              Information Model for IP Flow Information Export (IPFIX)

Abstract

   This document defines the data types and management policy for the
   information model for the IP Flow Information Export (IPFIX)
   protocol. This information model is maintained as the IANA "IPFIX
   Information Elements" registry, the initial contents of which were
   defined by RFC 5102. This information model is used by the IPFIX
   protocol for encoding measured traffic information and information
   related to the traffic Observation Point, the traffic Metering
   Process, and the Exporting Process. Although this model was
   developed for the IPFIX protocol, it is defined in an open way that
   allows it to be easily used in other protocols, interfaces, and
   applications. This document obsoletes RFC 5102.

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1. Introduction

   The IP Flow Information Export (IPFIX) protocol serves as a means for
   transmitting information related to network traffic measurement. The
   IPFIX Protocol Specification [RFC7011] defines how Information
   Elements are transmitted and also specifies the encoding of a set of
   basic data types for these Information Elements. However, the list
   of Information Elements that can be transmitted by the protocol, such
   as Flow attributes (source IP address, number of packets, etc.) and
   information about the Metering Process and Exporting Process (packet
   Observation Point, sampling rate, Flow timeout interval, etc.), is
   not specified in [RFC7011].

   The IANA "IPFIX Information Elements" registry [IANA-IPFIX] is the
   current complete reference for IPFIX Information Elements. The
   initial values for this registry were provided by [RFC5102].

   This document complements the IPFIX Protocol Specification [RFC7011]
   by providing an overview of the IPFIX information model and
   specifying data types for it. IPFIX-specific terminology used in
   this document is defined in Section 2 of [RFC7011]. As in [RFC7011],
   these IPFIX-specific terms have the first letter of a word
   capitalized when used in this document.

The use of the term 'information model' is not fully in line with the
definition of this term in [RFC3444], as the IPFIX information model
does not specify relationships between Information Elements, nor does
it specify a concrete encoding of Information Elements. For an
encoding suitable for use with the IPFIX protocol, see [RFC7011].
Besides the encoding used by the IPFIX protocol, other encodings of
IPFIX Information Elements can be applied, for example, XML-based
encodings.

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 [RFC2119].

1.1. Changes since RFC 5102

This document obsoletes the Proposed Standard revision of the IPFIX
information model specification [RFC5102]. The following changes
have been made to this document with respect to the previous
document:

- At the time of this publication, technical and editorial errata
  reported for [RFC5102] have been reviewed and addressed as needed.

- All references to [RFC5101] have been updated to [RFC7011],
  reflecting changes to [RFC5101].

- Information Element definitions have been removed, as the reference
  for these is now [IANA-IPFIX]; a historical note on categorizations
  of Information Elements as defined in [RFC5102] has been retained
  in Section 5.

- The process for modifying [IANA-IPFIX] has been improved and is now
  described in [RFC7013]; Section 6 has been updated accordingly, and
  a new Section 7.3 provides IANA considerations for this process.

- Definitions of timestamp data types have been clarified.

- Appendices A and B have been removed.

1.2. IPFIX Documents Overview

The IPFIX protocol provides network administrators with access to
network flow information. The architecture for the export of
measured flow information out of an IPFIX Exporting Process to a
Collecting Process is defined in [RFC5470], per the requirements
defined in [RFC3917]. The IPFIX Protocol Specification [RFC7011]

   defines how IPFIX Data Records and templates are carried via a number
   of transport protocols from IPFIX Exporting Processes to IPFIX
   Collecting Processes.

   Four IPFIX optimizations/extensions are currently specified: a
   bandwidth-saving method for the IPFIX protocol [RFC5473], an
   efficient method for exporting bidirectional flows [RFC5103], a
   method for the definition and export of complex data structures
   [RFC6313], and the specification of the Protocol on IPFIX Mediators
   [IPFIX-MED-PROTO] based on the IPFIX Mediation Framework [RFC6183].

   IPFIX has a formal description of IPFIX Information Elements -- their
   names, data types, and additional semantic information -- as
   specified in this document. The export of the Information Element
   types is specified in [RFC5610].

   [RFC6728] specifies a data model for configuring and monitoring
   devices that are IPFIX and Packet Sampling (PSAMP) compliant using
   the Network Configuration Protocol (NETCONF), while [RFC6615]
   specifies MIB modules for monitoring.

   In terms of development, [RFC5153] provides guidelines for the
   implementation and use of the IPFIX protocol, while [RFC5471]
   provides guidelines for testing.

   Finally, [RFC5472] describes what types of applications can use the
   IPFIX protocol and how they can use the information provided. It
   furthermore shows how the IPFIX framework relates to other
   architectures and frameworks.

2. Properties of IPFIX Protocol Information Elements

2.1. Information Element Specification Template

   Information in messages of the IPFIX protocol is modeled in terms of
   Information Elements of the IPFIX information model. The IPFIX
   Information Elements mentioned in Section 5 are specified in
   [IANA-IPFIX].

   All Information Elements specified for the IPFIX protocol MUST have
   the following properties defined:

   name - A unique and meaningful name for the Information Element.

   elementId - A numeric identifier of the Information Element. If this
      identifier is used without an enterprise identifier (see [RFC7011]
      and the definition of enterpriseId listed below), then it is
      globally unique, and the list of allowed values is administered by
      IANA. It is used for compact identification of an Information
      Element when encoding Templates in the protocol.

   description - The semantics of this Information Element. Describes
      how this Information Element is derived from the Flow or other
      information available to the observer. Information Elements of
      dataType string or octetArray that have length constraints (fixed
      length, minimum and/or maximum length) MUST note these constraints
      in their descriptions.

   dataType - One of the types listed in Section 3.1 of this document or
      registered in the IANA "IPFIX Information Element Data Types"
      subregistry. The type space for attributes is constrained to
      facilitate implementation. The existing type space encompasses
      most primitive types used in modern programming languages, as well
      as some derived types (such as ipv4Address) that are common to
      this domain.

   status - The status of the specification of this Information Element.
      Allowed values are 'current' and 'deprecated'. All newly defined
      Information Elements have 'current' status. The process for
      moving Information Elements to the 'deprecated' status is defined
      in Section 5.3 of [RFC7013].

   Enterprise-specific Information Elements MUST have the following
   property defined:

   enterpriseId - Enterprises may wish to define Information Elements
      without registering them with IANA, for example, for enterprise-
      internal purposes. For such Information Elements, the Information
      Element identifier described above is not sufficient when the
      Information Element is used outside the enterprise. If
      specifications of enterprise-specific Information Elements are
      made public and/or if enterprise-specific identifiers are used by
      the IPFIX protocol outside the enterprise, then the enterprise-
      specific identifier MUST be made globally unique by combining it
      with an enterprise identifier. Valid values for the enterpriseId
      are defined by IANA as Structure of Management Information (SMI)
      network management private enterprise numbers, defined at
      [IANA-PEN].

All Information Elements specified for the IPFIX protocol either in
this document or by any future extension MAY have the following
properties defined:

dataTypeSemantics - The integral types are qualified by additional
   semantic details. Valid values for the data type semantics are
   either specified in Section 3.2 of this document or will be
   specified in a future extension of the information model.

units - If the Information Element is a measure of some kind, the
   units identify what the measure is.

range - Some Information Elements may only be able to take on a
   restricted set of values that can be expressed as a range (e.g., 0
   through 511, inclusive). If this is the case, the valid inclusive
   range SHOULD be specified; values for this Information Element
   outside the range are invalid and MUST NOT be exported.

reference - Identifies additional specifications that more precisely
   define this item or provide additional context for its use.

The following two Information Element properties are defined to allow
the management of an Information Elements registry with Information
Element definitions that may be updated over time, per the process
defined in Section 5.2 of [RFC7013]:

revision - The revision number of an Information Element, starting at
   0 for Information Elements at time of definition and incremented
   by one for each revision.

date - The date of the entry of this revision of the Information
   Element into the registry.

A template for specifying Information Elements is given in
Section 9.1 of [RFC7013].

2.2. Scope of Information Elements

   By default, most Information Elements have a scope specified in their
   definitions. Within Data Records defined by Options Templates, the
   IPFIX protocol allows further limiting of the Information Element
   scope. The new scope is specified by one or more scope fields and
   defined as the combination of all specified scope values; see
   Section 3.4.2.1 on IPFIX scopes in [RFC7011].

2.3. Naming Conventions for Information Elements

   The following naming conventions were used for naming Information
   Elements in this document. It is recommended that extensions of the
   model use the same conventions.

   o Names of Information Elements SHOULD be descriptive.

   o Names of Information Elements MUST be unique within the "IPFIX
      Information Elements" registry [IANA-IPFIX]. Enterprise-specific
      Information Elements SHOULD be prefixed with a vendor name.

   o Names of Information Elements MUST start with lowercase letters.

   o Composed names MUST use capital letters for the first letter of
      each component (except for the first one). All other letters are
      lowercase, even for acronyms. Exceptions are made for acronyms
      containing a mixture of lowercase and capital letters, such as
      'IPv4' and 'IPv6'. Examples are "sourceMacAddress" and
      "destinationIPv4Address".

   o Middleboxes [RFC3234] may change Flow properties, such as the
      Differentiated Services Code Point (DSCP) value or the source IP
      address. If an IPFIX Observation Point is located in the path of
      a Flow before one or more middleboxes that potentially modify
      packets of the Flow, then it may be desirable to also report Flow
      properties after the modification performed by the middleboxes.
      An example is an Observation Point before a packet marker changing
      a packet's IPv4 Type of Service (TOS) field that is encoded in
      Information Element ipClassOfService. Then the value observed and
      reported by Information Element ipClassOfService is valid at the
      Observation Point but not after the packet passed the packet
      marker. For reporting the change value of the TOS field, the
      IPFIX information model uses Information Elements that have a name
      prefix "post", for example, "postIpClassOfService". Information
      Elements with prefix "post" report on Flow properties that are not
      necessarily observed at the Observation Point but that are
      obtained within the Flow's Observation Domain by other means
      considered to be sufficiently reliable, for example, by analyzing
      the packet marker's marking tables.

3. Type Space

   This section describes the abstract data types that can be used for
   the specification of IPFIX Information Elements in Section 4.
   Section 3.1 describes the set of abstract data types.

   Abstract data types unsigned8, unsigned16, unsigned32, unsigned64,
   signed8, signed16, signed32, and signed64 are integral data types.
   As described in Section 3.2, their data type semantics can be further
   specified, for example, by 'totalCounter', 'deltaCounter',
   'identifier', or 'flags'.

3.1. Abstract Data Types

   This section describes the set of valid abstract data types of the
   IPFIX information model, independent of encoding. Note that further
   abstract data types may be specified by future updates to this
   document. Changes to the associated IPFIX "Information Element Data
   Types" subregistry [IANA-IPFIX] specified in [RFC5610] require a
   Standards Action [RFC5226].

   The current encodings of these data types for use with the IPFIX
   protocol are defined in [RFC7011]; encodings allowing the use of the
   IPFIX Information Elements [IANA-IPFIX] with other protocols may be
   defined in the future by referencing this document.

3.1.1. unsigned8

   The type "unsigned8" represents a non-negative integer value in the
   range of 0 to 255.

3.1.2. unsigned16

   The type "unsigned16" represents a non-negative integer value in the
   range of 0 to 65535.

3.1.3. unsigned32

   The type "unsigned32" represents a non-negative integer value in the
   range of 0 to 4294967295.

3.1.4. unsigned64

   The type "unsigned64" represents a non-negative integer value in the
   range of 0 to 18446744073709551615.

3.1.5. signed8

   The type "signed8" represents an integer value in the range of -128
   to 127.

3.1.6. signed16

   The type "signed16" represents an integer value in the range of
   -32768 to 32767.

3.1.7. signed32

   The type "signed32" represents an integer value in the range of
   -2147483648 to 2147483647.

3.1.8. signed64

   The type "signed64" represents an integer value in the range of
   -9223372036854775808 to 9223372036854775807.

3.1.9. float32

   The type "float32" corresponds to an IEEE single-precision 32-bit
   floating-point type as defined in [IEEE.754.2008].

3.1.10. float64

   The type "float64" corresponds to an IEEE double-precision 64-bit
   floating-point type as defined in [IEEE.754.2008].

3.1.11. boolean

   The type "boolean" represents a binary value. The only allowed
   values are "true" and "false".

3.1.12. macAddress

   The type "macAddress" represents a MAC-48 address as defined in
   [IEEE.802-3.2012].

3.1.13. octetArray

   The type "octetArray" represents a finite-length string of octets.

3.1.14. string

   The type "string" represents a finite-length string of valid
   characters from the Unicode coded character set [ISO.10646]. Unicode
   incorporates ASCII [RFC20] and the characters of many other
   international character sets.

3.1.15. dateTimeSeconds

   The type "dateTimeSeconds" represents a time value expressed with
   second-level precision.

3.1.16. dateTimeMilliseconds

   The type "dateTimeMilliseconds" represents a time value expressed
   with millisecond-level precision.

3.1.17. dateTimeMicroseconds

   The type "dateTimeMicroseconds" represents a time value expressed
   with microsecond-level precision.

3.1.18. dateTimeNanoseconds

   The type "dateTimeNanoseconds" represents a time value expressed with
   nanosecond-level precision.

3.1.19. ipv4Address

   The type "ipv4Address" represents an IPv4 address.

3.1.20. ipv6Address

   The type "ipv6Address" represents an IPv6 address.

3.1.21. basicList

   The type "basicList" supports structured data export as described in
   [RFC6313]; see Section 4.5.1 of that document for encoding details.

3.1.22. subTemplateList

   The type "subTemplateList" supports structured data export as
   described in [RFC6313]; see Section 4.5.2 of that document for
   encoding details.

3.1.23. subTemplateMultiList

   The type "subTemplateMultiList" supports structured data export as
   described in [RFC6313]; see Section 4.5.3 of that document for
   encoding details.

3.2. Data Type Semantics

   This section describes the set of valid data type semantics of the
   IPFIX information model. A subregistry of data type semantics
   [IANA-IPFIX] is established in [RFC5610]; the restrictions on the use
   of semantics below are compatible with those specified in
   Section 3.10 of that document. These semantics apply only to numeric
   types, as noted in the description of each semantic below.

   Further data type semantics may be specified by future updates to
   this document. Changes to the associated "IPFIX Information Element
   Semantics" subregistry [IANA-IPFIX] require a Standards Action
   [RFC5226].

3.2.1. quantity

   "quantity" is a numeric (integral or floating point) value
   representing a measured value pertaining to the record. This is
   distinguished from counters that represent an ongoing measured value
   whose "odometer" reading is captured as part of a given record. This
   is the default semantic type of all numeric data types.

3.2.2. totalCounter

   "totalCounter" is an integral value reporting the value of a counter.
   Counters are unsigned and wrap back to zero after reaching the limit
   of the type. For example, an unsigned64 with counter semantics will
   continue to increment until reaching the value of $2**64 - 1$. At this
   point, the next increment will wrap its value to zero and continue
   counting from zero. The semantics of a total counter is similar to
   the semantics of counters used in the Simple Network Management
   Protocol (SNMP), such as Counter32 as defined in [RFC2578]. The only
   difference between total counters and counters used in SNMP is that
   the total counters have an initial value of 0. A total counter
   counts independently of the export of its value.

3.2.3. deltaCounter

   "deltaCounter" is an integral value reporting the value of a counter.
   Counters are unsigned and wrap back to zero after reaching the limit
   of the type. For example, an unsigned64 with counter semantics will
   continue to increment until reaching the value of $2**64 - 1$. At this

point, the next increment will wrap its value to zero and continue
counting from zero. The semantics of a delta counter is similar to
the semantics of counters used in SNMP, such as Counter32 as defined
in [RFC2578]. The only difference between delta counters and
counters used in SNMP is that the delta counters have an initial
value of 0. A delta counter is reset to 0 each time it is exported
and/or expires without export.

3.2.4. identifier

"identifier" is an integral value that serves as an identifier.
Specifically, mathematical operations on two identifiers (aside from
the equality operation) are meaningless. For example, Autonomous
System ID 1 * Autonomous System ID 2 is meaningless. Identifiers
MUST be one of the signed or unsigned data types.

3.2.5. flags

"flags" is an integral value that represents a set of bit fields.
Logical operations are appropriate on such values, but other
mathematical operations are not. Flags MUST always be of an unsigned
data type.

4. Information Element Identifiers

All Information Elements defined in the IANA "IPFIX Information
Elements" registry [IANA-IPFIX] have their identifiers assigned
by IANA.

The values of these identifiers are in the range of 1-32767. Within
this range, Information Element identifier values in the sub-range of
1-127 are compatible with field types used by NetFlow version 9
[RFC3954] for historical reasons.

In general, IANA will add newly registered Information Elements to
the registry, assigning the lowest available Information Element
identifier in the range of 128-32767.

Enterprise-specific Information Element identifiers have the same
range of 1-32767, but they are coupled with an additional enterprise
identifier. For enterprise-specific Information Elements,
Information Element identifier 0 is also reserved. Enterprise-
specific Information Element identifiers can be chosen by an
enterprise arbitrarily within the range of 1-32767. The same
identifier may be assigned by other enterprises for different
purposes; these Information Elements are distinct because the
Information Element identifier is coupled with an enterprise
identifier.

Enterprise identifiers are to be registered as SMI network management
private enterprise code numbers with IANA. The registry can be found
at [IANA-PEN].

5. Information Elements

   [IANA-IPFIX] is now the normative reference for IPFIX Information
   Elements. When [RFC5102] was published, it defined, in its
   Section 5, the initial contents of that registry.

   As a historical note, Information Elements (IEs) were organized into
   categories in [RFC5102] according to their semantics and their
   applicability; these categories were not carried forward into
   [IANA-IPFIX] as an organizing principle. The categories (with
   example IEs) were:

      1. Identifiers (e.g., ingressInterface)
      2. Metering and Exporting Process Configuration
          (e.g., exporterIPv4Address)
      3. Metering and Exporting Process Statistics
          (e.g., exportedOctetTotalCount)
      4. IP Header Fields (e.g., sourceIPv4Address)
      5. Transport Header Fields (e.g., sourceTransportPort)
      6. Sub-IP Header Fields (e.g., sourceMacAddress)
      7. Derived Packet Properties (e.g., bgpSourceAsNumber)
      8. Min/Max Flow Properties (e.g., minimumIpTotalLength)
      9. Flow Timestamps (e.g., flowStartTimeMilliseconds)
      10. Per-Flow Counters (e.g., octetDeltaCount)
      11. Miscellaneous Flow Properties (e.g., flowEndReason)
      12. Padding (paddingOctets)

   Information Elements derived from fields of packets or from Packet
   Treatment can typically serve as Flow Keys used for mapping packets
   to Flows. These Information Elements were placed in categories 4-7
   in the original categorization.

   Information Elements not serving as Flow Keys may have different
   values for each packet in a Flow. For Information Elements with
   values derived from fields of packets or from Packet Treatment, and
   for which the value may change from packet to packet within a single
   Flow, the exported value of an Information Element is by default
   determined by the first packet observed for the corresponding Flow;
   the description of the Information Element may, however, explicitly
   specify different semantics. This simple rule allows the writing of
   all Information Elements related to header fields once, when the
   first packet of the Flow is observed. For further observed packets

of the same Flow, only Flow properties that depend on more than one
packet need to be updated; these Information Elements were placed in
categories 8-11 in the original categorization.

Information Elements with a name having the "post" prefix (e.g.,
postIpClassOfService) do not necessarily report properties that were
actually observed at the Observation Point but may be retrieved by
other means within the Observation Domain. These Information
Elements can be used if there are middlebox functions within the
Observation Domain changing Flow properties after packets passed the
Observation Point; they may also be reported directly by the
Observation Point if the Observation Point is situated where it can
observe packets on both sides of the middlebox.

6. Extending the Information Model

   A key requirement for IPFIX is to allow for extension of the
   Information Model via the "IP Flow Information Export (IPFIX)
   Entities" registry [IANA-IPFIX]. New Information Element definitions
   can be added to this registry subject to Expert Review [RFC5226],
   with additional process considerations as described in [RFC7013];
   that document also provides guidelines for authors and reviewers of
   new Information Element definitions.

   For new Information Elements, the type space defined in Section 3 can
   be used. If required, new abstract data types can be added to the
   "IPFIX Information Element Data Types" subregistry [IANA-IPFIX] as
   defined in [RFC5610]. New abstract data types and semantics are
   subject to Standards Action [RFC5226] and MUST be defined in IETF
   Standards Track documents updating this document.

   Enterprises may wish to define Information Elements without
   registering them with IANA. IPFIX explicitly supports enterprise-
   specific Information Elements. Enterprise-specific Information
   Elements are described in Sections 2.1 and 4; guidelines for using
   them appear in [RFC7013].

7. IANA Considerations

   As this document obsoletes [RFC5102], IANA has updated the references
   in the "IP Flow Information Export (IPFIX) Entities" registry
   [IANA-IPFIX], the "IPFIX MPLS label type" subregistry of that
   registry, the urn:ietf:params:xml:ns:ipfix-info XML namespace, and
   the urn:ietf:params:xml:schema:ipfix-info XML schema to refer to this
   document.

However, [RFC5102] still provides a historical reference for the
initial entries in the "IPFIX Information Elements" registry.
Therefore, IANA has kept [RFC5102] as the requestor of those
Information Elements in the "IPFIX Information Elements" registry
that list [RFC5102] as their requestor and added the following
explanatory note to the "IPFIX Information Elements" registry:

   "RFC 7012 has obsoleted RFC 5102; references to RFC 5102 in this
   registry remain as part of the historical record".

The Information Element Specification Template (Section 2.1) requires
two new columns not present in [RFC5102]. IANA has created a new
Revision column in the "IPFIX Information Elements" registry and set
the Revision of existing Information Elements to 0. IANA has also
created a new Date column in that registry and set the Date of all
existing Information Elements to the publication date of this
document.

To identify Information Elements with identifiers 127 or below as
NetFlow version 9 [RFC3954] compatible, IANA has set the Name of all
existing Reserved Information Elements with identifier 127 or less to
"Assigned for NetFlow v9 compatibility" and the Reference of those
Information Elements to [RFC3954].

As IANA now has change control of the schema used for the IANA "IPFIX
Information Elements" registry [IANA-IPFIX], IANA has deprecated the
previous XML schema for the description of Information Elements
urn:ietf:params:xml:schema:ipfix-info [IPFIX-XML-SCHEMA].

To support the process described in Section 7.4, IANA has established
a mailing list for communicating with the IE-DOCTORS, named
ie-doctors@ietf.org.

The remaining subsections of this section contain no actions
for IANA.

7.1. IPFIX Information Elements

   This document refers to Information Elements, for which the Internet
   Assigned Numbers Authority (IANA) has created the IPFIX "Information
   Elements" registry [IANA-IPFIX]. The columns of this registry must,
   at minimum, be able to store the information defined in the template
   detailed in Section 2.1; it may contain other information as
   necessary for the management of the registry.

   The process for making additions or other changes to the "IPFIX
   Information Elements" registry is given in Section 7.4.

7.2. MPLS Label Type Identifier

   Information Element #46, named mplsTopLabelType, carries MPLS label
   types. Values for 5 different types have initially been defined.
   For ensuring the extensibility of this information, IANA has created
   a new subregistry for MPLS label types and filled it with the initial
   list from the description Information Element #46, mplsTopLabelType.

   New assignments for MPLS label types are administered by IANA through
   Expert Review [RFC5226], i.e., review by one of a group of experts
   designated by an IETF Area Director. The group of experts must
   double-check the label type definitions with already-defined label
   types for completeness, accuracy, and redundancy. The specification
   of new MPLS label types MUST be published using a well-established
   and persistent publication medium.

7.3. XML Namespace and Schema

   The prior version of this document [RFC5102] specified an XML schema
   for IPFIX Information Element definitions [IPFIX-XML-SCHEMA] that was
   used in the generation of the document text itself. When the IANA
   "IPFIX Information Elements" registry [IANA-IPFIX] was created,
   change control on the registry and the schema used to validate it
   passed to IANA.

   The use of a machine-readable syntax for the registry enables the
   creation of IPFIX tools that can automatically adapt to extensions to
   the information model. It should be noted that the use of XML in
   Exporters, Collectors, or other tools is not mandatory for the
   deployment of IPFIX. In particular, Exporting Processes do not
   produce or consume XML as part of their operation. IPFIX Collectors
   MAY take advantage of the machine-readability of the information
   model versus hard-coding their behavior or inventing proprietary
   means for accommodating extensions. However, in order to avoid
   unnecessary load on the IANA infrastructure serving the registry,
   Collectors SHOULD NOT poll the IANA registry [IANA-IPFIX] directly at
   runtime.

   The reference to the current schema is embedded in the registry
   [IANA-IPFIX]; this schema may change from time to time as necessary
   to support the maintenance of the registry. As such, the schema
   urn:ietf:params:xml:schema:ipfix-info [IPFIX-XML-SCHEMA] specified in
   [RFC5102] has been deprecated.

7.4. Addition, Revision, and Deprecation

   New assignments for the "IPFIX Information Elements" registry are
   administered by IANA through Expert Review [RFC5226]. These experts
   are referred to as IE-DOCTORS and are appointed by the IESG. The
   process they follow is defined in [RFC7013].

   Information Element identifiers in the range of 1-127 are compatible
   with field types used by NetFlow version 9 [RFC3954] for historical
   reasons and must not be assigned unless the Information Element is
   compatible with the NetFlow version 9 protocol, as determined by one
   of the IE-DOCTORS designated by the IESG as a NetFlow version 9
   expert.

   Future assignments added to the "IPFIX Information Elements" registry
   that require subregistries for enumerated values (e.g., Section 7.2)
   must have those subregistries added simultaneously with the new
   assignment; additions to these subregistries must be subject to
   Expert Review [RFC5226]. Unless specified at assignment time, the
   experts for the subregistry will be the same as for the "IPFIX
   Information Elements" registry as a whole.

   When IANA receives a request to add, revise, or deprecate an
   Information Element in the "IPFIX Information Elements" registry, it
   forwards the request to the IE-DOCTORS for review.

   When IANA receives an approval for a request to add an Information
   Element definition from the IE-DOCTORS, it adds that Information
   Element to the registry. The approved request may include changes
   made by the requestor and/or reviewers as compared to the original
   request.

   When IANA receives an approval for a request to revise an Information
   Element definition from the IE-DOCTORS, it changes that Information
   Element's definition in the registry and updates the Revision and
   Date columns as appropriate. The approved request may include
   changes from the original request. If the original Information
   Element was added to the registry with IETF consensus (i.e., was
   defined by an RFC), the revision will require IETF consensus as well.

   When IANA receives an approval for a request to deprecate an
   Information Element definition from the IE-DOCTORS, it changes that
   Information Element's definition in the registry and updates the
   Revision and Date columns as appropriate. The approved request may
   include changes from the original request. If the original
   Information Element was added to the registry with IETF consensus
   (i.e., was defined by an RFC), the deprecation will require IETF
   consensus as well.

8. Security Considerations

   The IPFIX 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; this would otherwise
   only be possible for direct observers of the reported Flows along the
   data path.

   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. These
   protocols are defined in separate documents, specifically the IPFIX
   protocol document [RFC7011].

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10. References

10.1. Normative References

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
              Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC6313] Claise, B., Dhandapani, G., Aitken, P., and S. Yates,
              "Export of Structured Data in IP Flow Information Export
              (IPFIX)", RFC 6313, July 2011.

   [RFC7011] Claise, B., Ed., Trammell, B., Ed., and P. Aitken,
              "Specification of the IP Flow Information Export (IPFIX)
              Protocol for the Exchange of Flow Information", STD 77,
              RFC 7011, September 2013.

   [RFC7013] Trammell, B., and B. Claise, "Guidelines for Authors and
              Reviewers of IP Flow Information Export (IPFIX)
              Information Elements", BCP 184, RFC 7013, September 2013.

10.2. Informative References

   [IANA-IPFIX]
             IANA, "IP Flow Information Export (IPFIX) Entities",
             <http://www.iana.org/assignments/ipfix/>.

   [IEEE.754.2008]
             Institute of Electrical and Electronics Engineers, "IEEE
             Standard for Floating-Point Arithmetic", IEEE
             Standard 754, August 2008.

   [IEEE.802-3.2012]
             Institute of Electrical and Electronics Engineers, "IEEE
             Standard for Ethernet", IEEE Standard 802.3, 2012.

   [IPFIX-MED-PROTO]
             Claise, B., Kobayashi, A., and B. Trammell, "Operation of
             the IP Flow Information Export (IPFIX) Protocol on IPFIX
             Mediators", Work in Progress, July 2013.

   [IPFIX-XML-SCHEMA]
             IANA, "IETF XML Registry",
             <http://www.iana.org/assignments/xml-registry/>.

   [ISO.10646]
             International Organization for Standardization,
             "Information technology - Universal Coded Character Set
             (UCS)", ISO/IEC 10646:2012, November 2012.

   [IANA-PEN] IANA, "Private Enterprise Numbers",
             <http://www.iana.org/assignments/enterprise-numbers>.

   [RFC20]   Cerf, V., "ASCII format for Network Interchange", RFC 20,
             October 1969.

   [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J.
             Schoenwaelder, Ed., "Structure of Management Information
             Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.

   [RFC3234] Carpenter, B. and S. Brim, "Middleboxes: Taxonomy and
             Issues", RFC 3234, February 2002.

   [RFC3444] Pras, A. and J. Schoenwaelder, "On the Difference between
             Information Models and Data Models", RFC 3444,
             January 2003.

   [RFC3917]   Quittek, J., Zseby, T., Claise, B., and S. Zander,
               "Requirements for IP Flow Information Export (IPFIX)",
               RFC 3917, October 2004.

   [RFC3954]   Claise, B., Ed., "Cisco Systems NetFlow Services Export
               Version 9", RFC 3954, October 2004.

   [RFC5101]   Claise, B., Ed., "Specification of the IP Flow Information
               Export (IPFIX) Protocol for the Exchange of IP Traffic
               Flow Information", RFC 5101, January 2008.

   [RFC5102]   Quittek, J., Bryant, S., Claise, B., Aitken, P., and J.
               Meyer, "Information Model for IP Flow Information Export",
               RFC 5102, January 2008.

   [RFC5103]   Trammell, B. and E. Boschi, "Bidirectional Flow Export
               Using IP Flow Information Export (IPFIX)", RFC 5103,
               January 2008.

   [RFC5153]   Boschi, E., Mark, L., Quittek, J., Stiemerling, M., and P.
               Aitken, "IP Flow Information Export (IPFIX) Implementation
               Guidelines", RFC 5153, April 2008.

   [RFC5226]   Narten, T. and H. Alvestrand, "Guidelines for Writing an
               IANA Considerations Section in RFCs", BCP 26, RFC 5226,
               May 2008.

   [RFC5470]   Sadasivan, G., Brownlee, N., Claise, B., and J. Quittek,
               "Architecture for IP Flow Information Export", RFC 5470,
               March 2009.

   [RFC5471]   Schmoll, C., Aitken, P., and B. Claise, "Guidelines for IP
               Flow Information Export (IPFIX) Testing", RFC 5471,
               March 2009.

   [RFC5472]   Zseby, T., Boschi, E., Brownlee, N., and B. Claise, "IP
               Flow Information Export (IPFIX) Applicability", RFC 5472,
               March 2009.

   [RFC5473]   Boschi, E., Mark, L., and B. Claise, "Reducing Redundancy
               in IP Flow Information Export (IPFIX) and Packet Sampling
               (PSAMP) Reports", RFC 5473, March 2009.

   [RFC5610]   Boschi, E., Trammell, B., Mark, L., and T. Zseby,
               "Exporting Type Information for IP Flow Information Export
               (IPFIX) Information Elements", RFC 5610, July 2009.

   [RFC6183] Kobayashi, A., Claise, B., Muenz, G., and K. Ishibashi,
              "IP Flow Information Export (IPFIX) Mediation: Framework",
              RFC 6183, April 2011.

   [RFC6615] Dietz, T., Ed., Kobayashi, A., Claise, B., and G. Muenz,
              "Definitions of Managed Objects for IP Flow Information
              Export", RFC 6615, June 2012.

   [RFC6728] Muenz, G., Claise, B., and P. Aitken, "Configuration Data
              Model for the IP Flow Information Export (IPFIX) and
              Packet Sampling (PSAMP) Protocols", RFC 6728,
              October 2012.

Contributors

   Juergen Quittek
   NEC
   Kurfuersten-Anlage 36
   Heidelberg 69115
   Germany

   Phone: +49 6221 90511-15
   EMail: quittek@nw.neclab.eu
   URI: http://www.neclab.eu/

   Stewart Bryant
   Cisco Systems, Inc.
   10 New Square, Bedfont Lakes
   Feltham, Middlesex TW18 8HA
   United Kingdom

   EMail: stbryant@cisco.com

   Paul Aitken
   Cisco Systems, Inc.
   96 Commercial Quay
   Edinburgh EH6 6LX
   Scotland

   Phone: +44 131 561 3616
   EMail: paitken@cisco.com

   Jeff Meyer
   PayPal
   2211 N. First St.
   San Jose, CA 95131-2021
   US

   Phone: +1 408 976-9149
   EMail: jemeyer@paypal.com
   URI: http://www.paypal.com

Authors' Addresses

   Benoit Claise (editor)
   Cisco Systems, Inc.
   De Kleetlaan 6a b1
   1831 Diegem
   Belgium

   Phone: +32 2 704 5622
   EMail: bclaise@cisco.com

   Brian Trammell (editor)
   Swiss Federal Institute of Technology Zurich
   Gloriastrasse 35
   8092 Zurich
   Switzerland

   Phone: +41 44 632 70 13
   EMail: trammell@tik.ee.ethz.ch