses (with their implications on both stream treatment and
interfaces associated with measurement points).

3.6. Passive Methods

Passive measurement methods are

o based solely on observations of undisturbed and unmodified packet
   stream of interest

o dependent on the existence of one or more packet streams to supply
   the stream of interest

o dependent on the presence of the packet stream of interest at one
   or more designated observation points.

Some passive methods simply observe and collect information on all
packets that pass Observation Point(s), while others filter the
packets as a first step and only collect information on packets that
match the filter criteria, and thereby narrow the stream of interest.

It is common that passive methods are conducted at one or more
Observation Points. Passive methods to assess Performance Metrics
often require multiple observation points, e.g., to assess latency of
packet transfer across a network path between two Observation Points.
In this case, the observed packets must include enough information to
determine the corresponding packets at different Observation Points.

Communication of the observations (in some form) to a collector is an
essential aspect of Passive Methods. In some configurations, the
traffic load associated with results export to a collector may
influence the network performance. However, the collection of
results is not unique to Passive Methods, and the load from
management and operations of measurement systems must always be
considered for potential effects on the measured values.

3.7. Passive Metric

Passive Metrics apply to observations of packet traffic (traffic
flows in [RFC7011]).

Passive performance metrics are assessed independent of the packets
or traffic flows, and solely through observation. Some refer to such
assessments as "out-of-band".

One example of passive performance metrics for IP packet transfer can
be found in ITU-T Recommendation Y.1540, where the metrics are
defined on the basis of reference events as packet pass reference
points, so the metrics are agnostic to the distinction between active
and passive when the necessary packet correspondence can be derived
from the observed stream of interest when required.

3.8. Hybrid Methods and Metrics

Methods of Measurement which use a combination of Active Methods and
Passive Methods, to assess Active Metrics, Passive Metrics, or new
metrics derived from the a' priori knowledge and observations of the
stream of interest. ITU-T Recommendation Y.1540 defines metrics are
applicable to the hybrid category, since packet correspondence at
different observation/reference points could be derived from "fields
which are dedicated to measurement", but otherwise the methods are
passive.

With respect to the stream of interest, Hybrid methods fit in the
continuum as follows, in terms of what happens at the Source(or
Observation Point nearby):

o If you generate the stream of interest => Active

o If you augment of modify a stream of interest => Hybrid

o If you solely observe a stream of interest => Passive

4. Discussion

This section illustrates the definitions and presents some examples.

4.1. Graphical Representation

If we compare the Active and Passive Methods, there are at least two
dimensions on which methods can be evaluated. This evaluation space
may be useful when a method is a combination of the two alternative
methods.

The two dimensions (initially chosen) are:

1. The degree to which the stream of interest effects overall
    network conditions experienced by that stream and other streams.
    This is a key dimension for Active measurement error analysis.
    (Comment: There is also the notion of time averages - a
    measurement stream may have significant effect while it is
    present, but the stream is only generated 0.1% of the time. On
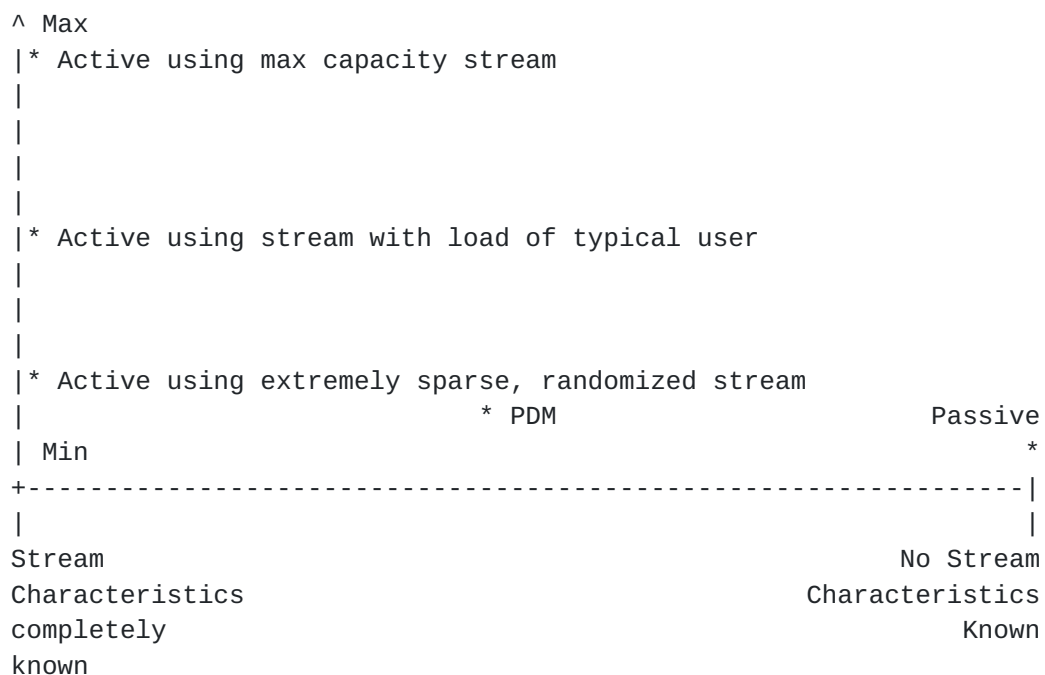   the other hand, observations alone have no effect on network

performance. To keep things simple, we consider the stream
effect only when it is present.)

2. The degree to which stream characteristics are know a' priori.
There are methodological advantages of knowing the source stream
characteristics, and having complete control of the stream
characteristics. For example, knowing the number of packets in a
stream allows more efficient operation of the measurement
receiver, and so is an asset for active measurement methods.
Passive methods (with no sample filter) have few clues available
to anticipate what the protocol first packet observed will use or
how many packets will comprise the flow, but once the standard
protocol of a flow is known the possibilities narrow (for some
compliant flows). Therefore this is a key dimension for Passive
measurement error analysis.

There are a few examples we can plot on a two-dimensional space. We
can anchor the dimensions with reference point descriptions.

```
Effect of the measured stream on network conditions
^ Max
|* Active using max capacity stream
|
|
|
|
|* Active using stream with load of typical user
|
|
|
|* Active using extremely sparse, randomized stream
|                                * PDM                      Passive
| Min                                                            *
+----------------------------------------------------------------|
|                                                                |
Stream                                              No Stream
Characteristics                                     Characteristics
completely                                               Known
known
```

We recognize that method categorization could be based on additional
dimensions, but this would require a different graphical approach.

For example, "effect of stream of interest on network conditions"
could easily be further qualified into:

1. effect on the performance of the stream of interest itself: for
    example, choosing a packet marking or DSCP resulting in domain
    treatment as a real-time stream (as opposed to default/best-
    effort marking.

2. effect on unmeasured streams that share the path and/or
    bottlenecks: for example, an extremely sparse measured stream of
    minimal size packets typically has little effect on other flows
    (and itself), while a stream designed to characterize path
    capacity may effect all other flows passing through the capacity
    bottleneck (including itself).

3. effect on network conditions resulting in network adaptation: for
    example, a network monitoring load and congestion conditions
    might change routing, placing some flows to alternate paths to
    mitigate the congestion.

At present, we have combined 1 and 2 on one axis, as examination of
examples indicates strong correlation of affects on this pair, and
network adaptation is not addressed. As suggestions emerge we will
re-examine the possibilities.

It is apparent that different methods of IP network measurement can
produce different results, even when measuring the same path at the
same time. The two dimensions of the graph help to understand how
the results might change with the method chosen. For example, an
Active Method to assess throughput adds some amount of traffic to the
network which might result in lower throughput for all streams.
However, a Passive Method to assess throughput can also err on the
low side due to unknown limitations of the hosts providing traffic,
competition for host resources, limitations of the network interface,
or private sub-networks that are not an intentional part of the path,
etc. And Hybrid Methods could easily suffer from both forms of
error. Another example of potential errors stems from the pitfalls
of using an Active stream with known bias, such as a periodic stream
defined in [RFC3432]. The strength of modelling periodic streams
(like VoIP) is a potential weakness when extending the measured
results to other application whose streams are non-periodic. The
solutions are to model the application streams more exactly with an
Active Method, or accept the risks and potential errors with the
Passive Method discussed above.

4.2. Discussion of PDM

In [I-D.ietf-ippm-6man-pdm-option], an IPv6 Option Header for
Performance and Diagnostic Measurements (PDM) is described which
(when added to the stream of interest at strategic interfaces)
supports performance measurements. This method processes a user

traffic stream and adds "fields which are dedicated to measurement".
Thus:

o The method may have a small effect on the measured stream and
   other streams in the network.

o The measured stream has unknown characteristics until it is
   processed to add the PDM Option header.

We conclude that this is a Hybrid method, having at least one
characteristic of both active and passive methods.

4.3. Discussion of "Coloring" Method

Draft [I-D.tempia-opsawg-p3m], proposed to color packets by re-
writing a field of the stream at strategic interfaces to support
performance measurements. This method processes a user traffic
stream and inserts "fields which are dedicated to measurement".
Thus:

o The method may have a small effect on the measured stream and
   other streams in the network (smaller than PDM above).

o The measured stream has unknown characteristics until it is
   processed to add the coloring in the header, and the stream could
   be measured and time-stamped during that process.

We note that [I-D.chen-ippm-coloring-based-ipfpm-framework] proposes
a method similar to [I-D.tempia-opsawg-p3m], and ippm-list discussion
indicates [I-D.chen-ippm-coloring-based-ipfpm-framework] may be
covered by the same IPR as [I-D.tempia-opsawg-p3m].

We conclude that this is a Hybrid method, having at least one
characteristic of both active and passive methods.

5. Security considerations

When considering privacy of those involved in measurement or those
whose traffic is measured, there is sensitive information
communicated and observed at observation and measurement points
described above. We refer the reader to the privacy considerations
described in the Large Scale Measurement of Broadband Performance
(LMAP) Framework [I-D.ietf-lmap-framework], which covers active and
passive measurement techniques and supporting material on measurement
context.

6. IANA Considerations

   This memo makes no requests for IANA consideration.

7. Acknowledgements

   Thanks to Mike Ackermann for asking the right question, and for
   several suggestions on terminology. Brian Trammell provided key
   terms and references for the passive category. Tiziano Ionta
   reviewed the draft and suggested the classification for the
   "coloring" method of measurement. Nalini Elkins identified several
   areas for clarification following her review. Bill Jouris reviewed
   01 editorially and suggested several improvements.

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