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Information Model for Packet Sampling Exports

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements.  Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol.  Distribution of this memo is unlimited.

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Abstract

   This memo defines an information model for the Packet SAMPling
   (PSAMP) protocol.  It is used by the PSAMP protocol for encoding
   sampled packet data and information related to the Sampling process.
   As the PSAMP protocol is based on the IP Flow Information eXport
   (IPFIX) protocol, this information model is an extension to the IPFIX
   information model.

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1.  Introduction

   Packet Sampling techniques are required for various measurement
   scenarios.  The Packet Sampling (PSAMP) protocol provides mechanisms
   for packet selection using different Filtering and Sampling
   techniques.  A standardized way for the export and storage of the
   Information Elements defined in Section 8 is required.  The
   definition of the PSAMP information and data model is based on the
   IPFIX information model [RFC5102].  The PSAMP protocol document
   [RFC5476] specifies how to use the IPFIX protocol in the PSAMP
   context.

   This document examines the IPFIX information model [RFC5102] and
   extends it to meet the PSAMP requirements.  Therefore, the structure
   of this document is strongly based on the IPFIX document.  It
   complements the PSAMP protocol specification by providing an
   appropriate PSAMP information model.  The main part of this document,
   Section 8, defines the list of Information Elements to be transmitted
   by the PSAMP protocol.  Sections 5 and 6 describe the data types and
   Information Element properties used within this document and their
   relationship to the IPFIX information model.

   Although the PSAMP charter specified no requirements for measuring
   packet errors (such as drops, malformed, etc.), and this document
   does not cover such data, if there is need for collecting and
   exporting packet error information, the appropriate Information

Elements can be requested from IANA, and exported with the PSAMP
protocol.

The main body of Section 8 was generated from an XML document.  The
XML-based specification of the PSAMP Information Elements can be used
for automatically checking syntactical correctness of the
specification.  Furthermore it can be used -- in combination with the
IPFIX information model -- for automated code generation.  The
resulting code can be used in PSAMP protocol implementations to deal
with processing PSAMP information elements.

For that reason, the XML document that served as the source for
Section 8 is attached to this document in Appendix A.

Note that although partially generated from the attached XML
documents, the main body of this document is normative while the
appendix is informational.

## 2.  PSAMP Documents Overview

This document is one out of a series of documents from the PSAMP
group.

[RFC5474]: "A Framework for Packet Selection and Reporting" describes
the PSAMP framework for network elements to select subsets of packets
by statistical and other methods, and to export a stream of reports
on the selected packets to a Collector.

[RFC5475]: "Sampling and Filtering Techniques for IP Packet
Selection" describes the set of packet selection techniques supported
by PSAMP.

[RFC5476]: "Packet Sampling (PSAMP) Protocol Specifications"
specifies the export of packet information from a PSAMP Exporting
Process to a PSAMP Collecting Process.

RFC 5477 (this document): "Information Model for Packet Sampling
Exports" defines an information and data model for PSAMP.

## 3.  Terminology

IPFIX-specific terminology used in this document is defined in
Section 2 of [RFC5101].  PSAMP-specific terminology used in this
document is defined in Section 3.2 of [RFC5476].  In this document,
as in [RFC5101] and [RFC5476], the first letter of each IPFIX- and
PSAMP-specific term is capitalized.

3.1.  Conventions Used in This Document

   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].

4.  Relationship between PSAMP and IPFIX

   As described in the PSAMP protocol [RFC5476], a PSAMP Report can be
   seen as a very special IPFIX Data Record.  It represents an IPFIX
   Flow containing only a single packet.  Therefore, the IPFIX
   information model can be used as a basis for PSAMP Reports.

   Nevertheless, there are properties required in PSAMP Reports that
   cannot be modeled using the current IPFIX information model.  This
   document describes extensions to the IPFIX information model that
   allow the modeling of information and data required by PSAMP.

   Some of these extensions allow the export of what may be considered
   sensitive information.  Refer to the Security Considerations section
   for a fuller discussion.

   Note that the export of sampled or filtered PSAMP Reports may not
   need all the Information Elements defined by the IPFIX information
   model [RFC5102], as discussed in Sections 6.2 and 6.3 of the PSAMP
   Framework [RFC5474].

5.  Properties of a PSAMP Information Element

   The PSAMP Information Elements are defined in accordance with
   Sections 2.1 to 2.3 of the IPFIX information model [RFC5102] to which
   reference should be made for more information.  Nevertheless, we
   strongly recommend defining the optional "units" property for every
   Information Element (if applicable).

   The Data Types defined in Section 3.1 of the IPFIX information model
   [RFC5102] are also used for the PSAMP Information Elements.

6.  Type Space

   The PSAMP Information Elements MUST be constructed from the basic
   abstract data types and data type semantics described in Section 3 of
   the IPFIX information model [RFC5102].  To ensure consistency between
   IPFIX and PSAMP, the data types are not repeated in this document.
   The encoding of these data types is described in the IPFIX protocol
   [RFC5101].

7.  Overloading Information Elements

   Information Elements SHOULD NOT be overloaded with multiple meanings
   or re-used for multiple purposes.  Different Information Elements
   SHOULD be allocated for each requirement.

   Although the presence of certain other Information Elements allows
   the selection method to be inferred, a separate Information Element
   is provided for the selectorAlgorithm to include as scope for the
   Selector Report Interpretation [RFC5476].

   Even if the Information Elements are specified with a specific
   selection method (i.e., a specific value of selectorAlgorithm) in
   mind, these Information Elements are not restricted to the selection
   method and MAY be used for different selection methods in the future.

8.  The PSAMP Information Elements

   This section describes the Information Elements used by the PSAMP
   protocol.

   For each Information Element specified in Sections 8.1 - 8.6 below, a
   unique identifier is allocated in accordance with Section 4 of the
   IPFIX information model [RFC5102].  The assignments are controlled by
   IANA as an extension of the IPFIX information model.

   The Information Elements specified by the IPFIX information model
   [RFC5102] are used by the PSAMP protocol where applicable.  To avoid
   inconsistencies between the IPFIX and the PSAMP information and data
   models, only those Information Elements that are not already
   described by the IPFIX information model are defined here.

Below is the list of additional PSAMP Information Elements:

```
+-----+---------------------------+-----+---------------------------+
| ID  | Name                      | ID  | Name                      |
+-----+---------------------------+-----+---------------------------+
| 301 | selectionSequenceId       | 321 | relativeError             |
| 302 | selectorId                | 322 | observationTimeSeconds    |
| 303 | informationElementId      | 323 | observationTimeMilliseconds|
| 304 | selectorAlgorithm         | 324 | observationTimeMicroseconds|
| 305 | samplingPacketInterval    | 325 | observationTimeNanoseconds |
| 306 | samplingPacketSpace       | 326 | digestHashValue           |
| 307 | samplingTimeInterval      | 327 | hashIPPayloadOffset       |
| 308 | samplingTimeSpace         | 328 | hashIPPayloadSize         |
| 309 | samplingSize              | 329 | hashOutputRangeMin        |
| 310 | samplingPopulation        | 330 | hashOutputRangeMax        |
| 311 | samplingProbability       | 331 | hashSelectedRangeMin      |
| 313 | ipHeaderPacketSection     | 332 | hashSelectedRangeMax      |
| 314 | ipPayloadPacketSection    | 333 | hashDigestOutput          |
| 316 | mplsLabelStackSection     | 334 | hashInitialiserValue      |
| 317 | mplsPayloadPacketSection  | 336 | upperCILimit              |
| 318 | selectorIdTotalPktsObserved| 337 | lowerCILimit              |
| 319 | selectorIdTotalPktsSelected| 338 | confidenceLevel           |
| 320 | absoluteError             |     |                           |
+-----+---------------------------+-----+---------------------------+
```

## 8.1.  Identifiers (301-303)

Information Elements in this section serve as identifiers.  All of
them have an integral abstract data type and data type semantics
"identifier".

```
+-----+---------------------------+-----+---------------------------+
| ID  | Name                      | ID  | Name                      |
+-----+---------------------------+-----+---------------------------+
| 301 | selectionSequenceId       | 303 | informationElementId      |
| 302 | selectorId                |     |                           |
+-----+---------------------------+-----+---------------------------+
```

### 8.1.1.  selectionSequenceId

Description:

From all the packets observed at an Observation Point, a subset of
the packets is selected by a sequence of one or more Selectors.
The selectionSequenceId is a unique value per Observation Domain,
specifying the Observation Point and the sequence of Selectors
through which the packets are selected.

   Abstract Data Type:  unsigned64

   Data Type Semantics:  identifier

   ElementId:  301

   Status:  current

## 8.1.2.  selectorId

   Description:

      The Selector ID is the unique ID identifying a Primitive Selector.
      Each Primitive Selector must have a unique ID in the Observation
      Domain.

   Abstract Data Type:  unsigned16

   Data Type Semantics:  identifier

   ElementId:  302

   Status:  current

## 8.1.3.  informationElementId

   Description:

      This Information Element contains the ID of another Information
      Element.

   Abstract Data Type:  unsigned16

   Data Type Semantics:  identifier

   ElementId:  303

   Status:  current

8.2.  Sampling Configuration (304-311)

   Information Elements in this section can be used for describing the
   Sampling configuration of a Selection Process.

```
+-----+-------------------------------+-----+----------------------------+
|  ID | Name                          |  ID | Name                       |
+-----+-------------------------------+-----+----------------------------+
| 304 | selectorAlgorithm             | 308 | samplingTimeSpace          |
| 305 | samplingPacketInterval        | 309 | samplingSize               |
| 306 | samplingPacketSpace           | 310 | samplingPopulation         |
| 307 | samplingTimeInterval          | 311 | samplingProbability        |
+-----+-------------------------------+-----+----------------------------+
```

8.2.1.  selectorAlgorithm

   Description:

      This Information Element identifies the packet selection methods
      (e.g., Filtering, Sampling) that are applied by the Selection
      Process.

      Most of these methods have parameters.  Further Information
      Elements are needed to fully specify packet selection with these
      methods and all their parameters.

      The methods listed below are defined in [RFC5475].  For their
      parameters, Information Elements are defined in the information
      model document.  The names of these Information Elements are
      listed for each method identifier.

      Further method identifiers may be added to the list below.  It
      might be necessary to define new Information Elements to specify
      their parameters.

      The selectorAlgorithm registry is maintained by IANA.  New
      assignments for the registry will be administered by IANA and are
      subject to Expert Review [RFC5226].

      The registry can be updated when specifications of the new
      method(s) and any new Information Elements are provided.

      The group of experts must double check the selectorAlgorithm
      definitions and Information Elements with already defined
      selectorAlgorithms and Information Elements for completeness,
      accuracy, and redundancy.  Those experts will initially be drawn
      from the Working Group Chairs and document editors of the IPFIX
      and PSAMP Working Groups.

The following packet selection methods identifiers are defined here:

| ID | Method | Parameters |
|----|--------|------------|
| 1 | Systematic count-based Sampling | samplingPacketInterval samplingPacketSpace |
| 2 | Systematic time-based Sampling | samplingTimeInterval samplingTimeSpace |
| 3 | Random n-out-of-N Sampling | samplingSize samplingPopulation |
| 4 | Uniform probabilistic Sampling | samplingProbability |
| 5 | Property Match Filtering | no agreed parameters |
| Hash-based Filtering | | hashInitialiserValue hashIPPayloadOffset |
| 6 | using BOB | hashIPPayloadSize hashSelectedRangeMin |
| 7 | using IPSX | hashSelectedRangeMax hashOutputRangeMin |
| 8 | using CRC | hashOutputRangeMax |

There is a broad variety of possible parameters that could be used for Property match Filtering (5), but currently there are no agreed parameters specified.

Abstract Data Type:  unsigned16

Data Type Semantics:  identifier

ElementId:  304

Status:  current

## 8.2.2.  samplingPacketInterval

   Description:

      This Information Element specifies the number of packets that are
      consecutively sampled.  A value of 100 means that 100 consecutive
      packets are sampled.

      For example, this Information Element may be used to describe the
      configuration of a systematic count-based Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  305

   Status:  current

   Units:  packets

## 8.2.3.  samplingPacketSpace

   Description:

      This Information Element specifies the number of packets between
      two "samplingPacketInterval"s.  A value of 100 means that the next
      interval starts 100 packets (which are not sampled) after the
      current "samplingPacketInterval" is over.

      For example, this Information Element may be used to describe the
      configuration of a systematic count-based Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  306

   Status:  current

   Units:  packets

8.2.4.  samplingTimeInterval

   Description:

      This Information Element specifies the time interval in
      microseconds during which all arriving packets are sampled.

      For example, this Information Element may be used to describe the
      configuration of a systematic time-based Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  307

   Status:  current

   Units:  microseconds

8.2.5.  samplingTimeSpace

   Description:

      This Information Element specifies the time interval in
      microseconds between two "samplingTimeInterval"s.  A value of 100
      means that the next interval starts 100 microseconds (during which
      no packets are sampled) after the current "samplingTimeInterval"
      is over.

      For example, this Information Element may used to describe the
      configuration of a systematic time-based Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  308

   Status:  current

   Units:  microseconds

8.2.6.  samplingSize

   Description:

      This Information Element specifies the number of elements taken
      from the parent Population for random Sampling methods.

      For example, this Information Element may be used to describe the
      configuration of a random n-out-of-N Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  309

   Status:  current

   Units:  packets

8.2.7.  samplingPopulation

   Description:

      This Information Element specifies the number of elements in the
      parent Population for random Sampling methods.

      For example, this Information Element may be used to describe the
      configuration of a random n-out-of-N Sampling Selector.

   Abstract Data Type:  unsigned32

   Data Type Semantics:  quantity

   ElementId:  310

   Status:  current

   Units:  packets

8.2.8.  samplingProbability

   Description:

      This Information Element specifies the probability that a packet
      is sampled, expressed as a value between 0 and 1.  The probability
      is equal for every packet.  A value of 0 means no packet was
      sampled since the probability is 0.

For example, this Information Element may be used to describe the
configuration of a uniform probabilistic Sampling Selector.

Abstract Data Type:  float64

Data Type Semantics:  quantity

ElementId:  311

Status:  current

## 8.3.  Hash Configuration (326-334)

The following Information Elements can be used for describing the
Sampling configuration of a Selection Process.  The individual
parameters are explained in more detail in Sections 6.2, 3.8, and 7.1
of [RFC5475].

| ID | Name | ID | Name |
|-----|--------------------------|-----|--------------------------|
| 326 | digestHashValue | 331 | hashSelectedRangeMin |
| 327 | hashIPPayloadOffset | 332 | hashSelectedRangeMax |
| 328 | hashIPPayloadSize | 333 | hashDigestOutput |
| 329 | hashOutputRangeMin | 334 | hashInitialiserValue |
| 330 | hashOutputRangeMax | | |

### 8.3.1.  digestHashValue

Description:

This Information Element specifies the value from the digest hash
function.

See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

Abstract Data Type:  unsigned64

Data Type Semantics:  quantity

ElementId:  326

Status:  current

8.3.2.  hashIPPayloadOffset

   Description:

      This Information Element specifies the IP payload offset used by a
      Hash-based Selection Selector.

      See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

   Abstract Data Type:  unsigned64

   Data Type Semantics:  quantity

   ElementId:  327

   Status:  current

8.3.3.  hashIPPayloadSize

   Description:

      This Information Element specifies the IP payload size used by a
      Hash-based Selection Selector.

      See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

   Abstract Data Type:  unsigned64

   Data Type Semantics:  quantity

   ElementId:  328

   Status:  current

8.3.4.  hashOutputRangeMin

   Description:

      This Information Element specifies the value for the beginning of
      a hash function's potential output range.

      See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

   Abstract Data Type:  unsigned64

   Data Type Semantics:  quantity

ElementId:  329

Status:  current

## 8.3.5.  hashOutputRangeMax

Description:

   This Information Element specifies the value for the end of a hash
   function's potential output range.

   See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

Abstract Data Type:  unsigned64

Data Type Semantics:  quantity

ElementId:  330

Status:  current

## 8.3.6.  hashSelectedRangeMin

Description:

   This Information Element specifies the value for the beginning of
   a hash function's selected range.

   See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

Abstract Data Type:  unsigned64

Data Type Semantics:  quantity

ElementId:  331

Status:  current

## 8.3.7.  hashSelectedRangeMax

Description:

   This Information Element specifies the value for the end of a hash
   function's selected range.

   See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

Abstract Data Type:  unsigned64

      Data Type Semantics:  quantity

      ElementId:  332

      Status:  current

8.3.8.  hashDigestOutput

   Description:

      This Information Element contains a boolean value that is TRUE if
      the output from this hash Selector has been configured to be
      included in the packet report as a packet digest, else FALSE.

      See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

   Abstract Data Type:  boolean

   Data Type Semantics:  quantity

   ElementId:  333

   Status:  current

8.3.9.  hashInitialiserValue

   Description:

      This Information Element specifies the initialiser value to the
      hash function.

      See also Sections 6.2, 3.8, and 7.1 of [RFC5475].

   Abstract Data Type:  unsigned64

   Data Type Semantics:  quantity

   ElementId:  334

   Status:  current

## 8.4. Timestamps (322-325)

The Information Elements listed below contain timestamps.  They can
be used for reporting the observation time of a single packet.

+-----+-----------------------------+-----+-----------------------------+
| ID  | Name                        | ID  | Name                        |
+-----+-----------------------------+-----+-----------------------------+
| 322 | observationTimeSeconds      | 324 | observationTimeMicroseconds |
| 323 | observationTimeMilliseconds | 325 | observationTimeNanoseconds  |
+-----+-----------------------------+-----+-----------------------------+

### 8.4.1. observationTimeSeconds

Description:

This Information Element specifies the absolute time in seconds of
an observation.

Abstract Data Type:  dateTimeSeconds

Data Type Semantics:  quantity

ElementId:  322

Status:  current

Units:  seconds

### 8.4.2. observationTimeMilliseconds

Description:

This Information Element specifies the absolute time in
milliseconds of an observation.

Abstract Data Type:  dateTimeMilliseconds

Data Type Semantics:  quantity

ElementId:  323

Status:  current

Units:  milliseconds

### 8.4.3.  observationTimeMicroseconds

Description:

This Information Element specifies the absolute time in
microseconds of an observation.

Abstract Data Type:  dateTimeMicroseconds

Data Type Semantics:  quantity

ElementId:  324

Status:  current

Units:  microseconds

### 8.4.4.  observationTimeNanoseconds

Description:

This Information Element specifies the absolute time in
nanoseconds of an observation.

Abstract Data Type:  dateTimeNanoseconds

Data Type Semantics:  quantity

ElementId:  325

Status:  current

Units:  nanoseconds

### 8.5.  Packet Data (313-314, 316-317)

The following Information Elements are all used for reporting raw
content of a packet.  All Information Elements containing sections of
the observed packet can also be used in IPFIX [RFC5101].  If the
values for those sections vary for different packets in a Flow, then
the Flow Report will contain the value observed in the first packet
of the Flow.

+-----+--------------------------------+-----+--------------------------------+
| ID  | Name                           | ID  | Name                           |
+-----+--------------------------------+-----+--------------------------------+
| 313 | ipHeaderPacketSection          | 316 | mplsLabelStackSection          |
| 314 | ipPayloadPacketSection         | 317 | mplsPayloadPacketSection       |
+-----+--------------------------------+-----+--------------------------------+

8.5.1.  ipHeaderPacketSection

   Description:

      This Information Element, which may have a variable length,
      carries a series of octets from the start of the IP header of a
      sampled packet.

      With sufficient length, this element also reports octets from the
      IP payload, subject to [RFC2804].  See the Security Considerations
      section.

      The size of the exported section may be constrained due to
      limitations in the IPFIX protocol.

      The data for this field MUST NOT be padded.

   Abstract Data Type:  octetArray

   ElementId:  313

   Status:  current

8.5.2.  ipPayloadPacketSection

   Description:

      This Information Element, which may have a variable length,
      carries a series of octets from the start of the IP payload of a
      sampled packet.

      The IPv4 payload is that part of the packet that follows the IPv4
      header and any options, which [RFC0791] refers to as "data" or
      "data octets".  For example, see the examples in [RFC0791],
      Appendix A.

      The IPv6 payload is the rest of the packet following the 40-octet
      IPv6 header.  Note that any extension headers present are
      considered part of the payload.  See [RFC2460] for the IPv6
      specification.

The size of the exported section may be constrained due to
limitations in the IPFIX protocol.

The data for this field MUST NOT be padded.

   Abstract Data Type:  octetArray

   ElementId:  314

   Status:  current

8.5.3.  mplsLabelStackSection

   Description:

This Information Element, which may have a variable length,
carries the first n octets from the MPLS label stack of a sampled
packet.

With sufficient length, this element also reports octets from the
MPLS payload, subject to [RFC2804].  See the Security
Considerations section.

See [RFC3031] for the specification of MPLS packets.

See [RFC3032] for the specification of the MPLS label stack.

The size of the exported section may be constrained due to
limitations in the IPFIX protocol.

The data for this field MUST NOT be padded.

   Abstract Data Type:  octetArray

   ElementId:  316

   Status:  current

8.5.4.  mplsPayloadPacketSection

   Description:

This Information Element, which may have a variable length,
carries the first n octets from the MPLS payload of a sampled
packet, being data that follows immediately after the MPLS label
stack.

See [RFC3031] for the specification of MPLS packets.

See [RFC3032] for the specification of the MPLS label stack.

The size of the exported section may be constrained due to limitations in the IPFIX protocol.

The data for this field MUST NOT be padded.

Abstract Data Type:  octetArray

ElementId:  317

Status:  current

## 8.6.  Statistics (318-321, 336-338)

Information Elements in this section can be used for reporting statistics from the Metering Process.

+-----+--------------------------------+-----+----------------------------+
| ID  | Name                           | ID  | Name                       |
+-----+--------------------------------+-----+----------------------------+
| 318 | selectorIdTotalPktsObserved    | 336 | upperCILimit               |
| 319 | selectorIdTotalPktsSelected    | 337 | lowerCILimit               |
| 320 | absoluteError                  | 338 | confidenceLevel            |
| 321 | relativeError                  |     |                            |
+-----+--------------------------------+-----+----------------------------+

### 8.6.1.  selectorIdTotalPktsObserved

Description:

This Information Element specifies the total number of packets observed by a Selector, for a specific value of SelectorId.

This Information Element should be used in an Options Template scoped to the observation to which it refers.  See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].

Abstract Data Type:  unsigned64

Data Type Semantics:  totalCounter

ElementId:  318

Status:  current

Units:  packets

## 8.6.2.  selectorIdTotalPktsSelected

Description:

> This Information Element specifies the total number of packets
> selected by a Selector, for a specific value of SelectorId.

> This Information Element should be used in an Options Template
> scoped to the observation to which it refers.  See Section 3.4.2.1
> of the IPFIX protocol document [RFC5101].

Abstract Data Type:  unsigned64

Data Type Semantics:  totalCounter

ElementId:  319

Status:  current

Units:  packets

## 8.6.3.  absoluteError

Description:

> This Information Element specifies the maximum possible
> measurement error of the reported value for a given Information
> Element.  The absoluteError has the same unit as the Information
> Element with which it is associated.  The real value of the metric
> can differ by absoluteError (positive or negative) from the
> measured value.

> This Information Element provides only the error for measured
> values.  If an Information Element contains an estimated value
> (from Sampling), the confidence boundaries and confidence level
> have to be provided instead, using the upperCILimit, lowerCILimit,
> and confidenceLevel Information Elements.

> This Information Element should be used in an Options Template
> scoped to the observation to which it refers.  See section 3.4.2.1
> of the IPFIX protocol document [RFC5101].

Abstract Data Type:  float64

Data Type Semantics:  quantity

ElementId:  320

   Status:  current

   Units:  The units of the Information Element for which the error is
      specified.

## 8.6.4.  relativeError

   Description:

      This Information Element specifies the maximum possible positive
      or negative error ratio for the reported value for a given
      Information Element as a percentage of the measured value.  The
      real value of the metric can differ by relativeError percent
      (positive or negative) from the measured value.

      This Information Element provides only the error for measured
      values.  If an Information Element contains an estimated value
      (from Sampling), the confidence boundaries and confidence level
      have to be provided instead, using the upperCILimit, lowerCILimit,
      and confidenceLevel Information Elements.

      This Information Element should be used in an Options Template
      scoped to the observation to which it refers.  See Section 3.4.2.1
      of the IPFIX protocol document [RFC5101].

   Abstract Data Type:  float64

   Data Type Semantics:  quantity

   ElementId:  321

   Status:  current

## 8.6.5.  upperCILimit

   Description:

      This Information Element specifies the upper limit of a confidence
      interval.  It is used to provide an accuracy statement for an
      estimated value.  The confidence limits define the range in which
      the real value is assumed to be with a certain probability p.
      Confidence limits always need to be associated with a confidence
      level that defines this probability p.  Please note that a
      confidence interval only provides a probability that the real
      value lies within the limits.  That means the real value can lie
      outside the confidence limits.

The upperCILimit, lowerCILimit, and confidenceLevel Information
Elements should all be used in an Options Template scoped to the
observation to which they refer.  See Section 3.4.2.1 of the IPFIX
protocol document [RFC5101].

Note that the upperCILimit, lowerCILimit, and confidenceLevel are
all required to specify confidence, and should be disregarded
unless all three are specified together.

Abstract Data Type:  float64

Data Type Semantics:  quantity

ElementId:  336

Status:  current

## 8.6.6.  lowerCILimit

Description:

This Information Element specifies the lower limit of a confidence
interval.  For further information, see the description of
upperCILimit.

The upperCILimit, lowerCILimit, and confidenceLevel Information
Elements should all be used in an Options Template scoped to the
observation to which they refer.  See Section 3.4.2.1 of the IPFIX
protocol document [RFC5101].

Note that the upperCILimit, lowerCILimit, and confidenceLevel are
all required to specify confidence, and should be disregarded
unless all three are specified together.

Abstract Data Type:  float64

Data Type Semantics:  quantity

ElementId:  337

Status:  current

8.6.7.  confidenceLevel

   Description:

      This Information Element specifies the confidence level.  It is
      used to provide an accuracy statement for estimated values.  The
      confidence level provides the probability p with which the real
      value lies within a given range.  A confidence level always needs
      to be associated with confidence limits that define the range in
      which the real value is assumed to be.

      The upperCILimit, lowerCILimit, and confidenceLevel Information
      Elements should all be used in an Options Template scoped to the
      observation to which they refer.  See Section 3.4.2.1 of the IPFIX
      protocol document [RFC5101].

      Note that the upperCILimit, lowerCILimit, and confidenceLevel are
      all required to specify confidence, and should be disregarded
      unless all three are specified together.

   Abstract Data Type:  float64

   Data Type Semantics:  quantity

   ElementId:  338

   Status:  current

9.  Security Considerations

   The PSAMP information model itself does not directly introduce
   security issues.  Rather, it defines a set of attributes that may for
   privacy or business issues be considered sensitive information.

   For example, exporting values of header fields may make attacks
   possible for the receiver of this information, which would otherwise
   only be possible for direct observers of the reported Flows along the
   data path.  Specifically, the Information Elements pertaining to
   packet sections MUST target no more than the packet header, some
   subsequent bytes of the packet, and encapsulating headers if present.
   Full packet capture of arbitrary packet streams is explicitly out of
   scope, per [RFC2804].

   The underlying protocol used to exchange the information described
   here MUST therefore apply appropriate procedures to guarantee the
   integrity and confidentiality of the exported information.  Such
   procedures are defined in separate documents, specifically the IPFIX
   protocol document [RFC5101].

10.  IANA Considerations

   The PSAMP information model, as set out in this document, has two
   sets of assigned numbers.  Considerations for assigning them are
   discussed in this section, using the example policies as set out in
   the "Guidelines for IANA Considerations" document [RFC5226].

10.1.  Related Considerations

   As the PSAMP protocol uses the IPFIX protocol, refer to the IANA
   Considerations section in [RFC5102] for the assignments of numbers
   used in the protocol and for the numbers used in the information
   model.

10.2.  PSAMP-Related Considerations

   This document specifies an initial set of PSAMP Information Elements
   fulfilling the needs specified in [RFC5475], as an extension to the
   IPFIX Information Elements [RFC5102].

   Note that the PSAMP Information Element IDs were initially started at
   value 301, in order to leave a gap for any ongoing IPFIX work
   requiring new Information Elements.  It is expected that this gap in
   the Information Element numbering will be filled in by IANA with new
   IPFIX Information Elements.

   Each new selection method MUST be assigned a unique value in the
   selectorAlgorithm registry.  Its configuration parameter(s), along
   with the way to report them with an Options Template, MUST be clearly
   specified.  The initial content of the selectorAlgorithm registry is
   found in Section 8.2.1.

   New assignments for the PSAMP selection method will be administered
   by IANA and are subject to Expert Review [RFC5226].  The group of
   experts must double check the Information Elements definitions with
   already defined Information Elements for completeness, accuracy, and
   redundancy.  Those experts will initially be drawn from the Working
   Group Chairs and document editors of the IPFIX and PSAMP Working
   Groups.  The selectorAlgorithm registry is maintained by IANA and can
   be updated as long as specifications of the new method(s) and any new
   Information Elements are provided.

11.  References

11.1.  Normative References

   [RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
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   [RFC5102]  Quittek, J., Bryant, S., Claise, B., Aitken, P., and J.
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   [RFC5476]  Claise, B., Ed., "Packet Sampling (PSAMP) Protocol
              Specifications", RFC 5476, March 2009.

11.2.  Informative References

   [RFC0791]  Postel, J., "Internet Protocol", STD 5, RFC 791,
              September 1981.

   [RFC2460]  Deering, S. and R. Hinden, "Internet Protocol, Version 6
              (IPv6) Specification", RFC 2460, December 1998.

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              June 1999.

   [RFC2804]  IAB and IESG, "IETF Policy on Wiretapping", RFC 2804,
              May 2000.

   [RFC3031]  Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol
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   [RFC3032]  Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y.,
              Farinacci, D., Li, T., and A. Conta, "MPLS Label Stack
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   [RFC5474]  Duffield, N., Ed., "A Framework for Packet Selection and
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Appendix A.  Formal Specification of PSAMP Information Elements

   This appendix contains a formal description of the PSAMP information
   model XML document.  Note that this appendix is of informational
   nature, while the text in Section 8 generated from this appendix is
   normative.

   Using a formal and machine-readable syntax for the information model
   enables the creation of PSAMP-aware tools that can automatically
   adapt to extensions to the information model, by simply reading
   updated information model specifications.

   The wide availability of XML-aware tools and libraries for client
   devices is a primary consideration for this choice.  In particular,
   libraries for parsing XML documents are readily available.  Also,
   mechanisms such as the Extensible Stylesheet Language (XSL) allow for
   transforming a source XML document into other documents.  This draft
   was authored in XML and transformed according to [RFC2629].

   It should be noted that the use of XML in Exporters, Collectors, or
   other tools is not mandatory for the deployment of PSAMP.  In
   particular, exporting processes do not produce or consume XML as part
   of their operation.  It is expected that PSAMP Collectors MAY take
   advantage of the machine readability of the information model vs.
   hardcoding their behavior or inventing proprietary means for
   accommodating extensions.

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
  This XML document is a product of the IETF IPFIX Working Group.
  Contact information:
    WG charter:
      http://www.ietf.org/html.charters/ipfix-charter.html

    Mailing Lists:
      General Discussion: ipfix@ietf.org
      To Subscribe: http://www1.ietf.org/mailman/listinfo/ipfix
      Archive:
        http://www1.ietf.org/mail-archive/web/ipfix/current/index.html

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      Germany
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      EMail: carle@in.tum.de
      URI: http://www.net.in.tum.de/~carle/

   Abstract:
    This memo defines an information model for the Packet SAMPling
    (PSAMP) protocol.  It is used by the PSAMP protocol for encoding
    sampled packet data and information related to the Sampling process.
    As the PSAMP protocol is based on the IPFIX protocol, this
    information model is an extension to the IPFIX information model.

-->
<fieldDefinitions xmlns="urn:ietf:params:xml:ns:ipfix-info"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:ietf:params:xml:ns:ipfix-info
            ipfix-info.xsd">
  <field name="selectionSequenceId" dataType="unsigned64"
    dataTypeSemantics="identifier" elementId="301" status="current"
    group="identifiers">
    <description>
      <paragraph>
        From all the packets observed at an Observation Point, a subset
        of the packets is selected by a sequence of one or more
        Selectors.  The selectionSequenceId is a unique value per
        Observation Domain, specifying the Observation Point and the

```
                  sequence of Selectors through which the packets are selected.
                </paragraph>
              </description>
            </field>

            <field name="selectorId" dataType="unsigned16"
              dataTypeSemantics="identifier" elementId="302" status="current"
              group="identifiers">
              <description>
                <paragraph>
                  The Selector ID is the unique ID identifying a Primitive
                  Selector.  Each Primitive Selector must have a unique ID in the
                  Observation Domain.
                </paragraph>
              </description>
            </field>

            <field name="informationElementId" dataType="unsigned16"
              dataTypeSemantics="identifier" elementId="303" status="current"
              group="identifiers">
              <description>
                <paragraph>
                  This Information Element contains the ID of another Information
                  Element.
                </paragraph>
              </description>
            </field>

            <field name="selectorAlgorithm" dataType="unsigned16"
              dataTypeSemantics="identifier" elementId="304" status="current"
              group="sampling configuration">
              <description>
                <paragraph>
                  This Information Element identifies the packet selection
                  methods (e.g., Filtering, Sampling) that are applied by
                  the Selection Process.

                  Most of these methods have parameters.  Further
                  Information Elements are needed to fully specify packet
                  selection with these methods and all their parameters.

                  The methods listed below are defined in
                  [RFC5475].  For their parameters,
                  Information Elements are defined in the information model
                  document.  The names of these Information Elements are
                  listed for each method identifier.
```

Further method identifiers may be added to the list
below.  It might be necessary to define new Information
Elements to specify their parameters.

The selectorAlgorithm registry is maintained by IANA.  New
assignments for the registry will be administered by IANA
and are subject to Expert Review [RFC5226].

The registry can be updated when specifications of the new
method(s) and any new Information Elements are provided.

The group of experts must double check the selectorAlgorithm
definitions and Information Elements with already defined
selectorAlgorithms and Information Elements for completeness,
accuracy, and redundancy.  Those experts will initially be drawn
from the Working Group Chairs and document editors of the IPFIX
and PSAMP Working Groups.

The following packet selection methods identifiers are
defined here:

| ID | Method | Parameters |
|----|--------|------------|
| 1 | Systematic count-based Sampling | samplingPacketInterval samplingPacketSpace |
| 2 | Systematic time-based Sampling | samplingTimeInterval samplingTimeSpace |
| 3 | Random n-out-of-N Sampling | samplingSize samplingPopulation |
| 4 | Uniform probabilistic Sampling | samplingProbability |
| 5 | Property Match Filtering | no agreed parameters |
| Hash-based Filtering | | hashInitialiserValue hashIPPayloadOffset |
| 6 | using BOB | hashIPPayloadSize hashSelectedRangeMin |
| 7 | using IPSX | hashSelectedRangeMax hashOutputRangeMin |
| 8 | using CRC | hashOutputRangeMax |

          There is a broad variety of possible parameters that could be
          used for Property Match Filtering (5), but currently there are
          no agreed parameters specified.
        </paragraph>
      </description>
    </field>

    <field name="samplingPacketInterval" dataType="unsigned32"
      dataTypeSemantics="quantity" elementId="305" status="current"
      group="sampling configuration">
      <description>
        <paragraph>
          This Information Element specifies the number of packets that
          are consecutively sampled.  A value of 100 means that
          100 consecutive packets are sampled.

          For example, this Information Element may be used to describe
          the configuration of a systematic count-based Sampling Selector.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="samplingPacketSpace" dataType="unsigned32"
      dataTypeSemantics="quantity" elementId="306" status="current"
      group="sampling configuration">
      <description>
        <paragraph>
          This Information Element specifies the number of packets between
          two "samplingPacketInterval"s.  A value of 100 means that the
          next interval starts 100 packets (which are not sampled)
          after the current "samplingPacketInterval" is over.

          For example, this Information Element may be used to describe
          the configuration of a systematic count-based Sampling Selector.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="samplingTimeInterval" dataType="unsigned32"
      dataTypeSemantics="quantity" elementId="307" status="current"
      group="sampling configuration">
      <description>
        <paragraph>
          This Information Element specifies the time interval in
          microseconds during which all arriving packets are sampled.

```
         For example, this Information Element may be used to describe
         the configuration of a systematic time-based Sampling Selector.
      </paragraph>
    </description>
    <units>microseconds</units>
  </field>

  <field name="samplingTimeSpace" dataType="unsigned32"
    dataTypeSemantics="quantity" elementId="308" status="current"
    group="sampling configuration">
    <description>
      <paragraph>
      This Information Element specifies the time interval in
      microseconds between two "samplingTimeInterval"s.  A value of 100
      means that the next interval starts 100 microseconds
      (during which no packets are sampled) after the current
      "samplingTimeInterval" is over.

      For example, this Information Element may used to describe the
      configuration of a systematic time-based Sampling Selector.
    </paragraph>
    </description>
    <units>microseconds</units>
  </field>

  <field name="samplingSize" dataType="unsigned32"
    dataTypeSemantics="quantity" elementId="309" status="current"
    group="sampling configuration">
    <description>
      <paragraph>
      This Information Element specifies the number of elements taken
      from the parent Population for random Sampling methods.

      For example, this Information Element may be used to describe
      the configuration of a random n-out-of-N Sampling Selector.
    </paragraph>
    </description>
    <units>packets</units>
  </field>

  <field name="samplingPopulation" dataType="unsigned32"
    dataTypeSemantics="quantity" elementId="310" status="current"
    group="sampling configuration">
    <description>
      <paragraph>
      This Information Element specifies the number of elements in the
      parent Population for random Sampling methods.
```

```
            For example, this Information Element may be used to describe
            the configuration of a random n-out-of-N Sampling Selector.
         </paragraph>
       </description>
       <units>packets</units>
     </field>

     <field name="samplingProbability" dataType="float64"
       dataTypeSemantics="quantity" elementId="311" status="current"
       group="sampling configuration">
       <description>
         <paragraph>
            This Information Element specifies the probability that a packet
            is sampled, expressed as a value between 0 and 1.  The
            probability is equal for every packet.  A value of 0 means no
            packet was sampled since the probability is 0.

            For example, this Information Element may be used to describe
            the configuration of a uniform probabilistic Sampling Selector.
         </paragraph>
       </description>
     </field>

     <field name="ipHeaderPacketSection" dataType="octetArray"
       elementId="313" status="current" group="packet data">
       <description>
         <paragraph>
            This Information Element, which may have a variable length,
            carries a series of octets from the start of the IP header of a
            sampled packet.

            With sufficient length, this element also reports octets from
            the IP payload, subject to [RFC2804].  See the Security
            Considerations section.

            The size of the exported section may be constrained due to
            limitations in the IPFIX protocol.

            The data for this field MUST NOT be padded.
         </paragraph>
       </description>
     </field>

     <field name="ipPayloadPacketSection" dataType="octetArray"
       elementId="314" status="current" group="packet data">
       <description>
         <paragraph>
            This Information Element, which may have a variable length,
```

carries a series of octets from the start of the IP payload of a
sampled packet.

The IPv4 payload is that part of the packet that follows the
IPv4 header and any options, which [RFC0791] refers to as "data"
or "data octets".  For example, see the examples in [RFC0791],
Appendix A.

The IPv6 payload is the rest of the packet following the
40-octet IPv6 header.  Note that any extension headers present
are considered part of the payload.  See [RFC2460] for the IPv6
specification.

The size of the exported section may be constrained due to
limitations in the IPFIX protocol.

The data for this field MUST NOT be padded.
```
          </paragraph>
       </description>
    </field>

  <field name="mplsLabelStackSection" dataType="octetArray"
    elementId="316" status="current" group="packet data">
    <description>
      <paragraph>
```
This Information Element, which may have a variable length,
carries the first n octets from the MPLS label stack of a
sampled packet.

With sufficient length, this element also reports octets from
the MPLS payload, subject to [RFC2804].  See the Security
Considerations section.

See [RFC3031] for the specification of MPLS packets.

See [RFC3032] for the specification of the MPLS label stack.

The size of the exported section may be constrained due to
limitations in the IPFIX protocol.

The data for this field MUST NOT be padded.
```
          </paragraph>
       </description>
    </field>

  <field name="mplsPayloadPacketSection" dataType="octetArray"
    elementId="317" status="current" group="packet data">
    <description>
```

```
      <paragraph>
        This Information Element, which may have a variable length,
        carries the first n octets from the MPLS payload of a sampled
        packet, being data that follows immediately after the MPLS label
        stack.

        See [RFC3031] for the specification of MPLS packets.

        See [RFC3032] for the specification of the MPLS label stack.

        The size of the exported section may be constrained due to
        limitations in the IPFIX protocol.

        The data for this field MUST NOT be padded.
      </paragraph>
    </description>
  </field>

  <field name="selectorIdTotalPktsObserved" dataType="unsigned64"
    dataTypeSemantics="totalCounter" elementId="318" status="current"
    group="statistics">
    <description>
      <paragraph>
        This Information Element specifies the total number of packets
        observed by a Selector, for a specific value of SelectorId.

        This Information Element should be used in an Options Template
        scoped to the observation to which it refers.
        See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].
      </paragraph>
    </description>
    <units>packets</units>
  </field>

  <field name="selectorIdTotalPktsSelected" dataType="unsigned64"
    dataTypeSemantics="totalCounter" elementId="319" status="current"
    group="statistics">
    <description>
      <paragraph>
        This Information Element specifies the total number of packets
        selected by a Selector, for a specific value of SelectorId.

        This Information Element should be used in an Options Template
        scoped to the observation to which it refers.
        See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].
      </paragraph>
    </description>
    <units>packets</units>
```

```
    </field>

    <field name="absoluteError" dataType="float64"
      dataTypeSemantics="quantity" elementId="320" status="current"
      group="statistics">
      <description>
        <paragraph>
          This Information Element specifies the maximum possible
          measurement error of the reported value for a given Information
          Element.  The absoluteError has the same unit as the Information
          Element with which it is associated.  The real value of the
          metric can differ by absoluteError (positive or negative) from
          the measured value.

          This Information Element provides only the
          error for measured values.  If an Information Element contains
          an estimated value (from Sampling), the confidence boundaries
          and confidence level have to be provided instead, using the
          upperCILimit, lowerCILimit, and confidenceLevel Information
          Elements.

          This Information Element should be used in an Options Template
          scoped to the observation to which it refers.
          See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].
        </paragraph>
      </description>
      <units>
        The units of the Information Element for which the error is
        specified.
      </units>
    </field>

    <field name="relativeError" dataType="float64"
      dataTypeSemantics="quantity" elementId="321" status="current"
      group="statistics">
      <description>
        <paragraph>
          This Information Element specifies the maximum possible positive
          or negative error ratio for the reported value for a given
          Information Element as a percentage of the measured value.
          The real value of the metric can differ by relativeError percent
          (positive or negative) from the measured value.

          This Information Element provides only the error for measured
          values.  If an Information Element contains an estimated value
          (from Sampling), the confidence boundaries and confidence
          level have to be provided instead, using the upperCILimit,
          lowerCILimit, and confidenceLevel Information Elements.
```

```
      This Information Element should be used in an Options Template
      scoped to the observation to which it refers.
      See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].
    </paragraph>
  </description>
</field>

<field name="observationTimeSeconds" dataType="dateTimeSeconds"
  dataTypeSemantics="quantity" elementId="322" status="current"
  group="timestamps">
  <description>
    <paragraph>
      This Information Element specifies the absolute time in seconds
      of an observation.
    </paragraph>
  </description>
  <units>seconds</units>
</field>

<field name="observationTimeMilliseconds"
  dataType="dateTimeMilliseconds" dataTypeSemantics="quantity"
  elementId="323" status="current" group="timestamps">
  <description>
    <paragraph>
      This Information Element specifies the absolute time in
      milliseconds of an observation.
    </paragraph>
  </description>
  <units>milliseconds</units>
</field>

<field name="observationTimeMicroseconds"
  dataType="dateTimeMicroseconds" dataTypeSemantics="quantity"
  elementId="324" status="current" group="timestamps">
  <description>
    <paragraph>
      This Information Element specifies the absolute time in
      microseconds of an observation.
    </paragraph>
  </description>
  <units>microseconds</units>
</field>

<field name="observationTimeNanoseconds"
  dataType="dateTimeNanoseconds" dataTypeSemantics="quantity"
  elementId="325" status="current" group="timestamps">
  <description>
    <paragraph>
```

```
                This Information Element specifies the absolute time in
                nanoseconds of an observation.
             </paragraph>
          </description>
          <units>nanoseconds</units>
       </field>

       <field name="digestHashValue" dataType="unsigned64"
          dataTypeSemantics="quantity" elementId="326" status="current"
          group="hash configuration">
          <description>
             <paragraph>
                This Information Element specifies the value from the digest
                hash function.

                See also Sections 6.2, 3.8, and 7.1 of
                [RFC5475].
             </paragraph>
          </description>
       </field>

       <field name="hashIPPayloadOffset" dataType="unsigned64"
          dataTypeSemantics="quantity" elementId="327" status="current"
          group="hash configuration">
          <description>
             <paragraph>
                This Information Element specifies the IP payload offset used by
                a Hash-based Selection Selector.

                See also Sections 6.2, 3.8, and 7.1 of
                [RFC5475].
             </paragraph>
          </description>
       </field>

       <field name="hashIPPayloadSize" dataType="unsigned64"
          dataTypeSemantics="quantity" elementId="328" status="current"
          group="hash configuration">
          <description>
             <paragraph>
                This Information Element specifies the IP payload size used by a
                Hash-based Selection Selector.
                See also Sections 6.2, 3.8, and 7.1 of
                [RFC5475]
             </paragraph>
          </description>
       </field>
```

```
<field name="hashOutputRangeMin" dataType="unsigned64"
  dataTypeSemantics="quantity" elementId="329" status="current"
  group="hash configuration">
  <description>
    <paragraph>
      This Information Element specifies the value for the beginning
      of a hash function's potential output range.
      See also Sections 6.2, 3.8, and 7.1 of
      [RFC5475].
    </paragraph>
  </description>
</field>

<field name="hashOutputRangeMax" dataType="unsigned64"
  dataTypeSemantics="quantity" elementId="330" status="current"
  group="hash configuration">
  <description>
    <paragraph>
      This Information Element specifies the value for the end of a
      hash function's potential output range.

      See also Sections 6.2, 3.8, and 7.1 of
      [RFC5475].
    </paragraph>
  </description>
</field>

<field name="hashSelectedRangeMin" dataType="unsigned64"
  dataTypeSemantics="quantity" elementId="331" status="current"
  group="hash configuration">
  <description>
    <paragraph>
      This Information Element specifies the value for the beginning
      of a hash function's selected range.

      See also Sections 6.2, 3.8, and 7.1 of
      [RFC5475].
    </paragraph>
  </description>
</field>

<field name="hashSelectedRangeMax" dataType="unsigned64"
  dataTypeSemantics="quantity" elementId="332" status="current"
  group="hash configuration">
  <description>
    <paragraph>
      This Information Element specifies the value for the end of a
      hash function's selected range.
```

```
      See also Sections 6.2, 3.8, and 7.1 of
      [RFC5475].
    </paragraph>
  </description>
</field>

<field name="hashDigestOutput" dataType="boolean"
  dataTypeSemantics="quantity" elementId="333" status="current"
  group="hash configuration">
  <description>
    <paragraph>
    This Information Element contains a boolean value that is TRUE
    if the output from this hash Selector has been configured to be
    included in the packet report as a packet digest, else FALSE.

    See also Sections 6.2, 3.8, and 7.1 of
    [RFC5475].
    </paragraph>
  </description>
</field>

<field name="hashInitialiserValue" dataType="unsigned64"
  dataTypeSemantics="quantity" elementId="334" status="current"
  group="hash configuration">
  <description>
    <paragraph>
    This Information Element specifies the initialiser value to the
    hash function.

    See also Sections 6.2, 3.8, and 7.1 of
    [RFC5475].
    </paragraph>
  </description>
</field>

<field name="upperCILimit" dataType="float64"
  dataTypeSemantics="quantity" elementId="336" status="current"
  group="statistics">
  <description>
    <paragraph>
    This Information Element specifies the upper limit of a
    confidence interval.  It is used to provide an accuracy
    statement for an estimated value.  The confidence limits
    define the range in which the real value is assumed to be
    with a certain probability p.  Confidence limits always need
    to be associated with a confidence level that defines this
    probability p.  Please note that a confidence interval only
    provides a probability that the real value lies within the
```

```
      limits.  That means the real value can lie outside the
      confidence limits.

      The upperCILimit, lowerCILimit, and confidenceLevel
      Information Elements should all be used in an Options Template
      scoped to the observation to which they refer.
      See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].

      Note that the upperCILimit, lowerCILimit, and confidenceLevel
      are all required to specify confidence, and should be
      disregarded unless all three are specified together.
    </paragraph>
  </description>
  </field>

<field name="lowerCILimit" dataType="float64"
  dataTypeSemantics="quantity" elementId="337" status="current"
  group="statistics">
  <description>
    <paragraph>
      This Information Element specifies the lower limit of a
      confidence interval.  For further information, see the
      description of upperCILimit.

      The upperCILimit, lowerCILimit, and confidenceLevel
      Information Elements should all be used in an Options Template
      scoped to the observation to which they refer.
      See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].

      Note that the upperCILimit, lowerCILimit, and confidenceLevel
      are all required to specify confidence, and should be
      disregarded unless all three are specified together.
    </paragraph>
  </description>
</field>

<field name="confidenceLevel" dataType="float64"
  dataTypeSemantics="quantity" elementId="338" status="current"
  group="statistics">
  <description>
    <paragraph>
      This Information Element specifies the confidence level.  It is
      used to provide an accuracy statement for estimated values.
      The confidence level provides the probability p with which the
      real value lies within a given range.  A confidence level
      always needs to be associated with confidence limits that
      define the range in which the real value is assumed to be.
```

                  The upperCILimit, lowerCILimit, and confidenceLevel
                  Information Elements should all be used in an Options Template
                  scoped to the observation to which they refer.
                  See Section 3.4.2.1 of the IPFIX protocol document [RFC5101].

                  Note that the upperCILimit, lowerCILimit, and confidenceLevel
                  are all required to specify confidence, and should be
                  disregarded unless all three are specified together.
            </paragraph>
          </description>
       </field>

</fieldDefinitions>

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