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.


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:

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

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".

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>selectionSequenceId</td>
</tr>
<tr>
<td>302</td>
<td>selectorId</td>
</tr>
<tr>
<td>303</td>
<td>informationElementId</td>
</tr>
</tbody>
</table>

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:

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

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].

+-----+----------------------------+-----+----------------------------+
<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>326</td>
<td>digestHashValue</td>
<td>331</td>
<td>hashSelectedRangeMin</td>
</tr>
<tr>
<td>327</td>
<td>hashIPPayloadOffset</td>
<td>332</td>
<td>hashSelectedRangeMax</td>
</tr>
<tr>
<td>328</td>
<td>hashIPPayloadSize</td>
<td>333</td>
<td>hashDigestOutput</td>
</tr>
<tr>
<td>329</td>
<td>hashOutputRangeMin</td>
<td>334</td>
<td>hashInitialiserValue</td>
</tr>
<tr>
<td>330</td>
<td>hashOutputRangeMax</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>322</td>
<td>observationTimeSeconds</td>
<td>324</td>
<td>observationTimeMicroseconds</td>
</tr>
<tr>
<td>323</td>
<td>observationTimeMilliseconds</td>
<td>325</td>
<td>observationTimeNanoseconds</td>
</tr>
</tbody>
</table>

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.
### 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

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

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


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

11.2. Informative References


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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  Thomas Dietz
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  Heidelberg 69115
  Germany

-->

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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 IPFIX protocol, this information model is an extension to the IPFIX information model.
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.

\[\text{footnote: [RFC5475]}\]
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:

<table>
<thead>
<tr>
<th>ID</th>
<th>Method</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Systematic count-based Sampling</td>
<td>samplingPacketInterval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>samplingPacketSpace</td>
</tr>
<tr>
<td>2</td>
<td>Systematic time-based Sampling</td>
<td>samplingTimeInterval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>samplingTimeSpace</td>
</tr>
<tr>
<td>3</td>
<td>Random n-out-of-N Sampling</td>
<td>samplingSize</td>
</tr>
<tr>
<td></td>
<td></td>
<td>samplingPopulation</td>
</tr>
<tr>
<td>4</td>
<td>Uniform probabilistic Sampling</td>
<td>samplingProbability</td>
</tr>
<tr>
<td>5</td>
<td>Property Match Filtering</td>
<td>no agreed parameters</td>
</tr>
<tr>
<td></td>
<td>Hash-based Filtering</td>
<td>hashInitialiserValue</td>
</tr>
<tr>
<td></td>
<td>using BOB</td>
<td>hashIPPayloadOffset</td>
</tr>
<tr>
<td></td>
<td>using IPSX</td>
<td>hashIPPayloadSize</td>
</tr>
<tr>
<td></td>
<td>using CRC</td>
<td>hashSelectedRangeMin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hashSelectedRangeMax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hashOutputRangeMin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hashOutputRangeMax</td>
</tr>
</tbody>
</table>

Dietz, et al. Standards Track [Page 33]
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.

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

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

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.

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.

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

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.

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.

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.

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.
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.

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].

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].
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].

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

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

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

<field name="hashIPPayloadOffset" dataType="unsigned64"
    dataTypeSemantics="quantity" elementId="327" status="current"
group="hash configuration">
    <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].
    </description>
</field>

<field name="hashIPPayloadSize" dataType="unsigned64"
    dataTypeSemantics="quantity" elementId="328" status="current"
group="hash configuration">
    <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].
    </description>
</field>
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].

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].

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].

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].

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

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

\[\text{This Information Element specifies the initialiser value to the hash function.} \]

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

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

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