Coloring based IP Flow Performance Measurement Framework
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Abstract

   By setting one unused bit of the IP header of packets to "color" the
   packets into different color blocks, it naturally gives a way to
   measure the real packet loss and delay without inserting any extra
   OAM packets. This is called "coloring" based IP Flow Performance
   Measurement (IPFPM). This document specifies a framework and
   protocol for this "coloring" based IPFPM.

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
   provisions of BCP 78 and BCP 79.

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   This Internet-Draft will expire on August 29, 2013.

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1. Introduction

Performance Measurement (PM) is an important tool that can not only provide Service Level Agreement (SLA) verification but facilitate in trouble shooting (e.g., fault localization or fault delimitation) and network visualization.

There are two types of performance measurement: one is active performance measurement, and the other is passive performance measurement.

In active performance measurement the receiver measures the injected packets to evaluate the performance of a path. The active measurement measures the performance of the extra injected packets, the rate, numbers and interval of the injected packets will largely affect the accuracy of the results. In addition, it also requires that the injected packets have to follow the same path as the real traffic; this normally cannot be guaranteed in the pure IP network. The One-Way Active Measurement Protocol (OWAMP) [RFC4656] and Two-Way Active Measurement Protocol (TWAMP) [RFC5357] are tools to enable active performance measurement.

In passive performance measurement, no artificial traffic is injected into the flow and measurements are taken to record the performance metrics of the real traffic. The Multiprotocol Label Switching (MPLS) PM protocol [RFC6374] for packet loss is an example of passive performance measurement. By periodically inserting auxiliary Operations, Administration, and Maintenance (OAM) packets, the traffic is delimited by the OAM packets into consecutive blocks, and the receivers count the packets and calculate the packets loss each block.

But, when the OAM channel is in-band, solutions like [RFC6374] are not pure passive measurement as the OAM packets are inserted into the data stream. Furthermore because solutions like [RFC6374] depend on the fixed positions of the delimiting OAM packets for packets counting, they are vulnerable to out-of-order arrival of packets. This could happen particularly with out-of-band OAM channels, but might also happen with in-band OAM because of the presence of multipath forwarding within the network. Out of order delivery of data and the delimiting OAM can give rise to inaccuracies in the performance measurement figures. The scale of these inaccuracies will depend on data speeds and the variation in delivery, but with out-of-band OAM, this could result in significant differences between real and reported performance.

This document describes a mechanism where data packets are marked or "colored" so that they form blocks of data. No additional delimiting

OAM is needed and the performance can be measured in-service without
the insertion of additional traffic. Furthermore, because coloring
based IP performance measurement does not require extra OAM packets
for traffic delimitation, it can be used in situations where there is
packets re-ordering. This document specifies a framework and
protocol for the "coloring" based IP Flow Performance Measurement
(IPFPM).

2. Overview and Concept

The concept of "coloring" IP packets for performance measurement is
described in [I-D.tempia-opsawg-p3m]. By "coloring" the packets of a
specific IP flow to different colors, it naturally splits the IP flow
into deferent consecutive blocks.

For packet loss measurement, there are two ways to color packets:
fixed packet numbers or fixed time period for each color block. This
document only talks about the way of fixed time period. The sender
and receiver nodes count the transmitted and received packets/octets
based on each color block. By collecting and comparing the
transmitted and received packets/octets, it can easily detect whether
there is packet loss and how many packets/octets get lost.

For packet delay measurement, there are two solutions. One is
similar to packet loss, it still colors the IP flow to different
color blocks and uses the time when color changing as the reference
time for delay calculation. This solution requires that there must
not be any out-of-order packets, otherwise, the result will not be
accurate. Because it uses the first packet of each color block for
delay measurement, if there is packet reordering, the first packet of
each block at the sender will be probably different from the first
packet of the block at the receiver. The other way is to
periodically color a single packet of the IP flow. Within a time
period, there is only one packet can be colored. The sender records
the timestamp when the colored packet is transmitted, the receiver
records the timestamp when detecting the colored packet. With the
two timestamps, the packet delay can be computed.

To make the above solutions work, two conditions are required. The
first one is that there have to be a way to collect the packet counts
and timestamps from the senders and receivers to a centralized
calculation element. The IP Flow Information eXport (IPFIX)
[RFC5101] protocol is used for collecting the performance measurement
statistic information (Section 5 of this document). The second is
that the centralized calculation element has to know what exactly a
pair of packet counts(one from the sender and the other is from the
receiver) are based on the same color block and a pair of timestamps

(one from the sender and the other is from the receiver) are based on
the same colored packet. The "Period Number" based solution (Section
4.2 of this document) is introduced to achieve this.

3. Reference Model and Functional Components

3.1. Reference Model

An Multipoint-to-Multipoint (MP2MP) reference model (as shown in
Figure 1) is introduced in this document. For a specific IP flow,
there may be one or more upstream and downstream Measurement Points
(MPs). An IP flow can be identified by the Source IP (SIP) and
Destination IP (DIP) addresses, and it may combine the SIP and DIP
with any or all of the Protocol number, the Source port, the
Destination port, and the Type of Service (TOS) to identify an IP
flow. For each flow, there will be a flow identifier that is unique
within a certain administrative domain.

An MP is a network node. From the measurement point of view, it
consists of two parts (as shown in Figure 2): Data Collecting Point
(DCP), and Target Logical Port (TLP). For an MP, there is only one
DCP and may be one or more TLPs. The Measurement Control Point (MCP)
is a centralized calculation element, MPs periodically report their
measurement data to the MCP for final performance calculation. The
report protocol is defined Section 5 of this document.

The reason for choosing MP2MP model is that it can satisfy all the
scenarios that include Point-to-Point (P2P), Point-to-Multipoint
(P2MP), Multipoint-to-Point (MP2P), and MP2MP. P2P scenario is
obvious and can be used anywhere. P2MP and MP2P are very common in
mobile backhaul networks. For example, a Cell Site Gateway (CSG)
multi-homing to two Radio Network Controller (RNC) Site Gateways
(RSGs) is a typical network design. When there is a failure, there
is a requirement to monitor the flows between the CSG and the two
RSGs hence to determine whether the fault is in the transport network
or in the wireless network(this is normally called "fault
delimitation"). This is especially useful in the situation where the
transport network belongs to one service provider and wireless
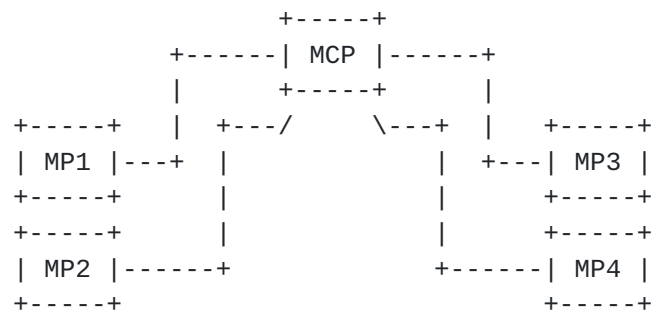network belongs to other service providers.

```
                        +-----+
               +------| MCP |------+
               |        +-----+      |
    +-----+    |   +---/     \---+   |   +-----+
    | MP1 |---+   |             | +---| MP3 |
    +-----+      |             |     +-----+
    +-----+      |             |     +-----+
    | MP2 |------+             +------| MP4 |
    +-----+                          +-----+
              Figure 1: MP2MP based Model


        +---------------------+
        |      +--------+      |
        |      |  DCP   |      | Control Plane
        |      +--------+      |
  ----------|-----/----------\-----|-------------
        | +--+--+      +--+--+ |
        | | TLP1|      | TLP2| | Data plane
        | +-----+      +-----+ |
        +---------------------+
            Figure 2: Measurement Point
```
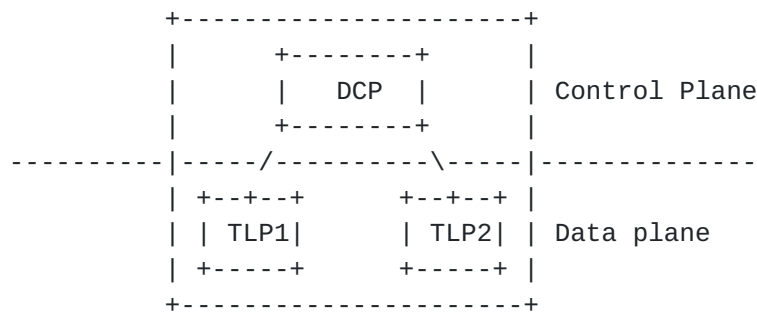
3.2. Functional Components

3.2.1. Measurement Control Point

   The MCP is responsible for calculating the final performance metrics
   according to the received measurement data from the MPs (actually
   from the DCPs). For packet loss, based on each color block, the
   difference between the total counts received from all upstream MPs
   and the total counts received from all downstream MPs are the lost
   packet numbers. The MCP must make sure that the counts from the
   upstream MPs and downstream MPs are related to the same color block.
   For packet delay (e.g., one way delay), the difference between the
   timestamps from the downstream MP and upstream MP is the packet
   delay. Similarly to packet loss, the MCP must make sure the two
   timestamps are based on the same colored packet.

   This document introduces a Period Number (PN) based synchronization
   mechanism to help the MCP to determine whether any two or more packet
   counts (from distributed MPs) are related to the same color block or
   any two timestamps are related to the same colored packet. The PN is
   generated each time a DCP reads the packet counts and timestamps from
   the TLP, and is equal to the modulo of the local time (when the
   counts and timestamps are read) and the interval of the color time
   period. Each packet count and timestamp has a PN when reported to
   the MCP, and the same PN means that they are related to the same

color block or colored packet. This requires that the upstream and
downstream MPs having a certain time synchronization capability
(e.g., supporting the Network Time Protocol (NTP) [RFC5905], or the
IEEE 1588 Precision Time Protocol (PTP) [IEEE1588].) and assumes that
the upstream and downstream MPs have already time synchronized.
Since is the intention to measure packet delay, this requirement for
time synchronization is already present.

3.2.2. Data Collecting Point

The DCP is responsible for periodically collecting the measurement
data from the TLPs and for reporting the data to the MCP. In
addition, when to change the color, when to color a packet (for
packet delay measurement), and when to read the packet counts and
timestamps are also controlled by DCP. Each DCP will maintain two
timers, one (C-timer, used at upstream DCP) is for color changing,
the other (R-timer, used at downstream DCP) is for reading the packet
counts and timestamps. The two timers have the same time interval
but are started at different times. A DCP can be either an upstream
or a downstream DCP: the role is specific to an IP flow. For a
specific IP flow, the upstream DCP will change the color and read the
packet counts and timestamps when the C-timer expires, the downstream
DCP just reads the packets counts and timestamps when the R-timer
expires. In order to allow for a certain degree of packets re-
ordering, the R-timer should be started later than a defined period
of time after the C-timer is started (e.g., 1/3 or 2/3 T, where T is
the interval of the C-timer). It recommends that: for packet loss
measurement, the R-timer should be started at 1/3 T after the C-Timer
is started, and for packet delay measurement, the R-timer should be
started at 2/3 T after the C-Timer is started.

To make the implementation simple, the C-timer should be started at
the beginning of each time period. This document recommends the
implementation to support at least these time periods (1s, 10s, 1min,
10min and 1h). So, if the time period is 10s, the C-timer should be
started at the time of any multiples of 10 in seconds (e.g., 0s, 10s,
20s, etc.), then the R-timer should be started, for example, at the
time of T+1/3 or 2/3 T. With this method, each DCP can independently
start its C-timer and R-timer given that the clocks have been
synchronized.

3.2.3. Target Logical Port

The TLP is a logical entity that actually executes the final
measurement actions (e.g., colors the packets, counts the packets,
records the timestamps, etc.). Normally, a physical interface
corresponds to a TLP, and the TLP resides in the data plane. For a
measurement instance (corresponding to an IP flow), a TLP will

maintain a pairs of packet counters and a timestamp counter for each color block. One packet counter is for counting packets and the other is for counting octets.

4. Principles of Coloring based IPFPM

The flows discussed in this document are all unidirectional. For a specific flow, there will be upstream and downstream TLPs and upstream and downstream packet counts/timestamp accordingly.

4.1. Packet Loss Measurement

For packet loss measurement, this document defines the following counters and quantities:

U-CountP[n][m]: U-CountP identifies the packets transmitted by a upstream TLP, the "n" identifies the "period number" of the measured color block, the "m" identifies the No. m TLP of the upstream TLPs.

D-CountP[n][m]: U-CountP identifies the packets received by a downstream TLP, the "n" identifies the "period number" of the measured color block, the "m" identifies the No. m TLP of the downstream TLPs.

U-CountO[n][m]: U-CountO identifies the octets transmitted by a upstream TLP, the "n" identifies the "period number" of the measured color block, the "m" identifies the No. m TLP of the upstream TLPs.

D-CountO[n][m]: U-CountO identifies the packets received by a downstream TLP, the "n" identifies the "period number" of the measured color block, the "m" identifies the No. m TLP of the downstream TLPs.

LossP: the number of packets transmitted by the upstream TLPs but not received at the downstream TLPs.

LossO: the total octets transmitted by the upstream TLPs but not received at the downstream TLPs.

The the total packet loss of a flow can be computed as follows:

LossP = U-CountP[1][1] + U-CountP[1][2].... + U-CountP[n][m] - D-CountP[1][1]-D-CountP[1][2]-D-CountP[n][m'].

LossO = U-CountO[1][1] + U-CountO[1][2].... + U-CountO[n][m] - D-CountO[1][1]-D-CountO[1][2]-D-CountO[n][m'].

Where the m is the number of the upstream TLPs, and the m' is the
number of the downstream TLPs.

4.2. Packet Delay Measurement

For packet delay measurement, there will be only one upstream TLP and
may be one or more (P2MP) downstream TLPs. Although the coloring
based IPFPM supports P2MP model, this document only discusses P2P
model, the P2MP model is left for future study. This document
defines the following timestamps and quantities:

U-Time[n]: U-Time identifies the time when sent a colored packet, the
"n" identifies the "period number" of the colored packet.

D-Time[n]: D-Time identifies the time when received a colored packet,
the "n" identifies the "period number" of the colored packet. This
is only for P2P model.

D-Time[n][m]: D-Time identifies the time when received a colored
packet, the "n" identifies the "period number" of the colored packet,
the "m" identifies the No. m TLP of the downstream TLPs. This is for
P2MP model and is left for future study.

One-way Delay[n]: The one-way delay metric for packet networks is
described in [RFC2679]. The "n" identifies the "period number" of
the colored packet.

One-way Delay[1] = D-Time[1] - U-Time[1].

One-way Delay[2] = D-Time[2] - U-Time[2].

...

One-way Delay[n] = D-Time[n] - U-Time[n].

In the case of two-way delay, the delay is the sum of the two one-way
delays of the two flows that have the same TLPs but have opposite
directions.

Two-way Delay[1] = (D-Time[1] - U-Time[1]) + (D-Time'[1] -
U-Time'[1]).

Two-way Delay[2] = (D-Time[2] - U-Time[2]) + (D-Time'[2] -
U-Time'[2]).

...

Two-way Delay[1] = (D-Time[n] - U-Time[n]) + (D-Time'[n] -

U-Time'[n]).

Where the D-Time and U-Time are for one forward flow, the D-Time' and U-Time' are for reverse flow.

5. Color Bits Selection

This document does not specify which bits should be used for coloring, it just introduces some options that the operators can select for packet coloring usage. There are not too much bits in the IP header that can be used for IP packet coloring, this document introduces two options:

One is to use the reserved bit of the Flag field. There is only one bit that is left, so it cannot be used for packet loss and delay measurement simultaneously.

The other option is to use some "unused" bits of the Type Of Service (TOS) field.

For both options, the operators should carefully think of the color bits selection to make sure that the setting or changing of the color bits SHOULD NOT affect the normal packet forwarding and process.

The implementations should provide some knobs for operators to configure and change the color bits according to their network design and policies.

6. Statistic Information Report

As described in Section 4 of this document, when the performance measurement started, each DCP will periodically report performance measurement statistic information to the MCP, and the MCP will compute the final performance measurement results according to the received statistic information.

For a specific IP flow, whatever for packet delay or loss measurement, there will be at least one upstream and one downstream DCP. As described above section, time synchronization is required and the Period Number is used for MCP to identify and correlate the packet counts and timestamps from the upstream and downstream DCPs to a specific color block or colored packet.

For packet loss measurement, the following information is required to report to the MCP:

DCP Identifier

TLP Identifier

Flow Identifier

Period Number

Packet Number Count

Packet Octets Count

For packet delay measurement, the following information is required
to report to the MCP:

DCP Identifier

TLP Identifier

Flow Identifier

Period Number

Timestamp

In addition, a DCP may report some status and statistic information
to the MCP, the following information may be included:

DCP Identifier

DCP Status

Others

6.1. IPFIX for coloring based IPFPM

The IPFIX protocol [RFC5101] defines how IP Flow information can be
exported from routers, measurement probes, or other devices. It
defines many Information Elements [RFC5102] that can be used to carry
and export the above information from DCP to MCP. Except the Period
Number and DCP Status, all the above information can be identified
with the existing Information Elements.

DCP Identifier: exporterIPv4Address/exporterIPv6Address (130/131)

TLP Identifier: meteringProcessId (143)

   Flow Identifier: flowId (148)

   Packet Number Count: packetTotalCount (86)

   Packet Octets Count: octetTotalCount (85)

   Timestamp: flowStartMilliseconds (152)

6.1.1. Information Element for IPFPM

6.1.1.1. periodNumber

   Description: The periodNumber is used to identify a packet count or
   timestamp that belongs to a specific color block or colored packet.
   The MCP uses it to determine whether any two or more packet counts
   (from distributed DCPs) are related to the same color block or any
   two timestamps are related to the same colored packet. The PN is
   generated each time a DCP reads the packet counts and timestamp from
   the TLP, and is equal to the modulo of the local time (when the
   counts and timestamps are read) and the interval of the color time
   period.

   Abstract Data Type: unsigned32

   ElementId: TBD

   Status: current

6.1.1.2. dcpStatus

   Description: The dcpStatus is used to carry some status of the DCP,
   for example, whether the DCP has already time synchronized.

   Abstract Data Type: unsigned8

   ElementId: TBD

   Status: current

   The dcpStaus is defined as follows:

```
    +-+-+-+-+-+-+-+-+
    |   Reserved  |T|
    +-+-+-+-+-+-+-+-+
```

   One bit (Time synchronized bit) is defined in this document, it is
   used to indicate whether a DCP is time synchronized. When T bit set,

the DCP is time synchronized, otherwise, the DCP is not time
synchronized. The MCP MUST calculate the results when all related
DCPs of a flow are time synchronized, otherwise, the results will not
correct.

6.1.2. DCP Status Template Set

The DCP Status Template is an Option Template Set, it is used to
report the status and statistic information of the DCP to MCP.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Set ID = 3           |          Length = 24          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Template ID 256        |        Field Count = 3        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Scope Field Count = 1     |0|      dcpStatus = TBD        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Scope 1 Field Length = 1   |0|exportedMessageTotalCount=41 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Scope 2 Field Length = 2   |0|exportedFlowRecordTotalCo.=42|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Field Length = 2       |             Padding           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The dcpStatus is as defined in Section 6.1.1.2of this document.

The exportedMessageTotalCount field is used to report how many IPFIX
messages that the DCP has sent to the MCP.

The exportedFlowRecordTotalCount is used to report how many IPFIX
flow records that the DCP has sent to the MCP.

6.1.3. Packet Loss Template Set

The Packet Loss Template Set is a Data Set, it is used to report the
packet loss measurement statistic of a flow to the MCP.

The Data Set will be as follows:

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |          Set ID = 2           |      Length = 32 octets       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |        Template ID 257        |        Field Count = 6        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|  exporterIPv4Address = 130  |        Field Length = 4       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|   meteringProcessId = 143   |        Field Length = 4       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|       flowId = 148          |        Field Length = 4       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|     periodNumber = TBD      |        Field Length = 4       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|    packetTotalCount = 86    |        Field Length = 8       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0|    octetTotalCount = 85     |        Field Length = 8       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The exporterIPv4Address is used to carry the DCP ID.

The meteringProcessId is used to carry the TLP ID.

The flowId is a identifier that is unique within a specific
administrative domain (e.g., an Autonomous System). The TLP, DCP and
MCP have to agree a flow identifier related to a specific flow. For
example, the flow identifier can be generated and maintained by a
centralized element. How to generate and maintain the flowId is out
the scope of this document.

The flowId has the following structure, it consists of two parts: one
the Reserved field that is left for future extensions, the other is
the Identifier field is 24-bit in length.

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |   Reserved    |                 Identifier                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The periodNumber is as defined in Section 6.1.1.1 of this document.

The packetTotalCount is used to carry the total transmitted/received
packets of a flow since the measurement start.

The octetTotalCount is used to carry the total transmitted/received

octets of a flow since the measurement start.

6.1.4. Packet Delay Template Set

The Packet Delay Template Set is a Data Set, it is used to report the
packet delay measurement statistic of a flow to the MCP.

The Data Set will be as follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |          Set ID = 2           |       Length = 24 octets      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        Template ID 258        |        Field Count = 5        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0|  exporterIPv4Address = 130  |        Field Length = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0|   meteringProcessId = 143   |        Field Length = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0|        flowId = 148         |        Field Length = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0|     PeriodNumber = TBD      |        Field Length = 4       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0| flowStartMilliseconds = 152 |        Field Length = 8       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The exporterIPv4Address is used to carry the DCP ID.

The meteringProcessId is used to carry the TLP ID.

The flowId is used to carry the flow identifier of a flow, the
structure is defined in Section 6.1.3 of this document.

The periodNumber is as defined in Section 6.1.1.1 of this document.

The flowStartMilliseconds is used to carry the timestamp of a colored
packet of a specific flow.

7. IANA Considerations

TBD.

8. Security Considerations

TBD.

9. Acknowledgements

The authors would like to thank Adrian Farrel for his review, suggestion and comments to this document.

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