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Information Model for IP Flow Information Export

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Abstract

This memo defines an information model for the IP Flow Information eXport (IPFIX) protocol. It 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 developed for the IPFIX protocol, the model is defined in an open way that easily allows using it in other protocols, interfaces, and applications.

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1. Introduction

The IP Flow Information eXport (IPFIX) protocol serves for transmitting information related to measured IP traffic over the Internet. The protocol specification in [RFC5101] defines how Information Elements are transmitted. For Information Elements, it specifies the encoding of a set of basic data types. 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 and Exporting Process (packet Observation Point, sampling rate, Flow timeout interval, etc.), is not specified in [RFC5101].

This document complements the IPFIX protocol specification by providing the IPFIX information model. IPFIX-specific terminology used in this document is defined in Section 2 of [RFC5101]. As in [RFC5101], 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]. The IPFIX information model does not specify relationships between Information Elements, but also it does not specify a concrete encoding of Information Elements. Besides the encoding used by the IPFIX protocol, other encodings of IPFIX Information Elements can be applied, for example, XML-based encodings.

The main part of this document is Section 5, which defines the (extensible) list of Information Elements to be transmitted by the IPFIX protocol. Section 2 defines a template for specifying IPFIX Information Elements in Section 5. Section 3 defines the set of abstract data types that are available for IPFIX Information Elements. Section 6 discusses extensibility of the IPFIX information model.

The main bodies of Sections 2, 3, and 5 were generated from XML documents. The XML-based specification of template, abstract data types, and IPFIX Information Elements can be used for automatically checking syntactical correctness of the specification of IPFIX Information Elements. It can further be used for generating IPFIX protocol implementation code that deals with processing IPFIX Information Elements. Also, code for applications that further process traffic information transmitted via the IPFIX protocol can be generated with the XML specification of IPFIX Information Elements.

For that reason, the XML document that served as a source for Section 5 and the XML schema that served as source for Sections 2 and 3 are attached to this document in Appendices A and B.

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

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].

2. Properties of IPFIX Protocol Information Elements

2.1. Information Elements Specification Template

Information in messages of the IPFIX protocol is modeled in terms of Information Elements of the IPFIX information model. IPFIX Information Elements are specified in Section 5. For specifying these Information Elements, a template is used that is described below.

All Information Elements specified for the IPFIX protocol either in this document or by any future extension 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 [RFC5101] and enterpriseId 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.

dataType - One of the types listed in Section 3.1 of this document or in a future extension of the information model. The type space for attributes is constrained to facilitate implementation. The existing type space does however encompass most basic types used in modern programming languages, as well as some derived types (such as ipv4Address) that are common to this domain and useful to distinguish.

status - The status of the specification of this Information Element. Allowed values are 'current', 'deprecated', and 'obsolete'.

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 codes. They are defined at http://www.iana.org/assignments/enterprise-numbers.

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 may be qualified by additional semantic details. Valid values for the data type semantics are specified in Section 3.2 of this document or 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.

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

2.2. Scope of Information Elements

By default, most Information Elements have a scope specified in their definitions.

- The Information Elements defined in Sections 5.2 and 5.3 have a default of "a specific Metering Process" or of "a specific Exporting Process", respectively.
- The Information Elements defined in Sections 5.4-5.11 have a scope of "a specific Flow".

Within Data Records defined by Option 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 [RFC5101].

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.

- Names of Information Elements should be descriptive.
- Names of Information Elements that are not enterprise-specific MUST be unique within the IPFIX information model. Enterprise-specific Information Elements SHOULD be prefixed with a vendor name.
- Names of Information Elements start with non-capitalized letters.

- Composed names use capital letters for the first letter of each component (except for the first one). All other letters are non-capitalized, even for acronyms. Exceptions are made for acronyms containing non-capitalized letter, such as 'IPv4' and 'IPv6'. Examples are sourceMacAddress and destinationIPv4Address.

- Middleboxes [RFC3234] may change Flow properties, such as the Differentiated Service 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 classOfServiceIPv4. Then the value observed and reported by Information Element classOfServiceIPv4 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, "postClassOfServiceIPv4". Information Elements with prefix "post" report on Flow properties that are not necessarily observed at the Observation Point, but which 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. Note that further abstract data types may be specified by future extensions of the IPFIX information model.

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.754.1985].

3.1.10. float64

The type "float64" corresponds to an IEEE double-precision 64-bit floating point type as defined in [IEEE.754.1985].

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 string of 6 octets.

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 character encoding set [ISO.10646-1.1993]. Unicode allows for ASCII [ISO.646.1991] and many other international character sets to be used.

3.1.15. dateTimeSeconds

The type "dateTimeSeconds" represents a time value in units of seconds based on coordinated universal time (UTC). The choice of an epoch, for example, 00:00 UTC, January 1, 1970, is left to corresponding encoding specifications for this type, for example, the IPFIX protocol specification. Leap seconds are excluded. Note that transformation of values might be required between different encodings if different epoch values are used.

3.1.16. dateTimeMilliseconds

The type "dateTimeMilliseconds" represents a time value in units of milliseconds based on coordinated universal time (UTC). The choice of an epoch, for example, 00:00 UTC, January 1, 1970, is left to corresponding encoding specifications for this type, for example, the IPFIX protocol specification. Leap seconds are excluded. Note that transformation of values might be required between different encodings if different epoch values are used.

3.1.17. dateTimeMicroseconds

The type "dateTimeMicroseconds" represents a time value in units of microseconds based on coordinated universal time (UTC). The choice of an epoch, for example, 00:00 UTC, January 1, 1970, is left to

corresponding encoding specifications for this type, for example, the IPFIX protocol specification. Leap seconds are excluded. Note that transformation of values might be required between different encodings if different epoch values are used.

3.1.18. dateTimeNanoseconds

The type "dateTimeNanoseconds" represents a time value in units of nanoseconds based on coordinated universal time (UTC). The choice of an epoch, for example, 00:00 UTC, January 1, 1970, is left to corresponding encoding specifications for this type, for example, the IPFIX protocol specification. Leap seconds are excluded. Note that transformation of values might be required between different encodings if different epoch values are used.

3.1.19. ipv4Address

The type "ipv4Address" represents a value of an IPv4 address.

3.1.20. ipv6Address

The type "ipv6Address" represents a value of an IPv6 address.

3.2. Data Type Semantics

This section describes the set of valid data type semantics of the IPFIX information model. Note that further data type semantics may be specified by future extensions of the IPFIX information model.

3.2.1. quantity

A quantity value represents a discrete 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. If no semantic qualifier is given, the Information Elements that have an integral data type should behave as a quantity.

3.2.2. totalCounter

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 SNMP, such as Counter32 defined in RFC 2578 [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

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 defined in RFC 2578 [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 its value is exported.

3.2.4. identifier

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.

3.2.5. flags

An integral value that actually represents a set of bit fields. Logical operations are appropriate on such values, but not other mathematical operations. Flags should always be of an unsigned type.

4. Information Element Identifiers

All Information Elements defined in Section 5 of this document or in future extensions of the IPFIX information model have their identifiers assigned by IANA. Their identifiers can be retrieved at http://www.iana.org/assignments/ipfix.

The value of these identifiers is 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].

Range of IANA-assigned Information Element identifiers	Description
0	Reserved.
1-127	Information Element identifiers compatible with NetFlow version 9 field types [RFC3954].
128-32767	Further Information Element identifiers.

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.

Still, Collecting Processes can distinguish these Information Elements because the Information Element identifier is coupled with an enterprise identifier.

Enterprise identifiers MUST be registered as SMI network management private enterprise code numbers with IANA. The registry can be found at http://www.iana.org/assignments/enterprise-numbers.

The following list gives an overview of the Information Element identifiers that are specified in Section 5 and are compatible with field types used by NetFlow version 9 [RFC3954].

ID	Name	ID	Name
1	octetDeltaCount	43	RESERVED
2	packetDeltaCount	44	sourceIPv4Prefix
3	RESERVED	45	destinationIPv4Prefix
4	protocolIdentifier	46	mplsTopLabelType
5	ipClassOfService	47	mplsTopLabelIPv4Address
6	tcpControlBits	48-51	RESERVED
7	sourceTransportPort	52	minimumTTL
8	sourceIPv4Address	53	maximumTTL
9	sourceIPv4PrefixLength	54	fragmentIdentification
10	ingressInterface	55	postIpClassOfService
11	destinationTransportPort	56	sourceMacAddress
12	destinationIPv4Address	57	postDestinationMacAddress
13	destinationIPv4PrefixLength	58	vlanId
14	egressInterface	59	postVlanId
15	ipNextHopIPv4Address	60	ipVersion
16	bgpSourceAsNumber	61	flowDirection
17	bgpDestinationAsNumber	62	ipNextHopIPv6Address
18	bgpNexthopIPv4Address	63	bgpNexthopIPv6Address
19	postMCastPacketDeltaCount	64	ipv6ExtensionHeaders
20	postMCastOctetDeltaCount	65-69	RESERVED
21	flowEndSysUpTime	70	mplsTopLabelStackSection
22	flowStartSysUpTime	71	mplsLabelStackSection2
23	postOctetDeltaCount	72	mplsLabelStackSection3
24	postPacketDeltaCount	73	mplsLabelStackSection4
25	minimumIpTotalLength	74	mplsLabelStackSection5
26	maximumIpTotalLength	75	mplsLabelStackSection6
27	sourceIPv6Address	76	mplsLabelStackSection7
28	destinationIPv6Address	77	mplsLabelStackSection8
29	sourceIPv6PrefixLength	78	mplsLabelStackSection9
30	destinationIPv6PrefixLength	79	mplsLabelStackSection10
31	flowLabelIPv6	80	destinationMacAddress
32	icmpTypeCodeIPv4	81	postSourceMacAddress
33	igmpType	82-84	RESERVED
34	RESERVED	85	octetTotalCount
35	RESERVED	86	packetTotalCount
36	flowActiveTimeout	87	RESERVED
37	flowIdleTimeout	88	fragmentOffset
38	RESERVED	89	RESERVED
39	RESERVED	90	mplsVpnRouteDistinguisher
40	exportedOctetTotalCount	91-127	RESERVED
41	exportedMessageTotalCount		
42	exportedFlowRecordTotalCount		

The following list gives an overview of the Information Element identifiers that are specified in Section 5 and extends the list of Information Element identifiers specified already in [RFC3954].

ID	Name	ID	Name
128	bgpNextAdjacentAsNumber	169	destinationIPv6Prefix
129	bgpPrevAdjacentAsNumber	170	sourceIPv6Prefix
130	exporterIPv4Address	171	postOctetTotalCount
131	exporterIPv6Address	172	postPacketTotalCount
132	droppedOctetDeltaCount	173	flowKeyIndicator
133	droppedPacketDeltaCount	174	postMCastPacketTotalCount
134	droppedOctetTotalCount	175	postMCastOctetTotalCount
135	droppedPacketTotalCount	176	icmpTypeIPv4
136	flowEndReason	177	icmpCodeIPv4
137	commonPropertiesId	178	icmpTypeIPv6
138	observationPointId	179	icmpCodeIPv6
139	icmpTypeCodeIPv6	180	udpSourcePort
140	mplsTopLabelIPv6Address	181	udpDestinationPort
141	lineCardId	182	tcpSourcePort
142	portId	183	tcpDestinationPort
143	meteringProcessId	184	tcpSequenceNumber
144	exportingProcessId	185	tcpAcknowledgementNumber
145	templateId	186	tcpWindowSize
146	wlanChannelId	187	tcpUrgentPointer
147	wlanSSID	188	tcpHeaderLength
148	flowId	189	ipHeaderLength
149	observationDomainId	190	totalLengthIPv4
150	flowStartSeconds	191	payloadLengthIPv6
151	flowEndSeconds	192	ipTTL
152	flowStartMilliseconds	193	nextHeaderIPv6
153	flowEndMilliseconds	194	mplsPayloadLength
154	flowStartMicroseconds	195	ipDiffServCodePoint
155	flowEndMicroseconds	196	ipPrecedence
156	flowStartNanoseconds	197	fragmentFlags
157	flowEndNanoseconds	198	octetDeltaSumOfSquares
158	flowStartDeltaMicroseconds	199	octetTotalSumOfSquares
159	flowEndDeltaMicroseconds	200	mplsTopLabelTTL
160	systemInitTimeMilliseconds	201	mplsLabelStackLength
161	flowDurationMilliseconds	202	mplsLabelStackDepth
162	flowDurationMicroseconds	203	mplsTopLabelExp
163	observedFlowTotalCount	204	ipPayloadLength
164	ignoredPacketTotalCount	205	udpMessageLength
165	ignoredOctetTotalCount	206	isMulticast
166	notSentFlowTotalCount	207	ipv4IHL
167	notSentPacketTotalCount	208	ipv4Options
168	notSentOctetTotalCount	209	tcpOptions

ID	Name	ID	Name
210	paddingOctets	218	tcpSynTotalCount
211	collectorIPv4Address	219	tcpFinTotalCount
212	collectorIPv6Address	220	tcpRstTotalCount
213	exportInterface	221	tcpPshTotalCount
214	exportProtocolVersion	222	tcpAckTotalCount
215	exportTransportProtocol	223	tcpUrgTotalCount
216	collectorTransportPort	224	ipTotalLength
217	exporterTransportPort	237	postMplsTopLabelExp
		238	tcpWindowScale

5. Information Elements

This section describes the Information Elements of the IPFIX information model. The elements are grouped into 12 groups according to their semantics and their applicability:

1. Identifiers
2. Metering and Exporting Process Configuration
3. Metering and Exporting Process Statistics
4. IP Header Fields
5. Transport Header Fields
6. Sub-IP Header Fields
7. Derived Packet Properties
8. Min/Max Flow Properties
9. Flow Timestamps
10. Per-Flow Counters
11. Miscellaneous Flow Properties
12. Padding

The Information Elements that are derived from fields of packets or from packet treatment, such as the Information Elements in groups 4-7, can typically serve as Flow Keys used for mapping packets to Flows.

If they do not serve as Flow Keys, their value may change from packet to packet within a single Flow. For Information Elements with values that are 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 IPFIX information model defines that their value is determined by the first packet observed for the corresponding Flow, unless the description of the Information Element explicitly specifies a different semantics. This simple rule allows writing 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, such as the Information Elements in groups 8-11, need to be updated.

Information Elements with a name having the "post" prefix, for example, "postClassOfServiceIPv4", do not report properties that were actually observed at the Observation Point, but 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.

Information Elements in this section use the reference property to reference [RFC0768], [RFC0791], [RFC0792], [RFC0793], [RFC1108], [RFC1112], [RFC1191], [RFC1323], [RFC1385], [RFC1812], [RFC1930], [RFC2113], [RFC2119], [RFC2460], [RFC2675], [RFC2863], [RFC3031], [RFC3032], [RFC3193], [RFC3234], [RFC3260], [RFC3270], [RFC3376], [RFC3954], [RFC4271], [RFC4291], [RFC4302], [RFC4303], [RFC4364], [RFC4382], [RFC4443], [RFC4960], [RFC5036], [IEEE.802-11.1999], [IEEE.802-1Q.2003], and [IEEE.802-3.2002].

5.1. Identifiers

Information Elements grouped in the table below are identifying components of the IPFIX architecture, of an IPFIX Device, or of the IPFIX protocol. All of them have an integral abstract data type and data type semantics "identifier" as described in Section 3.2.4.

Typically, some of them are used for limiting scopes of other Information Elements. However, other Information Elements MAY be used for limiting scopes. Note also that all Information Elements listed below MAY be used for other purposes than limiting scopes.

ID	Name	ID	Name
141	lineCardId	148	flowId
142	portId	145	templateId
10	ingressInterface	149	observationDomainId
14	egressInterface	138	observationPointId
143	meteringProcessId	137	commonPropertiesId
144	exportingProcessId		

5.1.1. lineCardId

Description:
An identifier of a line card that is unique per IPFIX Device hosting an Observation Point. Typically, this Information Element is used for limiting the scope of other Information Elements.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 141
Status: current

5.1.2. portId

Description:
An identifier of a line port that is unique per IPFIX Device hosting an Observation Point. Typically, this Information Element is used for limiting the scope of other Information Elements.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 142
Status: current

5.1.3. ingressInterface

Description:
The index of the IP interface where packets of this Flow are being received. The value matches the value of managed object 'ifIndex' as defined in RFC 2863. Note that ifIndex values are not assigned statically to an interface and that the interfaces may be renumbered every time the device's management system is re-initialized, as specified in RFC 2863.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 10
Status: current
Reference:
See RFC 2863 for the definition of the ifIndex object.

5.1.4. egressInterface

Description:
The index of the IP interface where packets of this Flow are being sent. The value matches the value of managed object 'ifIndex' as defined in RFC 2863. Note that ifIndex values are not assigned statically to an interface and that the interfaces may be renumbered every time the device's management system is re-initialized, as specified in RFC 2863.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 14
Status: current
Reference:
See RFC 2863 for the definition of the ifIndex object.

5.1.5. meteringProcessId

Description:
An identifier of a Metering Process that is unique per IPFIX Device. Typically, this Information Element is used for limiting the scope of other Information Elements. Note that process identifiers are typically assigned dynamically. The Metering Process may be re-started with a different ID.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 143
Status: current

5.1.6. exportingProcessId

Description:
An identifier of an Exporting Process that is unique per IPFIX Device. Typically, this Information Element is used for limiting the scope of other Information Elements. Note that process identifiers are typically assigned dynamically. The Exporting Process may be re-started with a different ID.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 144
Status: current

5.1.7. flowId

Description:
An identifier of a Flow that is unique within an Observation Domain. This Information Element can be used to distinguish between different Flows if Flow Keys such as IP addresses and port numbers are not reported or are reported in separate records.
Abstract Data Type: unsigned64
Data Type Semantics: identifier
ElementId: 148
Status: current

5.1.8. templateId

Description:
An identifier of a Template that is locally unique within a combination of a Transport session and an Observation Domain. Template IDs 0-255 are reserved for Template Sets, Options Template Sets, and other reserved Sets yet to be created. Template IDs of Data Sets are numbered from 256 to 65535. Typically, this Information Element is used for limiting the scope of other Information Elements. Note that after a re-start of the Exporting Process Template identifiers may be re-assigned.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 145
Status: current

5.1.9. observationDomainId

Description:
An identifier of an Observation Domain that is locally unique to an Exporting Process. The Exporting Process uses the Observation Domain ID to uniquely identify to the Collecting Process the Observation Domain where Flows were metered. It is RECOMMENDED that this identifier is also unique per IPFIX Device. A value of 0 indicates that no specific Observation Domain is identified by this Information Element. Typically, this Information Element is used for limiting the scope of other Information Elements.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 149
Status: current

5.1.10. observationPointId

Description:
An identifier of an Observation Point that is unique per Observation Domain. It is RECOMMENDED that this identifier is also unique per IPFIX Device. Typically, this Information Element is used for limiting the scope of other Information Elements.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 138
Status: current

5.1.11. commonPropertiesId

Description:
An identifier of a set of common properties that is unique per Observation Domain and Transport Session. Typically, this Information Element is used to link to information reported in separate Data Records.
Abstract Data Type: unsigned64
Data Type Semantics: identifier
ElementId: 137
Status: current

5.2. Metering and Exporting Process Configuration

Information Elements in this section describe the configuration of the Metering Process or the Exporting Process. The set of these Information Elements is listed in the table below.

ID	Name	ID	Name
130	exporterIPv4Address	213	exportInterface
131	exporterIPv6Address	214	exportProtocolVersion
217	exporterTransportPort	215	exportTransportProtocol
211	collectorIPv4Address	216	collectorTransportPort
212	collectorIPv6Address	173	flowKeyIndicator

5.2.1. exporterIPv4Address

Description:
The IPv4 address used by the Exporting Process. This is used by the Collector to identify the Exporter in cases where the identity of the Exporter may have been obscured by the use of a proxy.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 130
Status: current

5.2.2. exporterIPv6Address

Description:
The IPv6 address used by the Exporting Process. This is used by the Collector to identify the Exporter in cases where the identity of the Exporter may have been obscured by the use of a proxy.
Abstract Data Type: ipv6Address
Data Type Semantics: identifier
ElementId: 131
Status: current

5.2.3. exporterTransportPort

Description:
The source port identifier from which the Exporting Process sends Flow information. For the transport protocols UDP, TCP, and SCTP, this is the source port number. This field MAY also be used for future transport protocols that have 16-bit source port identifiers. This field may be useful for distinguishing multiple Exporting Processes that use the same IP address.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 217
Status: current
Reference:
See RFC 768 for the definition of the UDP source port field. See RFC 793 for the definition of the TCP source port field. See RFC 4960 for the definition of SCTP. Additional information on defined UDP and TCP port numbers can be found at http://www.iana.org/assignments/port-numbers.

5.2.4. collectorIPv4Address

Description:
An IPv4 address to which the Exporting Process sends Flow information.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 211
Status: current

5.2.5. collectorIPv6Address

Description:
An IPv6 address to which the Exporting Process sends Flow information.
Abstract Data Type: ipv6Address
Data Type Semantics: identifier
ElementId: 212
Status: current

5.2.6. exportInterface

Description:
The index of the interface from which IPFIX Messages sent by the Exporting Process to a Collector leave the IPFIX Device. The value matches the value of managed object 'ifIndex' as defined in RFC 2863. Note that ifIndex values are not assigned statically to an interface and that the interfaces may be renumbered every time the device's management system is re-initialized, as specified in RFC 2863.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 213
Status: current
Reference:
See RFC 2863 for the definition of the ifIndex object.

5.2.7. exportProtocolVersion

Description:
The protocol version used by the Exporting Process for sending Flow information. The protocol version is given by the value of the Version Number field in the Message Header. The protocol version is 10 for IPFIX and 9 for NetFlow version 9. A value of 0 indicates that no export protocol is in use.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 214
Status: current
Reference:
See the IPFIX protocol specification [RFC5101] for the definition of the IPFIX Message Header.
See RFC 3954 for the definition of the NetFlow version 9 message header.

5.2.8. exportTransportProtocol

Description:
The value of the protocol number used by the Exporting Process for sending Flow information. The protocol number identifies the IP packet payload type. Protocol numbers are defined in the IANA Protocol Numbers registry.
In Internet Protocol version 4 (IPv4), this is carried in the Protocol field. In Internet Protocol version 6 (IPv6), this is carried in the Next Header field in the last extension header of the packet.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 215
Status: current
Reference:
See RFC 791 for the specification of the IPv4 protocol field. See RFC 2460 for the specification of the IPv6 protocol field. See the list of protocol numbers assigned by IANA at http://www.iana.org/assignments/protocol-numbers.

5.2.9. collectorTransportPort

Description:
The destination port identifier to which the Exporting Process sends Flow information. For the transport protocols UDP, TCP, and SCTP, this is the destination port number. This field MAY also be used for future transport protocols that have 16-bit source port identifiers.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 216
Status: current
Reference:
See RFC 768 for the definition of the UDP destination port field.
See RFC 793 for the definition of the TCP destination port field.
See RFC 4960 for the definition of SCTP.
Additional information on defined UDP and TCP port numbers can be found at http://www.iana.org/assignments/port-numbers.

5.2.10. flowKeyIndicator

Description:
This set of bit fields is used for marking the Information Elements of a Data Record that serve as Flow Key. Each bit represents an Information Element in the Data Record with the n-th bit representing the n-th Information Element. A bit set to value 1 indicates that the corresponding Information Element is a Flow Key of the reported Flow. A bit set to value 0 indicates that this is not the case.
If the Data Record contains more than 64 Information Elements, the corresponding Template SHOULD be designed such that all Flow Keys are among the first 64 Information Elements, because the flowKeyIndicator only contains 64 bits. If the Data Record contains less than 64 Information Elements, then the bits in the flowKeyIndicator for which no corresponding Information Element exists MUST have the value 0.
Abstract Data Type: unsigned64
Data Type Semantics: flags
ElementId: 173
Status: current

5.3. Metering and Exporting Process Statistics

Information Elements in this section describe statistics of the Metering Process and/or the Exporting Process. The set of these Information Elements is listed in the table below.

ID	Name	ID	Name
41	exportedMessageTotalCount	165	ignoredOctetTotalCount
40	exportedOctetTotalCount	166	notSentFlowTotalCount
42	exportedFlowRecordTotalCount	167	notSentPacketTotalCount
163	observedFlowTotalCount	168	notSentOctetTotalCount
164	ignoredPacketTotalCount		

5.3.1. exportedMessageTotalCount

Description:
The total number of IPFIX Messages that the Exporting Process has sent since the Exporting Process (re-)initialization to a particular Collecting Process. The reported number excludes the IPFIX Message that carries the counter value. If this Information Element is sent to a particular Collecting Process, then by default it specifies the number of IPFIX Messages sent to this Collecting Process.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 41
Status: current
Units: messages

5.3.2. exportedOctetTotalCount

Description:
The total number of octets that the Exporting Process has sent since the Exporting Process (re-)initialization to a particular Collecting Process. The value of this Information Element is calculated by summing up the IPFIX Message Header length values of all IPFIX Messages that were successfully sent to the Collecting Process. The reported number excludes octets in the IPFIX Message that carries the counter value. If this Information Element is sent to a particular Collecting Process, then by default it specifies the number of octets sent to this Collecting Process.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 40
Status: current

Units: octets

5.3.3. exportedFlowRecordTotalCount

Description:
The total number of Flow Records that the Exporting Process has sent as Data Records since the Exporting Process (re-)initialization to a particular Collecting Process. The reported number excludes Flow Records in the IPFIX Message that carries the counter value. If this Information Element is sent to a particular Collecting Process, then by default it specifies the number of Flow Records sent to this process.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 42
Status: current
Units: flows

5.3.4. observedFlowTotalCount

Description:
The total number of Flows observed in the Observation Domain since the Metering Process (re-)initialization for this Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 163
Status: current
Units: flows

5.3.5. ignoredPacketTotalCount

Description:
The total number of observed IP packets that the Metering Process did not process since the (re-)initialization of the Metering Process.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 164
Status: current
Units: packets

5.3.6. ignoredOctetTotalCount

Description:
The total number of octets in observed IP packets (including the IP header) that the Metering Process did not process since the (re-)initialization of the Metering Process.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 165
Status: current
Units: octets

5.3.7. notSentFlowTotalCount

Description:
The total number of Flow Records that were generated by the Metering Process and dropped by the Metering Process or by the Exporting Process instead of being sent to the Collecting Process. There are several potential reasons for this including resource shortage and special Flow export policies.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 166
Status: current
Units: flows

5.3.8. notSentPacketTotalCount

Description:
The total number of packets in Flow Records that were generated by the Metering Process and dropped by the Metering Process or by the Exporting Process instead of being sent to the Collecting Process. There are several potential reasons for this including resource shortage and special Flow export policies.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 167
Status: current
Units: packets

5.3.9. notSentOctetTotalCount

Description:
The total number of octets in packets in Flow Records that were generated by the Metering Process and dropped by the Metering Process or by the Exporting Process instead of being sent to the Collecting Process. There are several potential reasons for this including resource shortage and special Flow export policies.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 168
Status: current
Units: octets

5.4. IP Header Fields

Information Elements in this section indicate values of IP header fields or are derived from IP header field values in combination with further information.

ID	Name	ID	Name
60	ipVersion	193	nextHeaderIPv6
8	sourceIPv4Address	195	ipDiffServCodePoint
27	sourceIPv6Address	196	ipPrecedence
9	sourceIPv4PrefixLength	5	ipClassOfService
29	sourceIPv6PrefixLength	55	postIpClassOfService
44	sourceIPv4Prefix	31	flowLabelIPv6
170	sourceIPv6Prefix	206	isMulticast
12	destinationIPv4Address	54	fragmentIdentification
28	destinationIPv6Address	88	fragmentOffset
13	destinationIPv4PrefixLength	197	fragmentFlags
30	destinationIPv6PrefixLength	189	ipHeaderLength
45	destinationIPv4Prefix	207	ipv4IHL
169	destinationIPv6Prefix	190	totalLengthIPv4
192	ipTTL	224	ipTotalLength
4	protocolIdentifier	191	payloadLengthIPv6

5.4.1. ipVersion

Description:
The IP version field in the IP packet header.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 60
Status: current

Reference:
See RFC 791 for the definition of the version field in the IPv4 packet header. See RFC 2460 for the definition of the version field in the IPv6 packet header. Additional information on defined version numbers can be found at http://www.iana.org/assignments/version-numbers.

5.4.2. sourceIPv4Address

Description:
The IPv4 source address in the IP packet header.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 8
Status: current
Reference:
See RFC 791 for the definition of the IPv4 source address field.

5.4.3. sourceIPv6Address

Description:
The IPv6 source address in the IP packet header.
Abstract Data Type: ipv6Address
Data Type Semantics: identifier
ElementId: 27
Status: current
Reference:
See RFC 2460 for the definition of the Source Address field in the IPv6 header.

5.4.4. sourceIPv4PrefixLength

Description:
The number of contiguous bits that are relevant in the sourceIPv4Prefix Information Element.
Abstract Data Type: unsigned8
ElementId: 9
Status: current
Units: bits
Range: The valid range is 0-32.

5.4.5. sourceIPv6PrefixLength

Description:
The number of contiguous bits that are relevant in the sourceIPv6Prefix Information Element.
Abstract Data Type: unsigned8
ElementId: 29
Status: current
Units: bits
Range: The valid range is 0-128.

5.4.6. sourceIPv4Prefix

Description:
IPv4 source address prefix.
Abstract Data Type: ipv4Address
ElementId: 44
Status: current

5.4.7. sourceIPv6Prefix

Description:
IPv6 source address prefix.
Abstract Data Type: ipv6Address
ElementId: 170
Status: current

5.4.8. destinationIPv4Address

Description:
The IPv4 destination address in the IP packet header.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 12
Status: current
Reference:
See RFC 791 for the definition of the IPv4 destination address field.

5.4.9. destinationIPv6Address

```
   Description:
      The IPv6 destination address in the IP packet header.
   Abstract Data Type: ipv6Address
   Data Type Semantics: identifier
   ElementId: 28
   Status: current
   Reference:
      See RFC 2460 for the definition of the Destination Address field
      in the IPv6 header.
```

5.4.10. destinationIPv4PrefixLength

```
   Description:
      The number of contiguous bits that are relevant in the
      destinationIPv4Prefix Information Element.
   Abstract Data Type: unsigned8
   ElementId: 13
   Status: current
   Units: bits
   Range: The valid range is 0-32.
```

5.4.11. destinationIPv6PrefixLength

```
   Description:
      The number of contiguous bits that are relevant in the
      destinationIPv6Prefix Information Element.
   Abstract Data Type: unsigned8
   ElementId: 30
   Status: current
   Units: bits
   Range: The valid range is 0-128.
```

5.4.12. destinationIPv4Prefix

```
   Description:
      IPv4 destination address prefix.
   Abstract Data Type: ipv4Address
   ElementId: 45
   Status: current
```

5.4.13. destinationIPv6Prefix

Description:
   IPv6 destination address prefix.
Abstract Data Type: ipv6Address
ElementId: 169
Status: current

5.4.14. ipTTL

Description:
   For IPv4, the value of the Information Element matches the value of the Time to Live (TTL) field in the IPv4 packet header. For IPv6, the value of the Information Element matches the value of the Hop Limit field in the IPv6 packet header.
Abstract Data Type: unsigned8
ElementId: 192
Status: current
Units: hops
Reference:
   See RFC 791 for the definition of the IPv4 Time to Live field. See RFC 2460 for the definition of the IPv6 Hop Limit field.

5.4.15. protocolIdentifier

Description:
   The value of the protocol number in the IP packet header. The protocol number identifies the IP packet payload type. Protocol numbers are defined in the IANA Protocol Numbers registry. In Internet Protocol version 4 (IPv4), this is carried in the Protocol field. In Internet Protocol version 6 (IPv6), this is carried in the Next Header field in the last extension header of the packet.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 4
Status: current
Reference:
   See RFC 791 for the specification of the IPv4 protocol field. See RFC 2460 for the specification of the IPv6 protocol field. See the list of protocol numbers assigned by IANA at http://www.iana.org/assignments/protocol-numbers.

5.4.16. nextHeaderIPv6

Description:
The value of the Next Header field of the IPv6 header. The value identifies the type of the following IPv6 extension header or of the following IP payload. Valid values are defined in the IANA Protocol Numbers registry.
Abstract Data Type: unsigned8
ElementId: 193
Status: current
Reference:
See RFC 2460 for the definition of the IPv6 Next Header field. See the list of protocol numbers assigned by IANA at http://www.iana.org/assignments/protocol-numbers.

5.4.17. ipDiffServCodePoint

Description:
The value of a Differentiated Services Code Point (DSCP) encoded in the Differentiated Services field. The Differentiated Services field spans the most significant 6 bits of the IPv4 TOS field or the IPv6 Traffic Class field, respectively.
This Information Element encodes only the 6 bits of the Differentiated Services field. Therefore, its value may range from 0 to 63.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 195
Status: current
Range: The valid range is 0-63.
Reference:
See RFC 3260 for the definition of the Differentiated Services field. See RFC 1812 (Section 5.3.2) and RFC 791 for the definition of the IPv4 TOS field. See RFC 2460 for the definition of the IPv6 Traffic Class field.

5.4.18. ipPrecedence

Description:
The value of the IP Precedence. The IP Precedence value is encoded in the first 3 bits of the IPv4 TOS field or the IPv6 Traffic Class field, respectively. This Information Element encodes only these 3 bits. Therefore, its value may range from 0 to 7.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 196
Status: current

Range: The valid range is 0-7.
Reference:
See RFC 1812 (Section 5.3.3) and RFC 791 for the definition of the IP Precedence. See RFC 1812 (Section 5.3.2) and RFC 791 for the definition of the IPv4 TOS field. See RFC 2460 for the definition of the IPv6 Traffic Class field.

5.4.19. ipClassOfService

Description:
For IPv4 packets, this is the value of the TOS field in the IPv4 packet header. For IPv6 packets, this is the value of the Traffic Class field in the IPv6 packet header.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 5
Status: current
Reference:
See RFC 1812 (Section 5.3.2) and RFC 791 for the definition of the IPv4 TOS field. See RFC 2460 for the definition of the IPv6 Traffic Class field.

5.4.20. postIpClassOfService

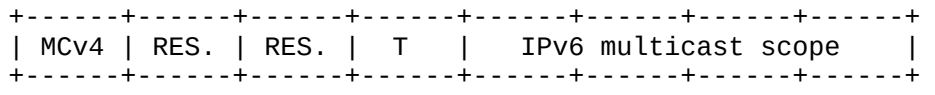
Description:
The definition of this Information Element is identical to the definition of Information Element 'ipClassOfService', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 55
Status: current
Reference:
See RFC 791 for the definition of the IPv4 TOS field. See RFC 2460 for the definition of the IPv6 Traffic Class field. See RFC 3234 for the definition of middleboxes.

5.4.21. flowLabelIPv6

Description:
The value of the IPv6 Flow Label field in the IP packet header.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 31
Status: current
Reference:
See RFC 2460 for the definition of the Flow Label field in the IPv6 packet header.

5.4.22. isMulticast

Description:
If the IP destination address is not a reserved multicast address, then the value of all bits of the octet (including the reserved ones) is zero.
The first bit of this octet is set to 1 if the Version field of the IP header has the value 4 and if the Destination Address field contains a reserved multicast address in the range from 224.0.0.0 to 239.255.255.255. Otherwise, this bit is set to 0. The second and third bits of this octet are reserved for future use.
The remaining bits of the octet are only set to values other than zero if the IP Destination Address is a reserved IPv6 multicast address. Then the fourth bit of the octet is set to the value of the T flag in the IPv6 multicast address and the remaining four bits are set to the value of the scope field in the IPv6 multicast address.



Bit 0: set to 1 if IPv4 multicast
Bits 1-2: reserved for future use
Bit 4: set to value of T flag, if IPv6 multicast
Bits 4-7: set to value of multicast scope if IPv6 multicast

Abstract Data Type: unsigned8
Data Type Semantics: flags
ElementId: 206
Status: current

Reference:
See RFC 1112 for the specification of reserved IPv4 multicast addresses. See RFC 4291 for the specification of reserved IPv6 multicast addresses and the definition of the T flag and the IPv6 multicast scope.

5.4.23. fragmentIdentification

Description:
The value of the Identification field in the IPv4 packet header or in the IPv6 Fragment header, respectively. The value is 0 for IPv6 if there is no fragment header.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 54
Status: current
Reference:
See RFC 791 for the definition of the IPv4 Identification field. See RFC 2460 for the definition of the Identification field in the IPv6 Fragment header.

5.4.24. fragmentOffset

Description:
The value of the IP fragment offset field in the IPv4 packet header or the IPv6 Fragment header, respectively. The value is 0 for IPv6 if there is no fragment header.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 88
Status: current
Reference:
See RFC 791 for the specification of the fragment offset in the IPv4 header. See RFC 2460 for the specification of the fragment offset in the IPv6 Fragment header.

5.4.25. fragmentFlags

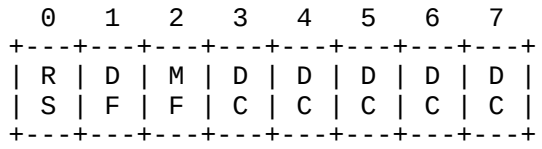
Description:
Fragmentation properties indicated by flags in the IPv4 packet header or the IPv6 Fragment header, respectively.

Bit 0: (RS) Reserved.
The value of this bit MUST be 0 until specified otherwise.

Bit 1: (DF) 0 = May Fragment, 1 = Don't Fragment.
Corresponds to the value of the DF flag in the IPv4 header. Will always be 0 for IPv6 unless a "don't fragment" feature is introduced to IPv6.

Bit 2: (MF) 0 = Last Fragment, 1 = More Fragments.
Corresponds to the MF flag in the IPv4 header or to the M flag in the IPv6 Fragment header, respectively. The value is 0 for IPv6 if there is no fragment header.

Bits 3-7: (DC) Don't Care.
The values of these bits are irrelevant.



Abstract Data Type: unsigned8
Data Type Semantics: flags
ElementId: 197
Status: current
Reference:
See RFC 791 for the specification of the IPv4 fragment flags. See RFC 2460 for the specification of the IPv6 Fragment header.

5.4.26. ipHeaderLength

Description:
The length of the IP header. For IPv6, the value of this Information Element is 40.
Abstract Data Type: unsigned8
ElementId: 189
Status: current
Units: octets
Reference:
See RFC 791 for the specification of the IPv4 header. See RFC 2460 for the specification of the IPv6 header.

5.4.27. ipv4IHL

Description:
The value of the Internet Header Length (IHL) field in the IPv4 header. It specifies the length of the header in units of 4 octets. Please note that its unit is different from most of the other Information Elements reporting length values.

```
   Abstract Data Type: unsigned8
   ElementId: 207
   Status: current
   Units: 4 octets
   Reference:
      See RFC 791 for the specification of the IPv4 header.
```

5.4.28. totalLengthIPv4

```
   Description:
      The total length of the IPv4 packet.
   Abstract Data Type: unsigned16
   ElementId: 190
   Status: current
   Units: octets
   Reference:
      See RFC 791 for the specification of the IPv4 total length.
```

5.4.29. ipTotalLength

```
   Description:
      The total length of the IP packet.
   Abstract Data Type: unsigned64
   ElementId: 224
   Status: current
   Units: octets
   Reference:
      See RFC 791 for the specification of the IPv4 total length.  See
      RFC 2460 for the specification of the IPv6 payload length.  See
      RFC 2675 for the specification of the IPv6 jumbo payload length.
```

5.4.30. payloadLengthIPv6

```
   Description:
      This Information Element reports the value of the Payload Length
      field in the IPv6 header.  Note that IPv6 extension headers belong
      to the payload.  Also note that in case of a jumbo payload option
      the value of the Payload Length field in the IPv6 header is zero
      and so will be the value reported by this Information Element.
   Abstract Data Type: unsigned16
   ElementId: 191
   Status: current
   Units: octets
   Reference:
      See RFC 2460 for the specification of the IPv6 payload length.
      See RFC 2675 for the specification of the IPv6 jumbo payload
      option.
```

5.5. Transport Header Fields

The set of Information Elements related to transport header fields and length includes the Information Elements listed in the table below.

ID	Name	ID	Name
7	sourceTransportPort	238	tcpWindowScale
11	destinationTransportPort	187	tcpUrgentPointer
180	udpSourcePort	188	tcpHeaderLength
181	udpDestinationPort	32	icmpTypeCodeIPv4
205	udpMessageLength	176	icmpTypeIPv4
182	tcpSourcePort	177	icmpCodeIPv4
183	tcpDestinationPort	139	icmpTypeCodeIPv6
184	tcpSequenceNumber	178	icmpTypeIPv6
185	tcpAcknowledgementNumber	179	icmpCodeIPv6
186	tcpWindowSize	33	igmpType

5.5.1. sourceTransportPort

Description:
The source port identifier in the transport header. For the transport protocols UDP, TCP, and SCTP, this is the source port number given in the respective header. This field MAY also be used for future transport protocols that have 16-bit source port identifiers.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 7
Status: current
Reference:
See RFC 768 for the definition of the UDP source port field. See RFC 793 for the definition of the TCP source port field. See RFC 4960 for the definition of SCTP.
Additional information on defined UDP and TCP port numbers can be found at http://www.iana.org/assignments/port-numbers.

5.5.2. destinationTransportPort

Description:
The destination port identifier in the transport header. For the transport protocols UDP, TCP, and SCTP, this is the destination port number given in the respective header. This field MAY also be used for future transport protocols that have 16-bit destination port identifiers.

```
   Abstract Data Type: unsigned16
   Data Type Semantics: identifier
   ElementId: 11
   Status: current
   Reference:
      See RFC 768 for the definition of the UDP destination port field.
      See RFC 793 for the definition of the TCP destination port field.
      See RFC 4960 for the definition of SCTP.  Additional information
      on defined UDP and TCP port numbers can be found at
      http://www.iana.org/assignments/port-numbers.
```

5.5.3. udpSourcePort

```
   Description:
      The source port identifier in the UDP header.
   Abstract Data Type: unsigned16
   Data Type Semantics: identifier
   ElementId: 180
   Status: current
   Reference:
      See RFC 768 for the definition of the UDP source port field.
      Additional information on defined UDP port numbers can be found at
      http://www.iana.org/assignments/port-numbers.
```

5.5.4. udpDestinationPort

```
   Description:
      The destination port identifier in the UDP header.
   Abstract Data Type: unsigned16
   Data Type Semantics: identifier
   ElementId: 181
   Status: current
   Reference:
      See RFC 768 for the definition of the UDP destination port field.
      Additional information on defined UDP port numbers can be found at
      http://www.iana.org/assignments/port-numbers.
```

5.5.5. udpMessageLength

```
   Description:
      The value of the Length field in the UDP header.
   Abstract Data Type: unsigned16
   ElementId: 205
   Status: current
   Units: octets
   Reference:
      See RFC 768 for the specification of the UDP header.
```

5.5.6. tcpSourcePort

Description:
The source port identifier in the TCP header.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 182
Status: current
Reference:
See RFC 793 for the definition of the TCP source port field.
Additional information on defined TCP port numbers can be found at
http://www.iana.org/assignments/port-numbers.

5.5.7. tcpDestinationPort

Description:
The destination port identifier in the TCP header.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 183
Status: current
Reference:
See RFC 793 for the definition of the TCP source port field.
Additional information on defined TCP port numbers can be found at
http://www.iana.org/assignments/port-numbers.

5.5.8. tcpSequenceNumber

Description:
The sequence number in the TCP header.
Abstract Data Type: unsigned32
ElementId: 184
Status: current
Reference:
See RFC 793 for the definition of the TCP sequence number.

5.5.9. tcpAcknowledgementNumber

Description:
The acknowledgement number in the TCP header.
Abstract Data Type: unsigned32
ElementId: 185
Status: current
Reference:
See RFC 793 for the definition of the TCP acknowledgement number.

5.5.10. tcpWindowSize

Description:
The window field in the TCP header. If the TCP window scale is supported, then TCP window scale must be known to fully interpret the value of this information.
Abstract Data Type: unsigned16
ElementId: 186
Status: current
Reference:
See RFC 793 for the definition of the TCP window field. See RFC 1323 for the definition of the TCP window scale.

5.5.11. tcpWindowScale

Description:
The scale of the window field in the TCP header.
Abstract Data Type: unsigned16
ElementId: 238
Status: current
Reference:
See RFC 1323 for the definition of the TCP window scale.

5.5.12. tcpUrgentPointer

Description:
The urgent pointer in the TCP header.
Abstract Data Type: unsigned16
ElementId: 187
Status: current
Reference:
See RFC 793 for the definition of the TCP urgent pointer.

5.5.13. tcpHeaderLength

Description:
The length of the TCP header. Note that the value of this Information Element is different from the value of the Data Offset field in the TCP header. The Data Offset field indicates the length of the TCP header in units of 4 octets. This Information Elements specifies the length of the TCP header in units of octets.
Abstract Data Type: unsigned8
ElementId: 188
Status: current
Units: octets
Reference:
See RFC 793 for the definition of the TCP header.

5.5.14. icmpTypeCodeIPv4

Description:
Type and Code of the IPv4 ICMP message. The combination of both values is reported as (ICMP type * 256) + ICMP code.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 32
Status: current
Reference:
See RFC 792 for the definition of the IPv4 ICMP type and code fields.

5.5.15. icmpTypeIPv4

Description:
Type of the IPv4 ICMP message.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 176
Status: current
Reference:
See RFC 792 for the definition of the IPv4 ICMP type field.

5.5.16. icmpCodeIPv4

Description:
Code of the IPv4 ICMP message.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 177
Status: current
Reference:
See RFC 792 for the definition of the IPv4 ICMP code field.

5.5.17. icmpTypeCodeIPv6

Description:
Type and Code of the IPv6 ICMP message. The combination of both values is reported as (ICMP type * 256) + ICMP code.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 139
Status: current
Reference:
See RFC 4443 for the definition of the IPv6 ICMP type and code fields.

5.5.18. icmpTypeIPv6

Description:
Type of the IPv6 ICMP message.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 178
Status: current
Reference:
See RFC 4443 for the definition of the IPv6 ICMP type field.

5.5.19. icmpCodeIPv6

Description:
Code of the IPv6 ICMP message.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 179
Status: current
Reference:
See RFC 4443 for the definition of the IPv6 ICMP code field.

5.5.20. igmpType

Description:
The type field of the IGMP message.
Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 33
Status: current
Reference:
See RFC 3376 for the definition of the IGMP type field.

5.6. Sub-IP Header Fields

The set of Information Elements related to Sub-IP header fields includes the Information Elements listed in the table below.

ID	Name	ID	Name
56	sourceMacAddress	201	mplsLabelStackLength
81	postSourceMacAddress	194	mplsPayloadLength
58	vlanId	70	mplsTopLabelStackSection
59	postVlanId	71	mplsLabelStackSection2
80	destinationMacAddress	72	mplsLabelStackSection3
57	postDestinationMacAddress	73	mplsLabelStackSection4
146	wlanChannelId	74	mplsLabelStackSection5
147	wlanSSID	75	mplsLabelStackSection6
200	mplsTopLabelTTL	76	mplsLabelStackSection7
203	mplsTopLabelExp	77	mplsLabelStackSection8
237	postMplsTopLabelExp	78	mplsLabelStackSection9
202	mplsLabelStackDepth	79	mplsLabelStackSection10

5.6.1. sourceMacAddress

Description:
The IEEE 802 source MAC address field.
Abstract Data Type: macAddress
Data Type Semantics: identifier
ElementId: 56
Status: current
Reference:
See IEEE.802-3.2002.

5.6.2. postSourceMacAddress

Description:
The definition of this Information Element is identical to the definition of Information Element 'sourceMacAddress', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: macAddress
Data Type Semantics: identifier
ElementId: 81
Status: current
Reference:
See IEEE.802-3.2002.

5.6.3. vlanId

Description:
The IEEE 802.1Q VLAN identifier (VID) extracted from the Tag Control Information field that was attached to the IP packet.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 58
Status: current
Reference:
See IEEE.802-1Q.2003.

5.6.4. postVlanId

Description:
The definition of this Information Element is identical to the definition of Information Element 'vlanId', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned16
Data Type Semantics: identifier
ElementId: 59
Status: current
Reference:
See IEEE.802-1Q.2003.

5.6.5. destinationMacAddress

Description:
The IEEE 802 destination MAC address field.
Abstract Data Type: macAddress
Data Type Semantics: identifier
ElementId: 80
Status: current
Reference:
See IEEE.802-3.2002.

5.6.6. postDestinationMacAddress

Description:
The definition of this Information Element is identical to the definition of Information Element 'destinationMacAddress', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: macAddress
Data Type Semantics: identifier
ElementId: 57
Status: current

```
   Reference:
      See IEEE.802-3.2002.
```

5.6.7. wlanChannelId

```
   Description:
      The identifier of the 802.11 (Wi-Fi) channel used.
   Abstract Data Type: unsigned8
   Data Type Semantics: identifier
   ElementId: 146
   Status: current
   Reference:
      See IEEE.802-11.1999.
```

5.6.8. wlanSSID

```
   Description:
      The Service Set IDentifier (SSID) identifying an 802.11 (Wi-Fi)
      network used.  According to IEEE.802-11.1999, the SSID is encoded
      into a string of up to 32 characters.
   Abstract Data Type: string
   ElementId: 147
   Status: current
   Reference:
      See IEEE.802-11.1999.
```

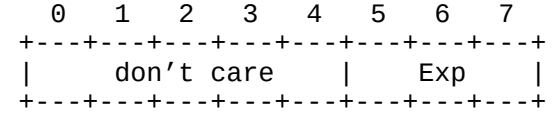
5.6.9. mplsTopLabelTTL

```
   Description:
      The TTL field from the top MPLS label stack entry, i.e., the last
      label that was pushed.
   Abstract Data Type: unsigned8
   ElementId: 200
   Status: current
   Units: hops
   Reference:
      See RFC 3032 for the specification of the TTL field.
```

5.6.10. mplsTopLabelExp

Description:
The Exp field from the top MPLS label stack entry, i.e., the last label that was pushed.

Bits 0-4: Don't Care, value is irrelevant.
Bits 5-7: MPLS Exp field.



Abstract Data Type: unsigned8
Data Type Semantics: flags
ElementId: 203
Status: current
Reference:
See RFC 3032 for the specification of the Exp field. See RFC 3270 for usage of the Exp field.

5.6.11. postMplsTopLabelExp

Description:
The definition of this Information Element is identical to the definition of Information Element 'mplsTopLabelExp', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned8
Data Type Semantics: flags
ElementId: 237
Status: current
Reference:
See RFC 3032 for the specification of the Exp field. See RFC 3270 for usage of the Exp field.

5.6.12. mplsLabelStackDepth

Description:
The number of labels in the MPLS label stack.
Abstract Data Type: unsigned32
ElementId: 202
Status: current
Units: label stack entries
Reference:
See RFC 3032 for the specification of the MPLS label stack.

5.6.13. mplsLabelStackLength

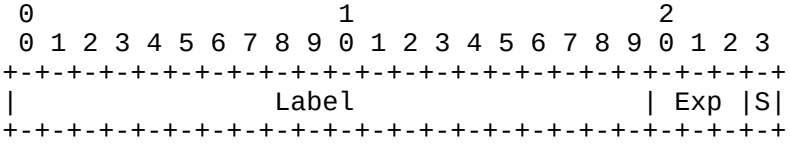
Description:
The length of the MPLS label stack in units of octets.
Abstract Data Type: unsigned32
ElementId: 201
Status: current
Units: octets
Reference:
See RFC 3032 for the specification of the MPLS label stack.

5.6.14. mplsPayloadLength

Description:
The size of the MPLS packet without the label stack.
Abstract Data Type: unsigned32
ElementId: 194
Status: current
Units: octets
Reference:
See RFC 3031 for the specification of MPLS packets. See RFC 3032 for the specification of the MPLS label stack.

5.6.15. mplsTopLabelStackSection

Description:
The Label, Exp, and S fields from the top MPLS label stack entry, i.e., from the last label that was pushed. The size of this Information Element is 3 octets.



Label: Label Value, 20 bits
Exp: Experimental Use, 3 bits
S: Bottom of Stack, 1 bit

Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 70
Status: current
Reference:
See RFC 3032.

5.6.16. mplsLabelStackSection2

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsTopLabelStackSection. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 71
Status: current
Reference:
See RFC 3032.

5.6.17. mplsLabelStackSection3

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection2. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 72
Status: current
Reference:
See RFC 3032.

5.6.18. mplsLabelStackSection4

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection3. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 73
Status: current
Reference:
See RFC 3032.

5.6.19. mplsLabelStackSection5

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection4. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 74
Status: current
Reference:
See RFC 3032.

5.6.20. mplsLabelStackSection6

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection5. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 75
Status: current
Reference:
See RFC 3032.

5.6.21. mplsLabelStackSection7

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection6. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 76
Status: current
Reference:
See RFC 3032.

5.6.22. mplsLabelStackSection8

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection7. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 77
Status: current
Reference:
See RFC 3032.

5.6.23. mplsLabelStackSection9

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection8. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 78
Status: current
Reference:
See RFC 3032.

5.6.24. mplsLabelStackSection10

Description:
The Label, Exp, and S fields from the label stack entry that was pushed immediately before the label stack entry that would be reported by mplsLabelStackSection9. See the definition of mplsTopLabelStackSection for further details. The size of this Information Element is 3 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 79
Status: current
Reference:
See RFC 3032.

5.7. Derived Packet Properties

The set of Information Elements derived from packet properties (for example, values of header fields) includes the Information Elements listed in the table below.

ID	Name	ID	Name
204	ipPayloadLength	18	bgpNextHopIPv4Address
15	ipNextHopIPv4Address	63	bgpNextHopIPv6Address
62	ipNextHopIPv6Address	46	mplsTopLabelType
16	bgpSourceAsNumber	47	mplsTopLabelIPv4Address
17	bgpDestinationAsNumber	140	mplsTopLabelIPv6Address
128	bgpNextAdjacentAsNumber	90	mplsVpnRouteDistinguisher
129	bgpPrevAdjacentAsNumber		

5.7.1. ipPayloadLength

Description:
The effective length of the IP payload. For IPv4 packets, the value of this Information Element is the difference between the total length of the IPv4 packet (as reported by Information Element totalLengthIPv4) and the length of the IPv4 header (as reported by Information Element headerLengthIPv4). For IPv6, the value of the Payload Length field in the IPv6 header is reported except in the case that the value of this field is zero and that there is a valid jumbo payload option. In this case, the value of the Jumbo Payload Length field in the jumbo payload option is reported.
Abstract Data Type: unsigned32
ElementId: 204
Status: current
Units: octets
Reference:
See RFC 791 for the specification of IPv4 packets. See RFC 2460 for the specification of the IPv6 payload length. See RFC 2675 for the specification of the IPv6 jumbo payload length.

5.7.2. ipNextHopIPv4Address

Description:
The IPv4 address of the next IPv4 hop.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 15
Status: current

5.7.3. ipNextHopIPv6Address

Description:
The IPv6 address of the next IPv6 hop.
Abstract Data Type: ipv6Address
Data Type Semantics: identifier
ElementId: 62
Status: current

5.7.4. bgpSourceAsNumber

Description:
The autonomous system (AS) number of the source IP address. If AS path information for this Flow is only available as an unordered AS set (and not as an ordered AS sequence), then the value of this Information Element is 0.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 16
Status: current
Reference:
See RFC 4271 for a description of BGP-4, and see RFC 1930 for the definition of the AS number.

5.7.5. bgpDestinationAsNumber

Description:
The autonomous system (AS) number of the destination IP address. If AS path information for this Flow is only available as an unordered AS set (and not as an ordered AS sequence), then the value of this Information Element is 0.
Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: 17
Status: current
Reference:
See RFC 4271 for a description of BGP-4, and see RFC 1930 for the definition of the AS number.

5.7.6. bgpNextAdjacentAsNumber

Description:
The autonomous system (AS) number of the first AS in the AS path to the destination IP address. The path is deduced by looking up the destination IP address of the Flow in the BGP routing information base. If AS path information for this Flow is only available as an unordered AS set (and not as an ordered AS sequence), then the value of this Information Element is 0.

```
   Abstract Data Type: unsigned32
   Data Type Semantics: identifier
   ElementId: 128
   Status: current
   Reference:
      See RFC 4271 for a description of BGP-4, and see RFC 1930 for the
      definition of the AS number.
```

5.7.7. bgpPrevAdjacentAsNumber

```
   Description:
      The autonomous system (AS) number of the last AS in the AS path
      from the source IP address.  The path is deduced by looking up the
      source IP address of the Flow in the BGP routing information base.
      If AS path information for this Flow is only available as an
      unordered AS set (and not as an ordered AS sequence), then the
      value of this Information Element is 0.  In case of BGP asymmetry,
      the bgpPrevAdjacentAsNumber might not be able to report the
      correct value.
   Abstract Data Type: unsigned32
   Data Type Semantics: identifier
   ElementId: 129
   Status: current
   Reference:
      See RFC 4271 for a description of BGP-4, and see RFC 1930 for the
      definition of the AS number.
```

5.7.8. bgpNextHopIPv4Address

```
   Description:
      The IPv4 address of the next (adjacent) BGP hop.
   Abstract Data Type: ipv4Address
   Data Type Semantics: identifier
   ElementId: 18
   Status: current
   Reference:
      See RFC 4271 for a description of BGP-4.
```

5.7.9. bgpNextHopIPv6Address

```
   Description:
      The IPv6 address of the next (adjacent) BGP hop.
   Abstract Data Type: ipv6Address
   Data Type Semantics: identifier
   ElementId: 63
   Status: current
   Reference:
      See RFC 4271 for a description of BGP-4.
```

5.7.10. mplsTopLabelType

Description:
This field identifies the control protocol that allocated the top-of-stack label. Initial values for this field are listed below. Further values may be assigned by IANA in the MPLS label type registry.

- 0x01 TE-MIDPT: Any TE tunnel mid-point or tail label
- 0x02 Pseudowire: Any PWE3 or Cisco AToM based label
- 0x03 VPN: Any label associated with VPN
- 0x04 BGP: Any label associated with BGP or BGP routing
- 0x05 LDP: Any label associated with dynamically assigned labels using LDP

Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 46
Status: current
Reference:
See RFC 3031 for the MPLS label structure. See RFC 4364 for the association of MPLS labels with Virtual Private Networks (VPNs). See RFC 4271 for BGP and BGP routing. See RFC 5036 for Label Distribution Protocol (LDP). See the list of MPLS label types assigned by IANA at http://www.iana.org/assignments/mpls-label-values.

5.7.11. mplsTopLabelIPv4Address

Description:
The IPv4 address of the system that the MPLS top label will cause this Flow to be forwarded to.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: 47
Status: current
Reference:
See RFC 3031 for the association between MPLS labels and IP addresses.

5.7.12. mplsTopLabelIPv6Address

Description:
The IPv6 address of the system that the MPLS top label will cause this Flow to be forwarded to.
Abstract Data Type: ipv6Address
Data Type Semantics: identifier
ElementId: 140
Status: current
Reference:
See RFC 3031 for the association between MPLS labels and IP addresses.

5.7.13. mplsVpnRouteDistinguisher

Description:
The value of the VPN route distinguisher of a corresponding entry in a VPN routing and forwarding table. Route distinguisher ensures that the same address can be used in several different MPLS VPNs and that it is possible for BGP to carry several completely different routes to that address, one for each VPN. According to RFC 4364, the size of mplsVpnRouteDistinguisher is 8 octets. However, in RFC 4382 an octet string with flexible length was chosen for representing a VPN route distinguisher by object MplsL3VpnRouteDistinguisher. This choice was made in order to be open to future changes of the size. This idea was adopted when choosing octetArray as abstract data type for this Information Element. The maximum length of this Information Element is 256 octets.
Abstract Data Type: octetArray
Data Type Semantics: identifier
ElementId: 90
Status: current
Reference:
See RFC 4364 for the specification of the route distinguisher.
See RFC 4382 for the specification of the MPLS/BGP Layer 3 Virtual Private Network (VPN) Management Information Base.

5.8. Min/Max Flow Properties

Information Elements in this section are results of minimum or maximum operations over all packets of a Flow.

ID	Name	ID	Name
25	minimumIpTotalLength	208	ipv4Options
26	maximumIpTotalLength	64	ipv6ExtensionHeaders
52	minimumTTL	6	tcpControlBits
53	maximumTTL	209	tcpOptions

5.8.1. minimumIpTotalLength

Description:
Length of the smallest packet observed for this Flow. The packet length includes the IP header(s) length and the IP payload length.
Abstract Data Type: unsigned64
ElementId: 25
Status: current
Units: octets
Reference:
See RFC 791 for the specification of the IPv4 total length. See RFC 2460 for the specification of the IPv6 payload length. See RFC 2675 for the specification of the IPv6 jumbo payload length.

5.8.2. maximumIpTotalLength

Description:
Length of the largest packet observed for this Flow. The packet length includes the IP header(s) length and the IP payload length.
Abstract Data Type: unsigned64
ElementId: 26
Status: current
Units: octets
Reference:
See RFC 791 for the specification of the IPv4 total length. See RFC 2460 for the specification of the IPv6 payload length. See RFC 2675 for the specification of the IPv6 jumbo payload length.

5.8.3. minimumTTL

Description:
Minimum TTL value observed for any packet in this Flow.

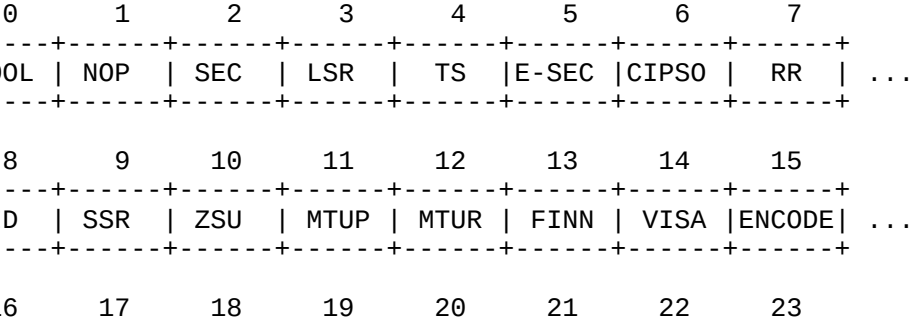
Abstract Data Type: unsigned8
ElementId: 52
Status: current
Units: hops
Reference:
See RFC 791 for the definition of the IPv4 Time to Live field.
See RFC 2460 for the definition of the IPv6 Hop Limit field.

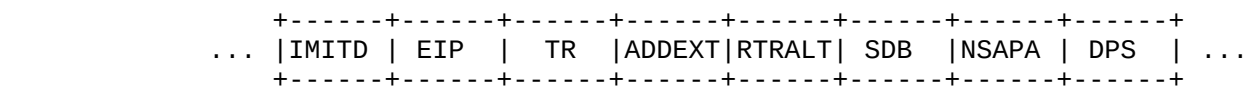
5.8.4. maximumTTL

Description:
Maximum TTL value observed for any packet in this Flow.
Abstract Data Type: unsigned8
ElementId: 53
Status: current
Units: hops
Reference:
See RFC 791 for the definition of the IPv4 Time to Live field.
See RFC 2460 for the definition of the IPv6 Hop Limit field.

5.8.5. ipv4Options

Description:
IPv4 options in packets of this Flow. The information is encoded in a set of bit fields. For each valid IPv4 option type, there is a bit in this set. The bit is set to 1 if any observed packet of this Flow contains the corresponding IPv4 option type. Otherwise, if no observed packet of this Flow contained the respective IPv4 option type, the value of the corresponding bit is 0. The list of valid IPv4 options is maintained by IANA. Note that for identifying an option not just the 5-bit Option Number, but all 8 bits of the Option Type need to match one of the IPv4 options specified at http://www.iana.org/assignments/ip-parameters. Options are mapped to bits according to their option numbers. Option number X is mapped to bit X. The mapping is illustrated by the figure below.





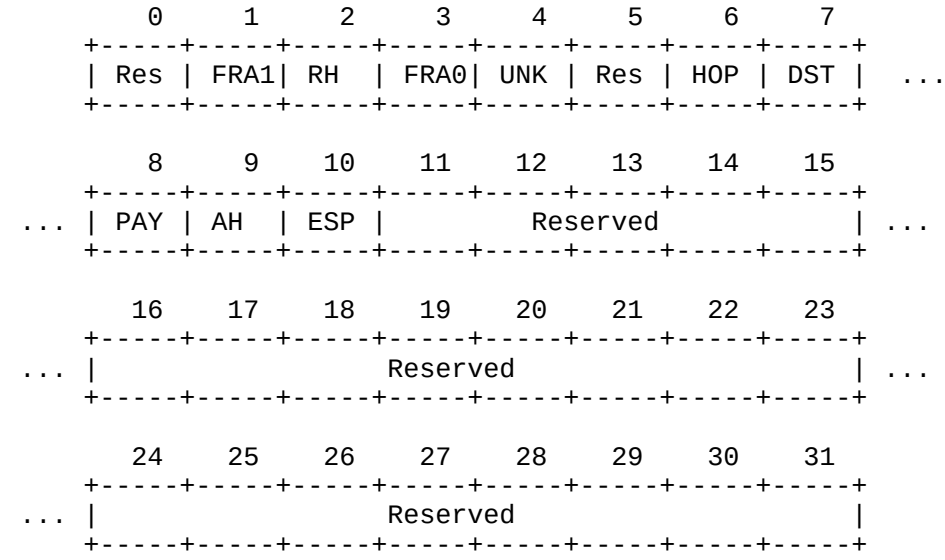
Bit	Type Value	Option Name	Reference
0	0	EOOL	End of Options List, RFC 791
1	1	NOP	No Operation, RFC 791
2	130	SEC	Security, RFC 1108
3	131	LSR	Loose Source Route, RFC 791
4	68	TS	Time Stamp, RFC 791
5	133	E-SEC	Extended Security, RFC 1108
6	134	CIPSO	Commercial Security
7	7	RR	Record Route, RFC 791
8	136	SID	Stream ID, RFC 791
9	137	SSR	Strict Source Route, RFC 791
10	10	ZSU	Experimental Measurement
11	11	MTUP	(obsoleted) MTU Probe, RFC 1191
12	12	MTUR	(obsoleted) MTU Reply, RFC 1191
13	205	FINN	Experimental Flow Control
14	142	VISA	Experimental Access Control
15	15	ENCODE	
16	144	IMITD	IMI Traffic Descriptor
17	145	EIP	Extended Internet Protocol, RFC 1385
18	82	TR	Traceroute, RFC 3193
19	147	ADDEXT	Address Extension
20	148	RTRALT	Router Alert, RFC 2113
21	149	SDB	Selective Directed Broadcast
22	150	NSAPA	NSAP Address
23	151	DPS	Dynamic Packet State
24	152	UMP	Upstream Multicast Pkt.
25	25	QS	Quick-Start
30	30	EXP	RFC3692-style Experiment
30	94	EXP	RFC3692-style Experiment
30	158	EXP	RFC3692-style Experiment
30	222	EXP	RFC3692-style Experiment
...	...	...	Further options numbers may be assigned by IANA

Abstract Data Type: unsigned32
Data Type Semantics: flags
ElementId: 208

Status: current
Reference:
See RFC 791 for the definition of IPv4 options. See the list of IPv4 option numbers assigned by IANA at http://www.iana.org/assignments/ip-parameters.

5.8.6. ipv6ExtensionHeaders

Description:
IPv6 extension headers observed in packets of this Flow. The information is encoded in a set of bit fields. For each IPv6 option header, there is a bit in this set. The bit is set to 1 if any observed packet of this Flow contains the corresponding IPv6 extension header. Otherwise, if no observed packet of this Flow contained the respective IPv6 extension header, the value of the corresponding bit is 0.



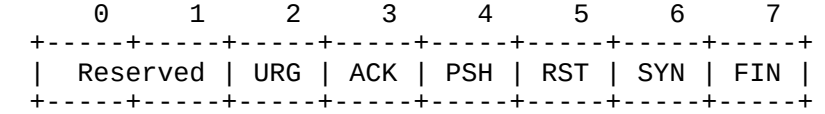
Bit	IPv6 Option	Description
0, Res		Reserved
1, FRA1	44	Fragmentation header - not first fragment
2, RH	43	Routing header
3, FRA0	44	Fragment header - first fragment
4, UNK		Unknown Layer 4 header (compressed, encrypted, not supported)
5, Res		Reserved
6, HOP	0	Hop-by-hop option header
7, DST	60	Destination option header

8, PAY	108	Payload compression header
9, AH	51	Authentication Header
10, ESP	50	Encrypted security payload
11 to 31		Reserved

Abstract Data Type: unsigned32
Data Type Semantics: flags
ElementId: 64
Status: current
Reference:
See RFC 2460 for the general definition of IPv6 extension headers and for the specification of the hop-by-hop options header, the routing header, the fragment header, and the destination options header. See RFC 4302 for the specification of the authentication header. See RFC 4303 for the specification of the encapsulating security payload.

5.8.7. tcpControlBits

Description:
TCP control bits observed for packets of this Flow. The information is encoded in a set of bit fields. For each TCP control bit, there is a bit in this set. A bit is set to 1 if any observed packet of this Flow has the corresponding TCP control bit set to 1. A value of 0 for a bit indicates that the corresponding bit was not set in any of the observed packets of this Flow.

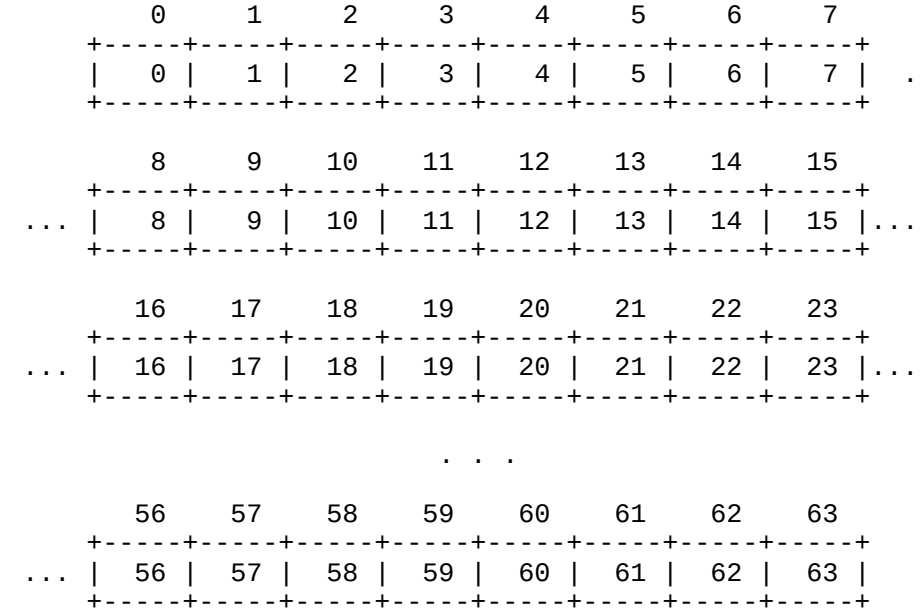


Reserved: Reserved for future use by TCP. Must be zero.
URG: Urgent Pointer field significant
ACK: Acknowledgment field significant
PSH: Push Function
RST: Reset the connection
SYN: Synchronize sequence numbers
FIN: No more data from sender

Abstract Data Type: unsigned8
Data Type Semantics: flags
ElementId: 6
Status: current
Reference:
See RFC 793 for the definition of the TCP control bits in the TCP header.

5.8.8. tcpOptions

Description:
TCP options in packets of this Flow. The information is encoded in a set of bit fields. For each TCP option, there is a bit in this set. The bit is set to 1 if any observed packet of this Flow contains the corresponding TCP option. Otherwise, if no observed packet of this Flow contained the respective TCP option, the value of the corresponding bit is 0.
Options are mapped to bits according to their option numbers. Option number X is mapped to bit X. TCP option numbers are maintained by IANA.



Abstract Data Type: unsigned64
Data Type Semantics: flags
ElementId: 209
Status: current
Reference:
See RFC 793 for the definition of TCP options. See the list of TCP option numbers assigned by IANA at http://www.iana.org/assignments/tcp-parameters.

5.9. Flow Timestamps

Information Elements in this section are timestamps of events.

Timestamps flowStartSeconds, flowEndSeconds, flowStartMilliseconds, flowEndMilliseconds, flowStartMicroseconds, flowEndMicroseconds, flowStartNanoseconds, flowEndNanoseconds, and systemInitTimeMilliseconds are absolute and have a well-defined fixed time base, such as, for example, the number of seconds since 0000 UTC Jan 1st 1970.

Timestamps flowStartDeltaMicroseconds and flowEndDeltaMicroseconds are relative timestamps only valid within the scope of a single IPFIX Message. They contain the negative time offsets relative to the export time specified in the IPFIX Message Header. The maximum time offset that can be encoded by these delta counters is 1 hour, 11 minutes, and 34.967295 seconds.

Timestamps flowStartSysUpTime and flowEndSysUpTime are relative timestamps indicating the time relative to the last (re-)initialization of the IPFIX Device. For reporting the time of the last (re-)initialization, systemInitTimeMilliseconds can be reported, for example, in Data Records defined by Option Templates.

ID	Name	ID	Name
150	flowStartSeconds	156	flowStartNanoseconds
151	flowEndSeconds	157	flowEndNanoseconds
152	flowStartMilliseconds	158	flowStartDeltaMicroseconds
153	flowEndMilliseconds	159	flowEndDeltaMicroseconds
154	flowStartMicroseconds	160	systemInitTimeMilliseconds
155	flowEndMicroseconds	22	flowStartSysUpTime
		21	flowEndSysUpTime

5.9.1. flowStartSeconds

Description:
The absolute timestamp of the first packet of this Flow.
Abstract Data Type: dateTimeSeconds
ElementId: 150
Status: current
Units: seconds

5.9.2. flowEndSeconds

Description:
The absolute timestamp of the last packet of this Flow.
Abstract Data Type: dateTimeSeconds
ElementId: 151
Status: current
Units: seconds

5.9.3. flowStartMilliseconds

Description:
The absolute timestamp of the first packet of this Flow.
Abstract Data Type: dateTimeMilliseconds
ElementId: 152
Status: current
Units: milliseconds

5.9.4. flowEndMilliseconds

Description:
The absolute timestamp of the last packet of this Flow.
Abstract Data Type: dateTimeMilliseconds
ElementId: 153
Status: current
Units: milliseconds

5.9.5. flowStartMicroseconds

Description:
The absolute timestamp of the first packet of this Flow.
Abstract Data Type: dateTimeMicroseconds
ElementId: 154
Status: current
Units: microseconds

5.9.6. flowEndMicroseconds

Description:
The absolute timestamp of the last packet of this Flow.
Abstract Data Type: dateTimeMicroseconds
ElementId: 155
Status: current
Units: microseconds

5.9.7. flowStartNanoseconds

Description:
The absolute timestamp of the first packet of this Flow.
Abstract Data Type: dateTimeNanoseconds
ElementId: 156
Status: current
Units: nanoseconds

5.9.8. flowEndNanoseconds

Description:
The absolute timestamp of the last packet of this Flow.
Abstract Data Type: dateTimeNanoseconds
ElementId: 157
Status: current
Units: nanoseconds

5.9.9. flowStartDeltaMicroseconds

Description:
This is a relative timestamp only valid within the scope of a single IPFIX Message. It contains the negative time offset of the first observed packet of this Flow relative to the export time specified in the IPFIX Message Header.
Abstract Data Type: unsigned32
ElementId: 158
Status: current
Units: microseconds
Reference:
See the IPFIX protocol specification [RFC5101] for the definition of the IPFIX Message Header.

5.9.10. flowEndDeltaMicroseconds

Description:
This is a relative timestamp only valid within the scope of a single IPFIX Message. It contains the negative time offset of the last observed packet of this Flow relative to the export time specified in the IPFIX Message Header.
Abstract Data Type: unsigned32
ElementId: 159
Status: current
Units: microseconds
Reference:
See the IPFIX protocol specification [RFC5101] for the definition of the IPFIX Message Header.

5.9.11. systemInitTimeMilliseconds

Description:
The absolute timestamp of the last (re-)initialization of the IPFIX Device.
Abstract Data Type: dateTimeMilliseconds
ElementId: 160
Status: current
Units: milliseconds

5.9.12. flowStartSysUpTime

Description:
The relative timestamp of the first packet of this Flow. It indicates the number of milliseconds since the last (re-)initialization of the IPFIX Device (sysUpTime).
Abstract Data Type: unsigned32
ElementId: 22
Status: current
Units: milliseconds

5.9.13. flowEndSysUpTime

Description:
The relative timestamp of the last packet of this Flow. It indicates the number of milliseconds since the last (re-)initialization of the IPFIX Device (sysUpTime).
Abstract Data Type: unsigned32
ElementId: 21
Status: current
Units: milliseconds

5.10. Per-Flow Counters

Information Elements in this section are counters all having integer values. Their values may change for every report they are used in. They cannot serve as part of a Flow Key used for mapping packets to Flows. However, potentially they can be used for selecting exported Flows, for example, by only exporting Flows with more than a threshold number of observed octets.

There are running counters and delta counters. Delta counters are reset to zero each time their values are exported. Running counters continue counting independently of the Exporting Process.

There are per-Flow counters and counters related to the Metering Process and/or the Exporting Process. Per-Flow counters are Flow properties that potentially change each time a packet belonging to

the Flow is observed. The set of per-Flow counters includes the Information Elements listed in the table below. Counters related to the Metering Process and/or the Exporting Process are described in Section 5.3.

ID	Name	ID	Name
1	octetDeltaCount	134	droppedOctetTotalCount
23	postOctetDeltaCount	135	droppedPacketTotalCount
198	octetDeltaSumOfSquares	19	postMCastPacketDeltaCount
85	octetTotalCount	20	postMCastOctetDeltaCount
171	postOctetTotalCount	174	postMCastPacketTotalCount
199	octetTotalSumOfSquares	175	postMCastOctetTotalCount
2	packetDeltaCount	218	tcpSynTotalCount
24	postPacketDeltaCount	219	tcpFinTotalCount
86	packetTotalCount	220	tcpRstTotalCount
172	postPacketTotalCount	221	tcpPshTotalCount
132	droppedOctetDeltaCount	222	tcpAckTotalCount
133	droppedPacketDeltaCount	223	tcpUrgTotalCount

5.10.1. octetDeltaCount

Description:
The number of octets since the previous report (if any) in incoming packets for this Flow at the Observation Point. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 1
Status: current
Units: octets

5.10.2. postOctetDeltaCount

Description:
The definition of this Information Element is identical to the definition of Information Element 'octetDeltaCount', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 23
Status: current
Units: octets

5.10.3. octetDeltaSumOfSquares

Description:
The sum of the squared numbers of octets per incoming packet since the previous report (if any) for this Flow at the Observation Point. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
ElementId: 198
Status: current

5.10.4. octetTotalCount

Description:
The total number of octets in incoming packets for this Flow at the Observation Point since the Metering Process (re-)initialization for this Observation Point. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 85
Status: current
Units: octets

5.10.5. postOctetTotalCount

Description:
The definition of this Information Element is identical to the definition of Information Element 'octetTotalCount', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 171
Status: current
Units: octets

5.10.6. octetTotalSumOfSquares

Description:
The total sum of the squared numbers of octets in incoming packets for this Flow at the Observation Point since the Metering Process (re-)initialization for this Observation Point. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
ElementId: 199
Status: current
Units: octets

5.10.7. packetDeltaCount

Description:
The number of incoming packets since the previous report (if any) for this Flow at the Observation Point.

Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 2
Status: current
Units: packets

5.10.8. postPacketDeltaCount

Description:
The definition of this Information Element is identical to the definition of Information Element 'packetDeltaCount', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 24
Status: current
Units: packets

5.10.9. packetTotalCount

Description:
The total number of incoming packets for this Flow at the Observation Point since the Metering Process (re-)initialization for this Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 86
Status: current
Units: packets

5.10.10. postPacketTotalCount

Description:
The definition of this Information Element is identical to the definition of Information Element 'packetTotalCount', except that it reports a potentially modified value caused by a middlebox function after the packet passed the Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 172
Status: current
Units: packets

5.10.11. droppedOctetDeltaCount

Description:
The number of octets since the previous report (if any) in packets of this Flow dropped by packet treatment. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 132
Status: current
Units: octets

5.10.12. droppedPacketDeltaCount

Description:
The number of packets since the previous report (if any) of this Flow dropped by packet treatment.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 133
Status: current
Units: packets

5.10.13. droppedOctetTotalCount

Description:
The total number of octets in packets of this Flow dropped by packet treatment since the Metering Process (re-)initialization for this Observation Point. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 134
Status: current
Units: octets

5.10.14. droppedPacketTotalCount

Description:
The number of packets of this Flow dropped by packet treatment since the Metering Process (re-)initialization for this Observation Point.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 135
Status: current
Units: packets

5.10.15. postMCastPacketDeltaCount

Description:
The number of outgoing multicast packets since the previous report (if any) sent for packets of this Flow by a multicast daemon within the Observation Domain. This property cannot necessarily be observed at the Observation Point, but may be retrieved by other means.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 19
Status: current
Units: packets

5.10.16. postMCastOctetDeltaCount

Description:
The number of octets since the previous report (if any) in outgoing multicast packets sent for packets of this Flow by a multicast daemon within the Observation Domain. This property cannot necessarily be observed at the Observation Point, but may be retrieved by other means. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: deltaCounter
ElementId: 20
Status: current
Units: octets

5.10.17. postMCastPacketTotalCount

Description:
The total number of outgoing multicast packets sent for packets of this Flow by a multicast daemon within the Observation Domain since the Metering Process (re-)initialization. This property cannot necessarily be observed at the Observation Point, but may be retrieved by other means.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 174
Status: current
Units: packets

5.10.18. postMCastOctetTotalCount

Description:
The total number of octets in outgoing multicast packets sent for packets of this Flow by a multicast daemon in the Observation Domain since the Metering Process (re-)initialization. This property cannot necessarily be observed at the Observation Point, but may be retrieved by other means. The number of octets includes IP header(s) and IP payload.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 175
Status: current
Units: octets

5.10.19. tcpSynTotalCount

Description:
The total number of packets of this Flow with TCP "Synchronize sequence numbers" (SYN) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 218
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP SYN flag.

5.10.20. tcpFinTotalCount

Description:
The total number of packets of this Flow with TCP "No more data from sender" (FIN) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 219
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP FIN flag.

5.10.21. tcpRstTotalCount

Description:
The total number of packets of this Flow with TCP "Reset the connection" (RST) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 220
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP RST flag.

5.10.22. tcpPshTotalCount

Description:
The total number of packets of this Flow with TCP "Push Function" (PSH) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 221
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP PSH flag.

5.10.23. tcpAckTotalCount

Description:
The total number of packets of this Flow with TCP "Acknowledgment field significant" (ACK) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 222
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP ACK flag.

5.10.24. tcpUrgTotalCount

Description:
The total number of packets of this Flow with TCP "Urgent Pointer field significant" (URG) flag set.
Abstract Data Type: unsigned64
Data Type Semantics: totalCounter
ElementId: 223
Status: current
Units: packets
Reference:
See RFC 793 for the definition of the TCP URG flag.

5.11. Miscellaneous Flow Properties

Information Elements in this section describe properties of Flows that are related to Flow start, Flow duration, and Flow termination, but they are not timestamps as the Information Elements in Section 5.9 are.

ID	Name	ID	Name
36	flowActiveTimeout	161	flowDurationMilliseconds
37	flowIdleTimeout	162	flowDurationMicroseconds
136	flowEndReason	61	flowDirection

5.11.1. flowActiveTimeout

Description:
The number of seconds after which an active Flow is timed out anyway, even if there is still a continuous flow of packets.
Abstract Data Type: unsigned16
ElementId: 36
Status: current
Units: seconds

5.11.2. flowIdleTimeout

Description:
A Flow is considered to be timed out if no packets belonging to the Flow have been observed for the number of seconds specified by this field.
Abstract Data Type: unsigned16
ElementId: 37
Status: current
Units: seconds

5.11.3. flowEndReason

Description:
The reason for Flow termination. The range of values includes the following:

0x01: idle timeout
The Flow was terminated because it was considered to be idle.

0x02: active timeout
The Flow was terminated for reporting purposes while it was still active, for example, after the maximum lifetime of unreported Flows was reached.

0x03: end of Flow detected
The Flow was terminated because the Metering Process detected signals indicating the end of the Flow, for example, the TCP FIN flag.

0x04: forced end
The Flow was terminated because of some external event, for example, a shutdown of the Metering Process initiated by a network management application.

0x05: lack of resources
The Flow was terminated because of lack of resources available to the Metering Process and/or the Exporting Process.

Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 136
Status: current

5.11.4. flowDurationMilliseconds

Description:
The difference in time between the first observed packet of this Flow and the last observed packet of this Flow.
Abstract Data Type: unsigned32
ElementId: 161
Status: current
Units: milliseconds

5.11.5. flowDurationMicroseconds

Description:
The difference in time between the first observed packet of this Flow and the last observed packet of this Flow.
Abstract Data Type: unsigned32
ElementId: 162
Status: current
Units: microseconds

5.11.6. flowDirection

Description:
The direction of the Flow observed at the Observation Point. There are only two values defined.

0x00: ingress flow
0x01: egress flow

Abstract Data Type: unsigned8
Data Type Semantics: identifier
ElementId: 61
Status: current

5.12. Padding

This section contains a single Information Element that can be used for padding of Flow Records.

IPFIX implementations may wish to align Information Elements within Data Records or to align entire Data Records to 4-octet or 8-octet boundaries. This can be achieved by including one or more paddingOctets Information Elements in a Data Record.

ID	Name	ID	Name
210	paddingOctets		

5.12.1. paddingOctets

Description:
The value of this Information Element is always a sequence of 0x00 values.
Abstract Data Type: octetArray
ElementId: 210
Status: current

6. Extending the Information Model

A key requirement for IPFIX is to allow for extending the set of Information Elements that are reported. This section defines the mechanism for extending this set.

Extension can be done by defining new Information Elements. Each new Information Element MUST be assigned a unique Information Element identifier as part of its definition. These unique Information Element identifiers are the connection between the record structure communicated by the protocol using Templates and a consuming application. For generally applicable Information Elements, using IETF and IANA mechanisms to extend the information model is RECOMMENDED.

Names of new Information Elements SHOULD be chosen according to the naming conventions given in Section 2.3.

For extensions, the type space defined in Section 3 can be used. If required, new abstract data types can be added. New abstract data types MUST be defined in IETF Standards Track documents.

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.

However, before creating enterprise-specific Information Elements, the general applicability of such Information Elements should be considered. IPFIX does not support enterprise-specific abstract data types.

7. IANA Considerations

7.1. IPFIX Information Elements

This document specifies an initial set of IPFIX Information Elements. The list of these Information Elements with their identifiers is given in Section 4. The Internet Assigned Numbers Authority (IANA) has created a new registry for IPFIX Information Element identifiers and filled it with the initial list in Section 4.

New assignments for IPFIX Information Elements will be administered by IANA through Expert Review [RFC2434], i.e., review by one of a group of experts designated by an IETF Area Director. The group of experts MUST check the requested Information Element for completeness and accuracy of the description and for correct naming according to the naming conventions in Section 2.3. Requests for Information Elements that duplicate the functionality of existing Information Elements SHOULD be declined. The smallest available identifier SHOULD be assigned to a new Information Element.

The specification of new IPFIX Information Elements MUST use the template specified in Section 2.1 and MUST be published using a well-established and persistent publication medium. The experts will initially be drawn from the Working Group Chairs and document editors of the IPFIX and PSAMP Working Groups.

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 extensibility of this information, IANA has created a new registry for MPLS label types and filled it with the initial list from the description Information Element #46, mplsTopLabelType.

New assignments for MPLS label types will be administered by IANA through Expert Review [RFC2434], 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

Appendix B defines an XML schema for IPFIX Information Element definitions. All Information Elements specified in this document are defined by the XML specification in Appendix A that is a valid XML record according to the schema in Appendix B. This schema may also be used for specifying further Information Elements in future extensions of the IPFIX information model in a machine-readable way.

Appendix B uses URNs to describe an XML namespace and an XML schema for IPFIX Information Elements conforming to a registry mechanism described in [RFC3688]. Two URI assignments have been made.

1. Registration for the IPFIX information model namespace
   * URI: urn:ietf:params:xml:ns:ipfix-info-15
   * Registrant Contact: IETF IPFIX Working Group <ipfix@ietf.org>, as designated by the IESG <iesg@ietf.org>.
   * XML: None. Namespace URIs do not represent an XML.

2. Registration for the IPFIX information model schema
   * URI: urn:ietf:params:xml:schema:ipfix-info-15
   * Registrant Contact: IETF IPFIX Working Group <ipfix@ietf.org>, as designated by the IESG <iesg@ietf.org>.
   * XML: See Appendix B of this document.

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, which 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. Such protocols are defined in separate documents, specifically the IPFIX protocol document [RFC5101].

This document does not specify any Information Element carrying keying material. If future extensions will do so, then appropriate precautions need to be taken for properly protecting such sensitive information.

9. Acknowledgements

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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.

[RFC5101] Claise, B., "Specification of the IPFIX Protocol for the Exchange", RFC 5101, January 2008.

10.2. Informative References

[IEEE.754.1985]
Institute of Electrical and Electronics Engineers, "Standard for Binary Floating-Point Arithmetic", IEEE Standard 754, August 1985.

[IEEE.802-11.1999]
"Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications", IEEE Standard 802.11, 1999, <http://standards.ieee.org/getieee802/download/802.11-1999.pdF>.

[IEEE.802-1Q.2003]
Institute of Electrical and Electronics Engineers, "Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks", IEEE Standard 802.1Q, March 2003.

[IEEE.802-3.2002]
"Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications", IEEE Standard 802.3, September 2002.

[ISO.10646-1.1993]
International Organization for Standardization, "Information Technology - Universal Multiple-octet coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane", ISO Standard 10646-1, May 1993.

[ISO.646.1991]
International Organization for Standardization, "Information technology - ISO 7-bit coded character set for information interchange", ISO Standard 646, 1991.

[RFC0768] Postel, J., "User Datagram Protocol", STD 6, RFC 768, August 1980.

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

[RFC0792] Postel, J., "Internet Control Message Protocol", STD 5, RFC 792, September 1981.

[RFC0793] Postel, J., "Transmission Control Protocol", STD 7, RFC 793, September 1981.

[RFC1108] Kent, S., "U.S. Department of Defense Security Options for the Internet Protocol", RFC 1108, November 1991.

[RFC1112] Deering, S., "Host extensions for IP multicasting", STD 5, RFC 1112, August 1989.

[RFC1191] Mogul, J. and S. Deering, "Path MTU discovery", RFC 1191, November 1990.

[RFC1323] Jacobson, V., Braden, R., and D. Borman, "TCP Extensions for High Performance", RFC 1323, May 1992.

[RFC1385] Wang, Z., "EIP: The Extended Internet Protocol", RFC 1385, November 1992.

[RFC1812] Baker, F., Ed., "Requirements for IP Version 4 Routers", RFC 1812, June 1995.

[RFC1930] Hawkinson, J. and T. Bates, "Guidelines for creation, selection, and registration of an Autonomous System (AS)", BCP 6, RFC 1930, March 1996.

[RFC2113] Katz, D., "IP Router Alert Option", RFC 2113, February 1997.

[RFC2434] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 2434, October 1998.

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

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

[RFC2629] Rose, M., "Writing I-Ds and RFCs using XML", RFC 2629, June 1999.

[RFC2675] Borman, D., Deering, S., and R. Hinden, "IPv6 Jumbograms", RFC 2675, August 1999.

[RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.

[RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031, January 2001.

[RFC3032] Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y., Farinacci, D., Li, T., and A. Conta, "MPLS Label Stack Encoding", RFC 3032, January 2001.

[RFC3193] Patel, B., Aboba, B., Dixon, W., Zorn, G., and S. Booth, "Securing L2TP using IPsec", RFC 3193, November 2001.

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

[RFC3260] Grossman, D., "New Terminology and Clarifications for Diffserv", RFC 3260, April 2002.

[RFC3270] Le Faucheur, F., Wu, L., Davie, B., Davari, S., Vaananen, P., Krishnan, R., Cheval, P., and J. Heinanen, "Multi-Protocol Label Switching (MPLS) Support of Differentiated Services", RFC 3270, May 2002.

[RFC3376] Cain, B., Deering, S., Kouvelas, I., Fenner, B., and A. Thyagarajan, "Internet Group Management Protocol, Version 3", RFC 3376, October 2002.

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

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, January 2004.

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

[RFC4271] Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A Border Gateway Protocol 4 (BGP-4)", RFC 4271, January 2006.

[RFC4291] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", RFC 4291, February 2006.

[RFC4302] Kent, S., "IP Authentication Header", RFC 4302, December 2005.

[RFC4303] Kent, S., "IP Encapsulating Security Payload (ESP)", RFC 4303, December 2005.

[RFC4364] Rosen, E. and Y. Rekhter, "BGP/MPLS IP Virtual Private Networks (VPNs)", RFC 4364, February 2006.

[RFC4382] Nadeau, T., Ed., and H. van der Linde, Ed., "MPLS/BGP Layer 3 Virtual Private Network (VPN) Management Information Base", RFC 4382, February 2006.

[RFC4443] Conta, A., Deering, S., and M. Gupta, Ed., "Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification", RFC 4443, March 2006.

[RFC4960] Stewart, R., Ed., "Stream Control Transmission Protocol", RFC 4960, September 2007.

[RFC5036] Andersson, L., Ed., Minei, I., Ed., and B. Thomas, Ed., "LDP Specification", RFC 5036, October 2007.

Appendix A. XML Specification of IPFIX Information Elements

This appendix contains a machine-readable description of the IPFIX information model coded in XML. Note that this appendix is of informational nature, while the text in Section 4 (generated from this appendix) is normative.

Using a machine-readable syntax for the information model enables the creation of IPFIX-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 document 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 IPFIX. In particular, Exporting Processes do not produce or consume XML as part of their operation. It is expected that IPFIX Collectors MAY take advantage of the machine readability of the information model vs. hard coding their behavior or inventing proprietary means for accommodating extensions.

```
<?xml version="1.0" encoding="UTF-8"?>

<fieldDefinitions xmlns="urn:ietf:params:xml:ns:ipfix-info"
             xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
             xsi:schemaLocation="urn:ietf:params:xml:ns:ipfix-info
             ipfix-info.xsd">

  <field name="lineCardId" dataType="unsigned32"
         group="scope"
         dataTypeSemantics="identifier"
         elementId="141" applicability="option" status="current">
    <description>
      <paragraph>
        An identifier of a line card that is unique per IPFIX
        Device hosting an Observation Point.  Typically, this
        Information Element is used for limiting the scope
        of other Information Elements.
      </paragraph>
    </description>
  </field>
  <field name="portId" dataType="unsigned32"
```

```
          group="scope"
          dataTypeSemantics="identifier"
          elementId="142" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of a line port that is unique per IPFIX
          Device hosting an Observation Point.  Typically, this
          Information Element is used for limiting the scope
          of other Information Elements.
        </paragraph>
      </description>
    </field>

    <field name="ingressInterface" dataType="unsigned32"
          group="scope"
          dataTypeSemantics="identifier"
          elementId="10" applicability="all" status="current">
      <description>
        <paragraph>
          The index of the IP interface where packets of this Flow
          are being received.  The value matches the value of managed
          object 'ifIndex' as defined in RFC 2863.
          Note that ifIndex values are not assigned statically to an
          interface and that the interfaces may be renumbered every
          time the device's management system is re-initialized, as
          specified in RFC 2863.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2863 for the definition of the ifIndex object.
        </paragraph>
      </reference>
    </field>

    <field name="egressInterface" dataType="unsigned32"
          group="scope"
          dataTypeSemantics="identifier"
          elementId="14" applicability="all" status="current">
      <description>
        <paragraph>
          The index of the IP interface where packets of
          this Flow are being sent.  The value matches the value of
          managed object 'ifIndex' as defined in RFC 2863.
          Note that ifIndex values are not assigned statically to an
          interface and that the interfaces may be renumbered every
          time the device's management system is re-initialized, as
          specified in RFC 2863.
```

```
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2863 for the definition of the ifIndex object.
        </paragraph>
      </reference>
    </field>

    <field name="meteringProcessId" dataType="unsigned32"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="143" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of a Metering Process that is unique per
          IPFIX Device.  Typically, this Information Element is used
          for limiting the scope of other Information Elements.
          Note that process identifiers are typically assigned
          dynamically.
          The Metering Process may be re-started with a different ID.
        </paragraph>
      </description>
    </field>

    <field name="exportingProcessId" dataType="unsigned32"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="144" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of an Exporting Process that is unique per
          IPFIX Device.  Typically, this Information Element is used
          for limiting the scope of other Information Elements.
          Note that process identifiers are typically assigned
          dynamically.  The Exporting Process may be re-started
          with a different ID.
        </paragraph>
      </description>
    </field>

    <field name="flowId" dataType="unsigned64"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="148" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of a Flow that is unique within an Observation
```

```
          Domain.  This Information Element can be used to distinguish
          between different Flows if Flow Keys such as IP addresses and
          port numbers are not reported or are reported in separate
          records.
        </paragraph>
      </description>
    </field>

    <field name="templateId" dataType="unsigned16"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="145" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of a Template that is locally unique within a
          combination of a Transport session and an Observation Domain.
        </paragraph>
        <paragraph>
          Template IDs 0-255 are reserved for Template Sets, Options
          Template Sets, and other reserved Sets yet to be created.
          Template IDs of Data Sets are numbered from 256 to 65535.
        </paragraph>
        <paragraph>
          Typically, this Information Element is used for limiting
          the scope of other Information Elements.
          Note that after a re-start of the Exporting Process Template
          identifiers may be re-assigned.
        </paragraph>
      </description>
    </field>

    <field name="observationDomainId" dataType="unsigned32"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="149" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of an Observation Domain that is locally
          unique to an Exporting Process.  The Exporting Process uses
          the Observation Domain ID to uniquely identify to the
          Collecting Process the Observation Domain where Flows
          were metered.  It is RECOMMENDED that this identifier is
          also unique per IPFIX Device.
        </paragraph>
        <paragraph>
          A value of 0 indicates that no specific Observation Domain
          is identified by this Information Element.
        </paragraph>
```

```
        <paragraph>
          Typically, this Information Element is used for limiting
          the scope of other Information Elements.
        </paragraph>
      </description>
    </field>

    <field name="observationPointId" dataType="unsigned32"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="138" applicability="option" status="current">
      <description>
        <paragraph>
        An identifier of an Observation Point that is unique per
        Observation Domain.  It is RECOMMENDED that this identifier is
        also unique per IPFIX Device.  Typically, this Information
        Element is used for limiting the scope of other Information
        Elements.
        </paragraph>
      </description>
    </field>
    <field name="commonPropertiesId" dataType="unsigned64"
           group="scope"
           dataTypeSemantics="identifier"
           elementId="137" applicability="option" status="current">
      <description>
        <paragraph>
          An identifier of a set of common properties that is
          unique per Observation Domain and Transport Session.
          Typically, this Information Element is used to link to
          information reported in separate Data Records.
        </paragraph>
      </description>
    </field>

    <field name="exporterIPv4Address" dataType="ipv4Address"
           dataTypeSemantics="identifier"
           group="config"
           elementId="130" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv4 address used by the Exporting Process.  This is used
        by the Collector to identify the Exporter in cases where the
        identity of the Exporter may have been obscured by the use of
        a proxy.
        </paragraph>
      </description>
    </field>
```

```
<field name="exporterIPv6Address" dataType="ipv6Address"
       dataTypeSemantics="identifier"
       group="config"
       elementId="131" applicability="all" status="current">
  <description>
    <paragraph>
    The IPv6 address used by the Exporting Process.  This is used
    by the Collector to identify the Exporter in cases where the
    identity of the Exporter may have been obscured by the use of
    a proxy.
    </paragraph>
  </description>
</field>

<field name="exporterTransportPort" dataType="unsigned16"
       group="config"
       dataTypeSemantics="identifier"
       elementId="217" applicability="all" status="current">
  <description>
    <paragraph>
    The source port identifier from which the Exporting
    Process sends Flow information.  For the transport protocols
    UDP, TCP, and SCTP, this is the source port number.
    This field MAY also be used for future transport protocols
    that have 16-bit source port identifiers.  This field may
    be useful for distinguishing multiple Exporting Processes
    that use the same IP address.
    </paragraph>
  </description>
  <reference>
    <paragraph>
    See RFC 768 for the definition of the UDP
    source port field.
    See RFC 793 for the definition of the TCP
    source port field.
    See RFC 4960 for the definition of SCTP.
    </paragraph>
    <paragraph>
    Additional information on defined UDP and TCP port numbers can
    be found at http://www.iana.org/assignments/port-numbers.
    </paragraph>
  </reference>
</field>

<field name="collectorIPv4Address" dataType="ipv4Address"
       dataTypeSemantics="identifier"
       group="config"
       elementId="211" applicability="all" status="current">
```

```
      <description>
        <paragraph>
        An IPv4 address to which the Exporting Process sends Flow
        information.
        </paragraph>
      </description>
    </field>

    <field name="collectorIPv6Address" dataType="ipv6Address"
           dataTypeSemantics="identifier"
           group="config"
           elementId="212" applicability="all" status="current">
      <description>
        <paragraph>
        An IPv6 address to which the Exporting Process sends Flow
        information.
        </paragraph>
      </description>
    </field>

    <field name="exportInterface" dataType="unsigned32"
           group="config"
           dataTypeSemantics="identifier"
           elementId="213" applicability="all" status="current">
      <description>
        <paragraph>
          The index of the interface from which IPFIX Messages sent
          by the Exporting Process to a Collector leave the IPFIX
          Device.  The value matches the value of
          managed object 'ifIndex' as defined in RFC 2863.
          Note that ifIndex values are not assigned statically to an
          interface and that the interfaces may be renumbered every
          time the device's management system is re-initialized, as
          specified in RFC 2863.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2863 for the definition of the ifIndex object.
        </paragraph>
      </reference>
    </field>

    <field name="exportProtocolVersion" dataType="unsigned8"
           dataTypeSemantics="identifier"
           group="config"
           elementId="214" applicability="all" status="current">
      <description>
```

```
        <paragraph>
          The protocol version used by the Exporting Process for
          sending Flow information.  The protocol version is given
          by the value of the Version Number field in the Message
          Header.
        </paragraph>
        <paragraph>
          The protocol version is 10 for IPFIX and 9 for NetFlow
          version 9.
          A value of 0 indicates that no export protocol is in use.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See the IPFIX protocol specification [RFC5101] for the
        definition of the IPFIX Message Header.
        </paragraph>
        <paragraph>
        See RFC 3954 for the definition of the NetFlow
        version 9 message header.
        </paragraph>
      </reference>
    </field>

    <field name="exportTransportProtocol" dataType="unsigned8"
           group="config"
           dataTypeSemantics="identifier"
           elementId="215" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the protocol number used by the Exporting Process
        for sending Flow information.
        The protocol number identifies the IP packet payload type.
        Protocol numbers are defined in the IANA Protocol Numbers
        registry.
        </paragraph>

        <paragraph>
        In Internet Protocol version 4 (IPv4), this is carried in the
        Protocol field.  In Internet Protocol version 6 (IPv6), this
        is carried in the Next Header field in the last extension
        header of the packet.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the IPv4
        protocol field.
```

```
        See RFC 2460 for the specification of the IPv6
        protocol field.
        See the list of protocol numbers assigned by IANA at
        http://www.iana.org/assignments/protocol-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="collectorTransportPort" dataType="unsigned16"
           group="config"
           dataTypeSemantics="identifier"
           elementId="216" applicability="all" status="current">
      <description>
        <paragraph>
        The destination port identifier to which the Exporting
        Process sends Flow information.  For the transport protocols
        UDP, TCP, and SCTP, this is the destination port number.
        This field MAY also be used for future transport protocols
        that have 16-bit source port identifiers.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the definition of the UDP
        destination port field.
        See RFC 793 for the definition of the TCP
        destination port field.
        See RFC 4960 for the definition of SCTP.
        </paragraph>
        <paragraph>
        Additional information on defined UDP and TCP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="flowKeyIndicator" dataType="unsigned64"
           dataTypeSemantics="flags"
           group="config"
           elementId="173" applicability="all" status="current">
      <description>
        <paragraph>
        This set of bit fields is used for marking the Information
        Elements of a Data Record that serve as Flow Key.  Each bit
        represents an Information Element in the Data Record with
        the n-th bit representing the n-th Information Element.
        A bit set to value 1 indicates that the corresponding
        Information Element is a Flow Key of the reported Flow.
```

```
        A bit set to value 0 indicates that this is not the case.
        </paragraph>
        <paragraph>
        If the Data Record contains more than 64 Information Elements,
        the corresponding Template SHOULD be designed such that all
        Flow Keys are among the first 64 Information Elements, because
        the flowKeyIndicator only contains 64 bits.  If the Data Record
        contains less than 64 Information Elements, then the bits in
        the flowKeyIndicator for which no corresponding Information
        Element exists MUST have the value 0.
        </paragraph>
      </description>
    </field>

    <field name="exportedMessageTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="41" applicability="data" status="current">
      <description>
        <paragraph>
          The total number of IPFIX Messages that the Exporting Process
          has sent since the Exporting Process (re-)initialization to
          a particular Collecting Process.
          The reported number excludes the IPFIX Message that carries
          the counter value.
          If this Information Element is sent to a particular
          Collecting Process, then by default it specifies the number
          of IPFIX Messages sent to this Collecting Process.
        </paragraph>
      </description>
      <units>messages</units>
    </field>

    <field name="exportedOctetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="40" applicability="data" status="current">
      <description>
        <paragraph>
          The total number of octets that the Exporting Process
          has sent since the Exporting Process (re-)initialization
          to a particular Collecting Process.
          The value of this Information Element is calculated by
          summing up the IPFIX Message Header length values of all
          IPFIX Messages that were successfully sent to the Collecting
          Process.  The reported number excludes octets in the IPFIX
          Message that carries the counter value.
          If this Information Element is sent to a particular
```

```
          Collecting Process, then by default it specifies the number
          of octets sent to this Collecting Process.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="exportedFlowRecordTotalCount" dataType="unsigned64"
           group="processCounter"
           dataTypeSemantics="totalCounter"
           elementId="42" applicability="data" status="current">
      <description>
        <paragraph>
          The total number of Flow Records that the Exporting
          Process has sent as Data Records since the Exporting
          Process (re-)initialization to a particular Collecting
          Process.  The reported number excludes Flow Records in
          the IPFIX Message that carries the counter value.
          If this Information Element is sent to a particular
          Collecting Process, then by default it specifies the number
          of Flow Records sent to this process.
        </paragraph>
      </description>
      <units>flows</units>
    </field>

    <field name="observedFlowTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="163" applicability="data" status="current">
      <description>
        <paragraph>
        The total number of Flows observed in the Observation Domain
        since the Metering Process (re-)initialization for this
        Observation Point.
        </paragraph>
      </description>
      <units>flows</units>
    </field>

    <field name="ignoredPacketTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="164" applicability="data" status="current">
      <description>
        <paragraph>
           The total number of observed IP packets that the
           Metering Process did not process since the
```

```
            (re-)initialization of the Metering Process.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="ignoredOctetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="165" applicability="data" status="current">
      <description>
        <paragraph>
           The total number of octets in observed IP packets
           (including the IP header) that the Metering Process
           did not process since the (re-)initialization of the
           Metering Process.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="notSentFlowTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="166" applicability="data" status="current">
      <description>
        <paragraph>
           The total number of Flow Records that were generated by the
           Metering Process and dropped by the Metering Process or
           by the Exporting Process instead of being sent to the
           Collecting Process.  There are several potential reasons for
           this including resource shortage and special Flow export
           policies.
        </paragraph>
      </description>
      <units>flows</units>
    </field>

    <field name="notSentPacketTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="processCounter"
           elementId="167" applicability="data" status="current">
      <description>
        <paragraph>
           The total number of packets in Flow Records that were
           generated by the Metering Process and dropped
           by the Metering Process or by the Exporting Process
           instead of being sent to the Collecting Process.
```

```
            There are several potential reasons for this including
            resource shortage and special Flow export policies.
          </paragraph>
        </description>
        <units>packets</units>
      </field>

      <field name="notSentOctetTotalCount" dataType="unsigned64"
            dataTypeSemantics="totalCounter"
            group="processCounter"
            elementId="168" applicability="data" status="current">
        <description>
          <paragraph>
            The total number of octets in packets in Flow Records
            that were generated by the Metering Process and
            dropped by the Metering Process or by the Exporting
            Process instead of being sent to the Collecting Process.
            There are several potential reasons for this including
            resource shortage and special Flow export policies.
          </paragraph>
        </description>
        <units>octets</units>
      </field>

      <field name="ipVersion" dataType="unsigned8"
            group="ipHeader"
            dataTypeSemantics="identifier"
            elementId="60" applicability="all" status="current">
        <description>
          <paragraph>
          The IP version field in the IP packet header.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 791 for the definition of the version field
          in the IPv4 packet header.
          See RFC 2460 for the definition of the version field
          in the IPv6 packet header.
          Additional information on defined version numbers
          can be found at
          http://www.iana.org/assignments/version-numbers.
          </paragraph>
        </reference>
      </field>

      <field name="sourceIPv4Address" dataType="ipv4Address"
            group="ipHeader"
```

```
            dataTypeSemantics="identifier"
            elementId="8" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv4 source address in the IP packet header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the definition of the IPv4 source
        address field.
        </paragraph>
      </reference>
    </field>

    <field name="sourceIPv6Address" dataType="ipv6Address"
           group="ipHeader"
           dataTypeSemantics="identifier"
           elementId="27" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv6 source address in the IP packet header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2460 for the definition of the
        Source Address field in the IPv6 header.
        </paragraph>
      </reference>
    </field>

    <field name="sourceIPv4PrefixLength" dataType="unsigned8"
           group="ipHeader"
           elementId="9" applicability="option" status="current">
      <description>
        <paragraph>
        The number of contiguous bits that are relevant in the
        sourceIPv4Prefix Information Element.
        </paragraph>
      </description>
      <units>bits</units>
      <range>0-32</range>
    </field>

    <field name="sourceIPv6PrefixLength" dataType="unsigned8"
           group="ipHeader"
           elementId="29" applicability="option" status="current">
```

```
      <description>
        <paragraph>
        The number of contiguous bits that are relevant in the
        sourceIPv6Prefix Information Element.
        </paragraph>
      </description>
      <units>bits</units>
      <range>0-128</range>
    </field>

    <field name="sourceIPv4Prefix" dataType="ipv4Address"
           group="ipHeader"
           elementId="44" applicability="data" status="current">
      <description>
        <paragraph>
        IPv4 source address prefix.
        </paragraph>
      </description>
    </field>

    <field name="sourceIPv6Prefix" dataType="ipv6Address"
           group="ipHeader"
           elementId="170" applicability="data" status="current">
      <description>
        <paragraph>
        IPv6 source address prefix.
        </paragraph>
      </description>
    </field>

    <field name="destinationIPv4Address" dataType="ipv4Address"
           group="ipHeader"
           dataTypeSemantics="identifier"
           elementId="12" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv4 destination address in the IP packet header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the definition of the IPv4
        destination address field.
        </paragraph>
      </reference>
    </field>

    <field name="destinationIPv6Address" dataType="ipv6Address"
```

```
            group="ipHeader"
            dataTypeSemantics="identifier"
            elementId="28" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv6 destination address in the IP packet header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2460 for the definition of the
        Destination Address field in the IPv6 header.
        </paragraph>
      </reference>
    </field>

    <field name="destinationIPv4PrefixLength" dataType="unsigned8"
           group="ipHeader"
           elementId="13" applicability="option" status="current">
      <description>
        <paragraph>
        The number of contiguous bits that are relevant in the
        destinationIPv4Prefix Information Element.
        </paragraph>
      </description>
      <units>bits</units>
      <range>0-32</range>
    </field>

    <field name="destinationIPv6PrefixLength" dataType="unsigned8"
           group="ipHeader"
           elementId="30" applicability="option" status="current">
      <description>
        <paragraph>
        The number of contiguous bits that are relevant in the
        destinationIPv6Prefix Information Element.
        </paragraph>
      </description>
      <units>bits</units>
      <range>0-128</range>
    </field>

    <field name="destinationIPv4Prefix" dataType="ipv4Address"
           group="ipHeader"
           elementId="45" applicability="data" status="current">
      <description>
        <paragraph> IPv4 destination address prefix. </paragraph>
      </description>
```

```
     </field>

     <field name="destinationIPv6Prefix" dataType="ipv6Address"
            group="ipHeader"
            elementId="169" applicability="data" status="current">
       <description>
         <paragraph> IPv6 destination address prefix. </paragraph>
       </description>
     </field>

     <field name="ipTTL" dataType="unsigned8"
            group="ipHeader"
            elementId="192" applicability="all" status="current">
       <description>
         <paragraph>
         For IPv4, the value of the Information Element matches
         the value of the Time to Live (TTL) field in the IPv4 packet
         header.  For IPv6, the value of the Information Element
         matches the value of the Hop Limit field in the IPv6
         packet header.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 791 for the definition of the IPv4
         Time to Live field.
         See RFC 2460 for the definition of the IPv6
         Hop Limit field.
         </paragraph>
       </reference>
       <units>hops</units>
     </field>

     <field name="protocolIdentifier" dataType="unsigned8"
            group="ipHeader"
            dataTypeSemantics="identifier"
            elementId="4" applicability="all" status="current">
       <description>
         <paragraph>
         The value of the protocol number in the IP packet header.
         The protocol number identifies the IP packet payload type.
         Protocol numbers are defined in the IANA Protocol Numbers
         registry.
            </paragraph>

         <paragraph>
         In Internet Protocol version 4 (IPv4), this is carried in the
         Protocol field.  In Internet Protocol version 6 (IPv6), this
```

```
         is carried in the Next Header field in the last extension
         header of the packet.
            </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 791 for the specification of the IPv4
         protocol field.
         See RFC 2460 for the specification of the IPv6
         protocol field.
         See the list of protocol numbers assigned by IANA at
         http://www.iana.org/assignments/protocol-numbers.
         </paragraph>
       </reference>
     </field>

     <field name="nextHeaderIPv6" dataType="unsigned8"
            group="ipHeader"
            elementId="193" applicability="all" status="current">
       <description>
         <paragraph>
         The value of the Next Header field of the IPv6 header.
         The value identifies the type of the following IPv6
         extension header or of the following IP payload.
         Valid values are defined in the IANA
         Protocol Numbers registry.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 2460 for the definition of the IPv6
         Next Header field.
         See the list of protocol numbers assigned by IANA at
         http://www.iana.org/assignments/protocol-numbers.
         </paragraph>
       </reference>
     </field>

     <field name="ipDiffServCodePoint" dataType="unsigned8"
            group="ipHeader"
            dataTypeSemantics="identifier"
            elementId="195" applicability="all" status="current">
       <description>
         <paragraph>
         The value of a Differentiated Services Code Point (DSCP)
         encoded in the Differentiated Services field.  The
         Differentiated Services field spans the most significant
         6 bits of the IPv4 TOS field or the IPv6 Traffic Class
```

```
        field, respectively.
        </paragraph>
        <paragraph>
        This Information Element encodes only the 6 bits of the
        Differentiated Services field.  Therefore, its value may
        range from 0 to 63.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3260 for the definition of the
        Differentiated Services field.
        See RFC 1812 (Section 5.3.2) and RFC 791 for the definition
        of the IPv4 TOS field.  See RFC 2460 for the definition of
        the IPv6 Traffic Class field.
        </paragraph>
      </reference>
      <range>0-63</range>
    </field>

    <field name="ipPrecedence" dataType="unsigned8"
           group="ipHeader"
           dataTypeSemantics="identifier"
           elementId="196" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the IP Precedence.  The IP Precedence value
        is encoded in the first 3 bits of the IPv4 TOS field
        or the IPv6 Traffic Class field, respectively.
        </paragraph>
        <paragraph>
        This Information Element encodes only these 3 bits.
        Therefore, its value may range from 0 to 7.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 1812 (Section 5.3.3) and RFC 791
        for the definition of the IP Precedence.
        See RFC 1812 (Section 5.3.2) and RFC 791
        for the definition of the IPv4 TOS field.
        See RFC 2460 for the definition of the IPv6
        Traffic Class field.
        </paragraph>
      </reference>
      <range>0-7</range>
    </field>
```

```
<field name="ipClassOfService" dataType="unsigned8"
       group="ipHeader"
       dataTypeSemantics="identifier"
       elementId="5" applicability="all" status="current">
  <description>
    <paragraph>
    For IPv4 packets, this is the value of the TOS field in
    the IPv4 packet header.  For IPv6 packets, this is the
    value of the Traffic Class field in the IPv6 packet header.
    </paragraph>
  </description>
  <reference>
    <paragraph>
    See RFC 1812 (Section 5.3.2) and RFC 791
    for the definition of the IPv4 TOS field.
    See RFC 2460 for the definition of the IPv6
    Traffic Class field.
    </paragraph>
  </reference>
</field>

<field name="postIpClassOfService" dataType="unsigned8"
       group="ipHeader"
       dataTypeSemantics="identifier"
       elementId="55" applicability="all" status="current">
  <description>
    <paragraph>
    The definition of this Information Element is identical
    to the definition of Information Element
    'ipClassOfService', except that it reports a
    potentially modified value caused by a middlebox
    function after the packet passed the Observation Point.
    </paragraph>
  </description>
  <reference>
    <paragraph>
    See RFC 791 for the definition of the IPv4
    TOS field.
    See RFC 2460 for the definition of the IPv6
    Traffic Class field.
    See RFC 3234 for the definition of middleboxes.
    </paragraph>
  </reference>
</field>

<field name="flowLabelIPv6" dataType="unsigned32"
       group="ipHeader"
       dataTypeSemantics="identifier"
```

```
          elementId="31" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the IPv6 Flow Label field in the IP packet header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2460 for the definition of the
        Flow Label field in the IPv6 packet header.
        </paragraph>
      </reference>
    </field>

    <field name="isMulticast" dataType="unsigned8"
           group="ipHeader"
           dataTypeSemantics="flags"
           elementId="206" applicability="data" status="current">
      <description>
        <paragraph>
          If the IP destination address is not a reserved multicast
          address, then the value of all bits of the octet (including
          the reserved ones) is zero.
        </paragraph>
        <paragraph>
          The first bit of this octet is set to 1 if the Version
          field of the IP header has the value 4 and if the
          Destination Address field contains a reserved multicast
          address in the range from 224.0.0.0 to 239.255.255.255.
          Otherwise, this bit is set to 0.
        </paragraph>
        <paragraph>
          The second and third bits of this octet are reserved for
          future use.
        </paragraph>
        <paragraph>
          The remaining bits of the octet are only set to values
          other than zero if the IP Destination Address is a
          reserved IPv6 multicast address.  Then the fourth bit
          of the octet is set to the value of the T flag in the
          IPv6 multicast address and the remaining four bits are
          set to the value of the scope field in the IPv6
          multicast address.
        </paragraph>
        <artwork>
            0      1      2      3      4      5      6      7
         +------+------+------+------+------+------+------+------+
         | MCv4 | RES. | RES. |  T   |   IPv6 multicast scope    |
```

```
          +------+------+------+------+------+------+------+------+

          Bit  0:    set to 1 if IPv4 multicast
          Bits 1-2:  reserved for future use
          Bit  4:    set to value of T flag, if IPv6 multicast
          Bits 4-7:  set to value of multicast scope if IPv6 multicast
        </artwork>
      </description>
      <reference>
        <paragraph>
        See RFC 1112 for the specification of reserved
        IPv4 multicast addresses.
        See RFC 4291 for the specification of reserved
        IPv6 multicast addresses and the definition of the T flag
        and the IPv6 multicast scope.
        </paragraph>
      </reference>
    </field>

    <field name="fragmentIdentification" dataType="unsigned32"
           group="ipHeader"
           dataTypeSemantics="identifier"
           elementId="54" applicability="data" status="current">
      <description>
        <paragraph>
        The value of the Identification field
        in the IPv4 packet header or in the IPv6 Fragment header,
        respectively.  The value is 0 for IPv6 if there is
        no fragment header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the definition of the IPv4
        Identification field.
        See RFC 2460 for the definition of the
        Identification field in the IPv6 Fragment header.
        </paragraph>
      </reference>
    </field>

    <field name="fragmentOffset" dataType="unsigned16"
           group="ipHeader"
           dataTypeSemantics="identifier"
           elementId="88" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the IP fragment offset field in the
```

```
        IPv4 packet header or the IPv6 Fragment header,
        respectively.  The value is 0 for IPv6 if there is
        no fragment header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        fragment offset in the IPv4 header.
        See RFC 2460 for the specification of the
        fragment offset in the IPv6 Fragment header.
        </paragraph>
      </reference>
    </field>

    <field name="fragmentFlags" dataType="unsigned8"
           group="ipHeader"
           dataTypeSemantics="flags"
           elementId="197" applicability="all" status="current">
      <description>
        <paragraph>
          Fragmentation properties indicated by flags in the IPv4
          packet header or the IPv6 Fragment header, respectively.
        </paragraph>
        <artwork>

        Bit 0:    (RS) Reserved.
                  The value of this bit MUST be 0 until specified
                  otherwise.
        Bit 1:    (DF) 0 = May Fragment,  1 = Don't Fragment.
                  Corresponds to the value of the DF flag in the
                  IPv4 header.  Will always be 0 for IPv6 unless
                  a "don't fragment" feature is introduced to IPv6.
        Bit 2:    (MF) 0 = Last Fragment, 1 = More Fragments.
                  Corresponds to the MF flag in the IPv4 header
                  or to the M flag in the IPv6 Fragment header,
                  respectively.  The value is 0 for IPv6 if there
                  is no fragment header.
        Bits 3-7: (DC) Don't Care.
                  The values of these bits are irrelevant.

           0   1   2   3   4   5   6   7
          +---+---+---+---+---+---+---+---+
          | R | D | M | D | D | D | D | D |
          | S | F | F | C | C | C | C | C |
          +---+---+---+---+---+---+---+---+
        </artwork>
      </description>
```

```
      <reference>
        <paragraph>
        See RFC 791 for the specification of the IPv4
        fragment flags.
        See RFC 2460 for the specification of the IPv6
        Fragment header.
        </paragraph>
      </reference>
    </field>

    <field name="ipHeaderLength" dataType="unsigned8"
           group="ipHeader"
           elementId="189" applicability="all" status="current">
      <description>
        <paragraph>
        The length of the IP header.  For IPv6, the value of this
        Information Element is 40.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 header.
        See RFC 2460 for the specification of the
        IPv6 header.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="ipv4IHL" dataType="unsigned8"
           group="ipHeader"
           elementId="207" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the Internet Header Length (IHL) field in
        the IPv4 header.  It specifies the length of the header
        in units of 4 octets.  Please note that its unit is
        different from most of the other Information Elements
        reporting length values.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 header.
        </paragraph>
      </reference>
```

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      <units>4 octets</units>
    </field>

    <field name="totalLengthIPv4" dataType="unsigned16"
           group="ipHeader"
           elementId="190" applicability="all" status="current">
      <description>
        <paragraph>
        The total length of the IPv4 packet.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 total length.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="ipTotalLength" dataType="unsigned64"
           group="ipHeader"
           elementId="224" applicability="all" status="current">
      <description>
        <paragraph>
        The total length of the IP packet.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 total length.
        See RFC 2460 for the specification of the
        IPv6 payload length.
        See RFC 2675 for the specification of the
        IPv6 jumbo payload length.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="payloadLengthIPv6" dataType="unsigned16"
           group="ipHeader"
           elementId="191" applicability="all" status="current">
      <description>
        <paragraph>
        This Information Element reports the value of the Payload
        Length field in the IPv6 header.  Note that IPv6 extension
```

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        headers belong to the payload.  Also note that in case of a
        jumbo payload option the value of the Payload Length field in
        the IPv6 header is zero and so will be the value reported
        by this Information Element.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 2460 for the specification of the
        IPv6 payload length.
        See RFC 2675 for the specification of the
        IPv6 jumbo payload option.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="sourceTransportPort" dataType="unsigned16"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="7" applicability="all" status="current">
      <description>
        <paragraph>
        The source port identifier in the transport header.
        For the transport protocols UDP, TCP, and SCTP, this is the
        source port number given in the respective header.  This
        field MAY also be used for future transport protocols that
        have 16-bit source port identifiers.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the definition of the UDP
        source port field.
        See RFC 793 for the definition of the TCP
        source port field.
        See RFC 4960 for the definition of SCTP.
        </paragraph>
        <paragraph>
        Additional information on defined UDP and TCP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="destinationTransportPort" dataType="unsigned16"
           group="transportHeader"
           dataTypeSemantics="identifier"
```

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          elementId="11" applicability="all" status="current">
      <description>
        <paragraph>
        The destination port identifier in the transport header.
        For the transport protocols UDP, TCP, and SCTP, this is the
        destination port number given in the respective header.
        This field MAY also be used for future transport protocols
        that have 16-bit destination port identifiers.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the definition of the UDP
        destination port field.
        See RFC 793 for the definition of the TCP
        destination port field.
        See RFC 4960 for the definition of SCTP.
        </paragraph>
        <paragraph>
        Additional information on defined UDP and TCP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="udpSourcePort" dataType="unsigned16"
          group="transportHeader"
          dataTypeSemantics="identifier"
          elementId="180" applicability="all" status="current">
      <description>
        <paragraph>
        The source port identifier in the UDP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the definition of the
        UDP source port field.
        Additional information on defined UDP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="udpDestinationPort" dataType="unsigned16"
          group="transportHeader"
          dataTypeSemantics="identifier"
          elementId="181" applicability="all" status="current">
```

```
      <description>
        <paragraph>
        The destination port identifier in the UDP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the definition of the
        UDP destination port field.
        Additional information on defined UDP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="udpMessageLength" dataType="unsigned16"
           group="transportHeader"
           elementId="205" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the Length field in the UDP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 768 for the specification of the
        UDP header.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="tcpSourcePort" dataType="unsigned16"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="182" applicability="all" status="current">
      <description>
        <paragraph>
        The source port identifier in the TCP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP
        source port field.
        Additional information on defined TCP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
```

```
      </reference>
    </field>

    <field name="tcpDestinationPort" dataType="unsigned16"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="183" applicability="all" status="current">
      <description>
        <paragraph>
        The destination port identifier in the TCP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP
        source port field.
        Additional information on defined TCP port numbers can
        be found at http://www.iana.org/assignments/port-numbers.
        </paragraph>
      </reference>
    </field>

    <field name="tcpSequenceNumber" dataType="unsigned32"
           group="transportHeader"
           elementId="184" applicability="all" status="current">
      <description>
        <paragraph>
        The sequence number in the TCP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP
        sequence number.
        </paragraph>
      </reference>
    </field>

    <field name="tcpAcknowledgementNumber" dataType="unsigned32"
           group="transportHeader"
           elementId="185" applicability="all" status="current">
      <description>
        <paragraph>
        The acknowledgement number in the TCP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
```

```
        See RFC 793 for the definition of the TCP
        acknowledgement number.
        </paragraph>
      </reference>
    </field>

    <field name="tcpWindowSize" dataType="unsigned16"
           group="transportHeader"
           elementId="186" applicability="all" status="current">
      <description>
        <paragraph>
        The window field in the TCP header.
        If the TCP window scale is supported,
        then TCP window scale must be known
        to fully interpret the value of this information.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP window field.
        See RFC 1323 for the definition of the TCP window scale.
        </paragraph>
      </reference>
    </field>

    <field name="tcpWindowScale" dataType="unsigned16"
           group="transportHeader"
           elementId="238" applicability="all" status="current">
      <description>
        <paragraph>
        The scale of the window field in the TCP header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 1323 for the definition of the TCP window scale.
        </paragraph>
      </reference>
    </field>

    <field name="tcpUrgentPointer" dataType="unsigned16"
           group="transportHeader"
           elementId="187" applicability="all" status="current">
      <description>
        <paragraph>
        The urgent pointer in the TCP header.
        </paragraph>
      </description>
```

```
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP
        urgent pointer.
        </paragraph>
      </reference>
    </field>

    <field name="tcpHeaderLength" dataType="unsigned8"
           group="transportHeader"
           elementId="188" applicability="all" status="current">
      <description>
        <paragraph>
        The length of the TCP header.  Note that the value of this
        Information Element is different from the value of the Data
        Offset field in the TCP header.  The Data Offset field
        indicates the length of the TCP header in units of 4 octets.
        This Information Elements specifies the length of the TCP
        header in units of octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the
        TCP header.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="icmpTypeCodeIPv4" dataType="unsigned16"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="32" applicability="all" status="current">
      <description>
        <paragraph>
        Type and Code of the IPv4 ICMP message.  The combination of
        both values is reported as (ICMP type * 256) + ICMP code.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 792 for the definition of the IPv4 ICMP
           type and code fields.
        </paragraph>
      </reference>
    </field>
```

```
     <field name="icmpTypeIPv4" dataType="unsigned8"
            group="transportHeader"
            dataTypeSemantics="identifier"
            elementId="176" applicability="all" status="current">
       <description>
         <paragraph>
         Type of the IPv4 ICMP message.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 792 for the definition of the IPv4 ICMP
         type field.
         </paragraph>
       </reference>
     </field>

     <field name="icmpCodeIPv4" dataType="unsigned8"
            group="transportHeader"
            dataTypeSemantics="identifier"
            elementId="177" applicability="all" status="current">
       <description>
         <paragraph>
         Code of the IPv4 ICMP message.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 792 for the definition of the IPv4
         ICMP code field.
         </paragraph>
       </reference>
     </field>

     <field name="icmpTypeCodeIPv6" dataType="unsigned16"
            group="transportHeader"
            dataTypeSemantics="identifier"
            elementId="139" applicability="all" status="current">
       <description>
         <paragraph>
         Type and Code of the IPv6 ICMP message.  The combination of
         both values is reported as (ICMP type * 256) + ICMP code.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 4443 for the definition of the IPv6
         ICMP type and code fields.
```

```
        </paragraph>
      </reference>
    </field>

    <field name="icmpTypeIPv6" dataType="unsigned8"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="178" applicability="all" status="current">
      <description>
        <paragraph>
        Type of the IPv6 ICMP message.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4443 for the definition of the IPv6
        ICMP type field.
        </paragraph>
      </reference>
    </field>

    <field name="icmpCodeIPv6" dataType="unsigned8"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="179" applicability="all" status="current">
      <description>
        <paragraph>
        Code of the IPv6 ICMP message.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4443 for the definition of the IPv6
        ICMP code field.
        </paragraph>
      </reference>
    </field>

    <field name="igmpType" dataType="unsigned8"
           group="transportHeader"
           dataTypeSemantics="identifier"
           elementId="33" applicability="all" status="current">
      <description>
        <paragraph>
        The type field of the IGMP message.
        </paragraph>
      </description>
      <reference>
```

```
        <paragraph>
        See RFC 3376 for the definition of the IGMP
        type field.
        </paragraph>
      </reference>
    </field>

    <field name="sourceMacAddress" dataType="macAddress"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="56" applicability="data" status="current">
      <description>
        <paragraph>
          The IEEE 802 source MAC address field.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See IEEE.802-3.2002.
        </paragraph>
      </reference>
    </field>

    <field name="postSourceMacAddress" dataType="macAddress"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="81" applicability="data" status="current">
      <description>
        <paragraph>
        The definition of this Information Element is identical
        to the definition of Information Element
        'sourceMacAddress', except that it reports a
        potentially modified value caused by a middlebox
        function after the packet passed the Observation Point.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See IEEE.802-3.2002.
        </paragraph>
      </reference>
    </field>

    <field name="vlanId" dataType="unsigned16"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="58" applicability="data" status="current">
      <description>
```

```
        <paragraph>
          The IEEE 802.1Q VLAN identifier (VID) extracted from the Tag
          Control Information field that was attached to the IP packet.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See IEEE.802-1Q.2003.
        </paragraph>
      </reference>
    </field>

    <field name="postVlanId" dataType="unsigned16"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="59" applicability="data" status="current">
      <description>
        <paragraph>
        The definition of this Information Element is identical
        to the definition of Information Element
        'vlanId', except that it reports a
        potentially modified value caused by a middlebox
        function after the packet passed the Observation Point.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See IEEE.802-1Q.2003.
        </paragraph>
      </reference>
    </field>

    <field name="destinationMacAddress" dataType="macAddress"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="80" applicability="data" status="current">
      <description>
        <paragraph>
          The IEEE 802 destination MAC address field.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See IEEE.802-3.2002.
        </paragraph>
      </reference>
    </field>
```

```
<field name="postDestinationMacAddress" dataType="macAddress"
       group="subIpHeader"
       dataTypeSemantics="identifier"
       elementId="57" applicability="data" status="current">
  <description>
    <paragraph>
    The definition of this Information Element is identical
    to the definition of Information Element
    'destinationMacAddress', except that it reports a
    potentially modified value caused by a middlebox
    function after the packet passed the Observation Point.
    </paragraph>
  </description>
  <reference>
    <paragraph>
    See IEEE.802-3.2002.
    </paragraph>
  </reference>
</field>

<field name="wlanChannelId" dataType="unsigned8"
       group="subIpHeader"
       dataTypeSemantics="identifier"
       elementId="146" applicability="data" status="current">
  <description>
    <paragraph>
      The identifier of the 802.11 (Wi-Fi) channel used.
    </paragraph>
  </description>
  <reference>
    <paragraph>
    See IEEE.802-11.1999.
    </paragraph>
  </reference>
</field>

<field name="wlanSSID" dataType="string"
       group="subIpHeader"
       elementId="147" applicability="data" status="current">
  <description>
    <paragraph>
      The Service Set IDentifier (SSID) identifying an 802.11
      (Wi-Fi) network used.  According to IEEE.802-11.1999, the
      SSID is encoded into a string of up to 32 characters.
    </paragraph>
  </description>
  <reference>
    <paragraph>
```

```
        See IEEE.802-11.1999.
        </paragraph>
      </reference>
    </field>

    <field name="mplsTopLabelTTL" dataType="unsigned8"
           group="subIpHeader"
           elementId="200" applicability="all" status="current">
      <description>
        <paragraph>
        The TTL field from the top MPLS label stack entry,
        i.e., the last label that was pushed.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032 for the specification of the
        TTL field.
        </paragraph>
      </reference>
      <units>hops</units>
    </field>

    <field name="mplsTopLabelExp" dataType="unsigned8"
           group="subIpHeader"
           dataTypeSemantics="flags"
           elementId="203" applicability="all" status="current">
      <description>
        <paragraph>
        The Exp field from the top MPLS label stack entry,
        i.e., the last label that was pushed.
        </paragraph>
        <artwork>
        Bits 0-4:  Don't Care, value is irrelevant.
        Bits 5-7:  MPLS Exp field.

            0   1   2   3   4   5   6   7
          +---+---+---+---+---+---+---+---+
          |     don't care    |    Exp    |
          +---+---+---+---+---+---+---+---+
        </artwork>
      </description>
      <reference>
        <paragraph>
        See RFC 3032 for the specification of the Exp field.
        See RFC 3270 for usage of the Exp field.
        </paragraph>
      </reference>
```

```
    </field>

    <field name="postMplsTopLabelExp" dataType="unsigned8"
           group="subIpHeader"
           dataTypeSemantics="flags"
           elementId="237" applicability="all" status="current">
      <description>
        <paragraph>
        The definition of this Information Element is identical to the
        definition of Information Element 'mplsTopLabelExp', except
        that it reports a potentially modified value caused by a
        middlebox function after the packet passed the Observation
        Point.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032 for the specification of the Exp field.
        See RFC 3270 for usage of the Exp field.
        </paragraph>
      </reference>
    </field>

    <field name="mplsLabelStackDepth" dataType="unsigned32"
           group="subIpHeader"
           elementId="202" applicability="all" status="current">
      <description>
        <paragraph>
        The number of labels in the MPLS label stack.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032 for the specification of
        the MPLS label stack.
        </paragraph>
      </reference>
      <units>label stack entries</units>
    </field>

    <field name="mplsLabelStackLength" dataType="unsigned32"
           group="subIpHeader"
           elementId="201" applicability="all" status="current">
      <description>
        <paragraph>
        The length of the MPLS label stack in units of octets.
        </paragraph>
      </description>
```

```
      <reference>
        <paragraph>
        See RFC 3032 for the specification of
        the MPLS label stack.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="mplsPayloadLength" dataType="unsigned32"
           group="subIpHeader"
           elementId="194" applicability="all" status="current">
      <description>
        <paragraph>
        The size of the MPLS packet without the label stack.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3031 for the specification of
        MPLS packets.
        See RFC 3032 for the specification of
        the MPLS label stack.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="mplsTopLabelStackSection" dataType="octetArray"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="70" applicability="all" status="current">
      <description>
        <paragraph>
        The Label, Exp, and S fields from the top MPLS label
        stack entry, i.e., from the last label that was pushed.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
        <artwork>
      0                   1                   2
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                Label                  | Exp |S|
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

     Label:  Label Value, 20 bits
```

```
      Exp:    Experimental Use, 3 bits
      S:      Bottom of Stack, 1 bit
         </artwork>
       </description>
       <reference>
         <paragraph>
         See RFC 3032.
         </paragraph>
       </reference>
     </field>

     <field name="mplsLabelStackSection2" dataType="octetArray"
            group="subIpHeader"
            dataTypeSemantics="identifier"
            elementId="71" applicability="all" status="current">
       <description>
         <paragraph>
         The Label, Exp, and S fields from the label stack entry that
         was pushed immediately before the label stack entry that would
         be reported by mplsTopLabelStackSection.  See the definition of
         mplsTopLabelStackSection for further details.
         </paragraph>
         <paragraph>
         The size of this Information Element is 3 octets.
         </paragraph>
       </description>
       <reference>
         <paragraph>
         See RFC 3032.
         </paragraph>
       </reference>
     </field>

     <field name="mplsLabelStackSection3" dataType="octetArray"
            group="subIpHeader"
            dataTypeSemantics="identifier"
            elementId="72" applicability="all" status="current">
       <description>
         <paragraph>
         The Label, Exp, and S fields from the label stack entry that
         was pushed immediately before the label stack entry that would
         be reported by mplsLabelStackSection2.  See the definition of
         mplsTopLabelStackSection for further details.
         </paragraph>
         <paragraph>
         The size of this Information Element is 3 octets.
         </paragraph>
       </description>
```

```
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
      </reference>
    </field>

    <field name="mplsLabelStackSection4" dataType="octetArray"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="73" applicability="all" status="current">
      <description>
        <paragraph>
        The Label, Exp, and S fields from the label stack entry that
        was pushed immediately before the label stack entry that would
        be reported by mplsLabelStackSection3.  See the definition of
        mplsTopLabelStackSection for further details.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
      </reference>
    </field>

    <field name="mplsLabelStackSection5" dataType="octetArray"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="74" applicability="all" status="current">
      <description>
        <paragraph>
        The Label, Exp, and S fields from the label stack entry that
        was pushed immediately before the label stack entry that would
        be reported by mplsLabelStackSection4.  See the definition of
        mplsTopLabelStackSection for further details.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
```

```
      </reference>
    </field>

    <field name="mplsLabelStackSection6" dataType="octetArray"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="75" applicability="all" status="current">
      <description>
        <paragraph>
        The Label, Exp, and S fields from the label stack entry that
        was pushed immediately before the label stack entry that would
        be reported by mplsLabelStackSection5.  See the definition of
        mplsTopLabelStackSection for further details.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
      </reference>
    </field>

    <field name="mplsLabelStackSection7" dataType="octetArray"
           group="subIpHeader"
           dataTypeSemantics="identifier"
           elementId="76" applicability="all" status="current">
      <description>
        <paragraph>
        The Label, Exp, and S fields from the label stack entry that
        was pushed immediately before the label stack entry that would
        be reported by mplsLabelStackSection6.  See the definition of
        mplsTopLabelStackSection for further details.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
      </reference>
    </field>

    <field name="mplsLabelStackSection8" dataType="octetArray"
```

```
            group="subIpHeader"
            dataTypeSemantics="identifier"
            elementId="77" applicability="all" status="current">
        <description>
          <paragraph>
          The Label, Exp, and S fields from the label stack entry that
          was pushed immediately before the label stack entry that would
          be reported by mplsLabelStackSection7.  See the definition of
          mplsTopLabelStackSection for further details.
          </paragraph>
          <paragraph>
          The size of this Information Element is 3 octets.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 3032.
          </paragraph>
        </reference>
      </field>

      <field name="mplsLabelStackSection9" dataType="octetArray"
            group="subIpHeader"
            dataTypeSemantics="identifier"
            elementId="78" applicability="all" status="current">
        <description>
          <paragraph>
          The Label, Exp, and S fields from the label stack entry that
          was pushed immediately before the label stack entry that would
          be reported by mplsLabelStackSection8.  See the definition of
          mplsTopLabelStackSection for further details.
          </paragraph>
          <paragraph>
          The size of this Information Element is 3 octets.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 3032.
          </paragraph>
        </reference>
      </field>

      <field name="mplsLabelStackSection10" dataType="octetArray"
            group="subIpHeader"
            dataTypeSemantics="identifier"
            elementId="79" applicability="all" status="current">
        <description>
```

```
        <paragraph>
        The Label, Exp, and S fields from the label stack entry that
        was pushed immediately before the label stack entry that would
        be reported by mplsLabelStackSection9.  See the definition of
        mplsTopLabelStackSection for further details.
        </paragraph>
        <paragraph>
        The size of this Information Element is 3 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3032.
        </paragraph>
      </reference>
    </field>

    <field name="ipPayloadLength" dataType="unsigned32"
           group="derived"
           elementId="204" applicability="all" status="current">
      <description>
        <paragraph>
        The effective length of the IP payload.
        </paragraph>
        <paragraph>
        For IPv4 packets, the value of this Information Element is
        the difference between the total length of the IPv4 packet
        (as reported by Information Element totalLengthIPv4) and the
        length of the IPv4 header (as reported by Information Element
        headerLengthIPv4).
        </paragraph>
        <paragraph>
        For IPv6, the value of the Payload Length field
        in the IPv6 header is reported except in the case that
        the value of this field is zero and that there is a valid
        jumbo payload option.  In this case, the value of the
        Jumbo Payload Length field in the jumbo payload option
        is reported.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of
        IPv4 packets.
        See RFC 2460 for the specification of the
        IPv6 payload length.
        See RFC 2675 for the specification of the
        IPv6 jumbo payload length.
```

```
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="ipNextHopIPv4Address" dataType="ipv4Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="15" applicability="data" status="current">
      <description>
        <paragraph>
        The IPv4 address of the next IPv4 hop.
        </paragraph>
      </description>
    </field>

    <field name="ipNextHopIPv6Address" dataType="ipv6Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="62" applicability="data" status="current">
      <description>
        <paragraph>
        The IPv6 address of the next IPv6 hop.
        </paragraph>
      </description>
    </field>

    <field name="bgpSourceAsNumber" dataType="unsigned32"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="16" applicability="all" status="current">
      <description>
        <paragraph>
        The autonomous system (AS) number of the source IP address.
        If AS path information for this Flow is only available as
        an unordered AS set (and not as an ordered AS sequence),
        then the value of this Information Element is 0.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4271 for a description of BGP-4, and see RFC 1930
        for the definition of the AS number.
        </paragraph>
      </reference>
    </field>

    <field name="bgpDestinationAsNumber" dataType="unsigned32"
```

```
            group="derived"
            dataTypeSemantics="identifier"
            elementId="17" applicability="all" status="current">
        <description>
          <paragraph>
          The autonomous system (AS) number of the destination IP
          address.  If AS path information for this Flow is only
          available as an unordered AS set (and not as an ordered AS
          sequence), then the value of this Information Element is 0.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 4271 for a description of BGP-4, and see RFC 1930 for
             the definition of the AS number.
          </paragraph>
        </reference>
      </field>

      <field name="bgpNextAdjacentAsNumber" dataType="unsigned32"
            group="derived"
            dataTypeSemantics="identifier"
            elementId="128" applicability="all" status="current">
        <description>
          <paragraph>
          The autonomous system (AS) number of the first AS in the AS
          path to the destination IP address.  The path is deduced
          by looking up the destination IP address of the Flow in the
          BGP routing information base.  If AS path information for
          this Flow is only available as an unordered AS set (and not
          as an ordered AS sequence), then the value of this Information
          Element is 0.
        </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 4271 for a description of BGP-4, and
          see RFC 1930 for the definition of the AS number.
          </paragraph>
        </reference>
      </field>

      <field name="bgpPrevAdjacentAsNumber" dataType="unsigned32"
            group="derived"
            dataTypeSemantics="identifier"
            elementId="129" applicability="all" status="current">
        <description>
          <paragraph>
```

```
        The autonomous system (AS) number of the last AS in the AS
        path from the source IP address.  The path is deduced
        by looking up the source IP address of the Flow in the BGP
        routing information base.  If AS path information for this
        Flow is only available as an unordered AS set (and not as
        an ordered AS sequence), then the value of this Information
        Element is 0.  In case of BGP asymmetry, the
        bgpPrevAdjacentAsNumber might not be able to report the correct
        value.
      </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4271 for a description of BGP-4, and
        see RFC 1930 for the definition of the AS number.
        </paragraph>
      </reference>
    </field>

    <field name="bgpNextHopIPv4Address" dataType="ipv4Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="18" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv4 address of the next (adjacent) BGP hop.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4271 for a description of BGP-4.
        </paragraph>
      </reference>
    </field>

    <field name="bgpNextHopIPv6Address" dataType="ipv6Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="63" applicability="all" status="current">
      <description>
        <paragraph>
        The IPv6 address of the next (adjacent) BGP hop.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4271 for a description of BGP-4.
        </paragraph>
```

```
      </reference>
    </field>

    <field name="mplsTopLabelType" dataType="unsigned8"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="46" applicability="data" status="current">
      <description>
        <paragraph>
        This field identifies the control protocol that allocated the
        top-of-stack label.  Initial values for this field are
        listed below.  Further values may be assigned by IANA in
        the MPLS label type registry.
        </paragraph>
        <artwork>
       - 0x01 TE-MIDPT: Any TE tunnel mid-point or tail label
       - 0x02 Pseudowire: Any PWE3 or Cisco AToM based label
       - 0x03 VPN: Any label associated with VPN
       - 0x04 BGP: Any label associated with BGP or BGP routing
       - 0x05 LDP: Any label associated with dynamically assigned
                   labels using LDP
        </artwork>
      </description>
      <reference>
        <paragraph>
        See RFC 3031 for the MPLS label structure.
        See RFC 4364 for the association of MPLS labels
        with Virtual Private Networks (VPNs).
        See RFC 4271 for BGP and BGP routing.
        See RFC 5036 for Label Distribution Protocol (LDP).
        See the list of MPLS label types assigned by IANA at
        http://www.iana.org/assignments/mpls-label-values.
        </paragraph>
      </reference>
    </field>

    <field name="mplsTopLabelIPv4Address" dataType="ipv4Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="47" applicability="data" status="current">
      <description>
        <paragraph>
          The IPv4 address of the system that the MPLS top label will
          cause this Flow to be forwarded to.
        </paragraph>
      </description>
      <reference>
        <paragraph>
```

```
        See RFC 3031 for the association between
        MPLS labels and IP addresses.
        </paragraph>
      </reference>
    </field>

    <field name="mplsTopLabelIPv6Address" dataType="ipv6Address"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="140" applicability="data" status="current">
      <description>
        <paragraph>
          The IPv6 address of the system that the MPLS top label will
          cause this Flow to be forwarded to.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 3031 for the association between
        MPLS labels and IP addresses.
        </paragraph>
      </reference>
    </field>

    <field name="mplsVpnRouteDistinguisher" dataType="octetArray"
           group="derived"
           dataTypeSemantics="identifier"
           elementId="90" applicability="all" status="current">
      <description>
        <paragraph>
        The value of the VPN route distinguisher of a corresponding
        entry in a VPN routing and forwarding table.  Route
        distinguisher ensures that the same address can be used in
        several different MPLS VPNs and that it is possible for BGP to
        carry several completely different routes to that address, one
        for each VPN.  According to RFC 4364, the size of
        mplsVpnRouteDistinguisher is 8 octets.  However, in RFC 4382 an
        octet string with flexible length was chosen for representing a
        VPN route distinguisher by object MplsL3VpnRouteDistinguisher.
        This choice was made in order to be open to future changes of
        the size.  This idea was adopted when choosing octetArray as
        abstract data type for this Information Element.  The maximum
        length of this Information Element is 256 octets.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 4364 for the specification of the route
```

```
        distinguisher.  See RFC 4382 for the specification
        of the MPLS/BGP Layer 3 Virtual Private Network (VPN)
        Management Information Base.
        </paragraph>
      </reference>
    </field>

    <field name="minimumIpTotalLength" dataType="unsigned64"
           group="minMax"
           elementId="25" applicability="all" status="current">
      <description>
        <paragraph>
        Length of the smallest packet observed for this Flow.
        The packet length includes the IP header(s) length and
        the IP payload length.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 total length.
        See RFC 2460 for the specification of the
        IPv6 payload length.
        See RFC 2675 for the specification of the
        IPv6 jumbo payload length.
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="maximumIpTotalLength" dataType="unsigned64"
           group="minMax"
           elementId="26" applicability="all" status="current">
      <description>
        <paragraph>
        Length of the largest packet observed for this Flow.
        The packet length includes the IP header(s) length and
        the IP payload length.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the specification of the
        IPv4 total length.
        See RFC 2460 for the specification of the
        IPv6 payload length.
        See RFC 2675 for the specification of the
        IPv6 jumbo payload length.
```

```
        </paragraph>
      </reference>
      <units>octets</units>
    </field>

    <field name="minimumTTL" dataType="unsigned8"
           group="minMax"
           elementId="52" applicability="data" status="current">
      <description>
        <paragraph>
          Minimum TTL value observed for any packet in this Flow.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the definition of the IPv4
        Time to Live field.
        See RFC 2460 for the definition of the IPv6
        Hop Limit field.
        </paragraph>
      </reference>
      <units>hops</units>
    </field>

    <field name="maximumTTL" dataType="unsigned8"
           group="minMax"
           elementId="53" applicability="data" status="current">
      <description>
        <paragraph>
          Maximum TTL value observed for any packet in this Flow.
        </paragraph>
      </description>
      <reference>
       <paragraph>
       See RFC 791 for the definition of the IPv4
       Time to Live field.
       See RFC 2460 for the definition of the IPv6
       Hop Limit field.
       </paragraph>
      </reference>
      <units>hops</units>
    </field>

    <field name="ipv4Options" dataType="unsigned32"
           dataTypeSemantics="flags"
           group="minMax"
           elementId="208" applicability="all" status="current">
      <description>
```

```
      <paragraph>
      IPv4 options in packets of this Flow.
      The information is encoded in a set of bit fields.  For
      each valid IPv4 option type, there is a bit in this set.
      The bit is set to 1 if any observed packet of this Flow
      contains the corresponding IPv4 option type.  Otherwise,
      if no observed packet of this Flow contained the
      respective IPv4 option type, the value of the
      corresponding bit is 0.
      </paragraph>
      <paragraph>
      The list of valid IPv4 options is maintained by IANA.
      Note that for identifying an option not just the 5-bit
      Option Number, but all 8 bits of the Option Type need to
      match one of the IPv4 options specified at
      http://www.iana.org/assignments/ip-parameters.
      </paragraph>
      <paragraph>
      Options are mapped to bits according to their option numbers.
      Option number X is mapped to bit X.
      The mapping is illustrated by the figure below.
      </paragraph>
      <artwork>
        0      1      2      3      4      5      6      7
     +------+------+------+------+------+------+------+------+
     | EOOL | NOP  | SEC  | LSR  |  TS  |E-SEC |CIPSO |  RR  | ...
     +------+------+------+------+------+------+------+------+

         8      9     10     11     12     13     14     15
     +------+------+------+------+------+------+------+------+
 ... | SID  | SSR  | ZSU  | MTUP | MTUR | FINN | VISA |ENCODE| ...
     +------+------+------+------+------+------+------+------+

        16     17     18     19     20     21     22     23
     +------+------+------+------+------+------+------+------+
 ... |IMITD | EIP  |  TR  |ADDEXT|RTRALT| SDB  |NSAPA | DPS  | ...
     +------+------+------+------+------+------+------+------+

        24     25     26     27     28     29     30     31
     +------+------+------+------+------+------+------+------+
 ... | UMP  |  QS  |   to be assigned by IANA  | EXP  |      |
     +------+------+------+------+------+------+------+------+

         Type   Option
     Bit Value  Name    Reference
     ---+-----+-------+-----------------------------------
      0     0   EOOL    End of Options List, RFC 791
      1     1   NOP     No Operation, RFC 791
```

```
        2   130   SEC     Security, RFC 1108
        3   131   LSR     Loose Source Route, RFC 791
        4    68   TS      Time Stamp, RFC 791
        5   133   E-SEC   Extended Security, RFC 1108
        6   134   CIPSO   Commercial Security
        7     7   RR      Record Route, RFC 791
        8   136   SID     Stream ID, RFC 791
        9   137   SSR     Strict Source Route, RFC 791
       10    10   ZSU     Experimental Measurement
       11    11   MTUP    (obsoleted) MTU Probe, RFC 1191
       12    12   MTUR    (obsoleted) MTU Reply, RFC 1191
       13   205   FINN    Experimental Flow Control
       14   142   VISA    Experimental Access Control
       15    15   ENCODE
       16   144   IMITD   IMI Traffic Descriptor
       17   145   EIP     Extended Internet Protocol, RFC 1385
       18    82   TR      Traceroute, RFC 3193
       19   147   ADDEXT  Address Extension
       20   148   RTRALT  Router Alert, RFC 2113
       21   149   SDB     Selective Directed Broadcast
       22   150   NSAPA   NSAP Address
       23   151   DPS     Dynamic Packet State
       24   152   UMP     Upstream Multicast Pkt.
       25    25   QS      Quick-Start
       30    30   EXP     RFC3692-style Experiment
       30    94   EXP     RFC3692-style Experiment
       30   158   EXP     RFC3692-style Experiment
       30   222   EXP     RFC3692-style Experiment
       ...  ...   ...     Further options numbers
                          may be assigned by IANA

        </artwork>
      </description>
      <reference>
        <paragraph>
        See RFC 791 for the definition of IPv4 options.
        See the list of IPv4 option numbers assigned by IANA
        at http://www.iana.org/assignments/ip-parameters.
        </paragraph>
      </reference>
    </field>

    <field name="ipv6ExtensionHeaders" dataType="unsigned32"
           dataTypeSemantics="flags"
           group="minMax"
           elementId="64" applicability="all" status="current">
      <description>
        <paragraph>
```

```
   IPv6 extension headers observed in packets of this Flow.
   The information is encoded in a set of bit fields.  For
   each IPv6 option header, there is a bit in this set.
   The bit is set to 1 if any observed packet of this Flow
   contains the corresponding IPv6 extension header.
   Otherwise, if no observed packet of this Flow contained
   the respective IPv6 extension header, the value of the
   corresponding bit is 0.
   </paragraph>
   <artwork>
        0     1     2     3     4     5     6     7
    +-----+-----+-----+-----+-----+-----+-----+-----+
    | Res | FRA1| RH  | FRA0| UNK | Res | HOP | DST |  ...
    +-----+-----+-----+-----+-----+-----+-----+-----+

        8     9    10    11    12    13    14    15
    +-----+-----+-----+-----+-----+-----+-----+-----+
... | PAY | AH  | ESP |         Reserved            | ...
    +-----+-----+-----+-----+-----+-----+-----+-----+

       16    17    18    19    20    21    22    23
    +-----+-----+-----+-----+-----+-----+-----+-----+
... |                  Reserved                     | ...
    +-----+-----+-----+-----+-----+-----+-----+-----+
       24    25    26    27    28    29    30    31
    +-----+-----+-----+-----+-----+-----+-----+-----+
... |                  Reserved                     |
    +-----+-----+-----+-----+-----+-----+-----+-----+

  Bit    IPv6 Option   Description
 0, Res                Reserved
 1, FRA1     44        Fragmentation header - not first fragment
 2, RH       43        Routing header
 3, FRA0     44        Fragment header - first fragment
 4, UNK                Unknown Layer 4 header
                       (compressed, encrypted, not supported)
 5, Res                Reserved
 6, HOP       0        Hop-by-hop option header
 7, DST      60        Destination option header
 8, PAY     108        Payload compression header
 9, AH       51        Authentication Header
10, ESP      50        Encrypted security payload
11 to 31               Reserved
   </artwork>
 </description>
 <reference>
   <paragraph>
   See RFC 2460 for the general definition of
```

```
      IPv6 extension headers and for the specification of
      the hop-by-hop options header, the routing header,
      the fragment header, and the destination options header.
      See RFC 4302 for the specification of the
      authentication header.
      See RFC 4303 for the specification of the
      encapsulating security payload.
      </paragraph>
    </reference>
  </field>

  <field name="tcpControlBits" dataType="unsigned8"
         dataTypeSemantics="flags"
         group="minMax"
         elementId="6" applicability="all" status="current">
    <description>
      <paragraph>
      TCP control bits observed for packets of this Flow.
      The information is encoded in a set of bit fields.
      For each TCP control bit, there is a bit in this
      set.  A bit is set to 1 if any observed packet of this
      Flow has the corresponding TCP control bit set to 1.
      A value of 0 for a bit indicates that the corresponding
      bit was not set in any of the observed packets
      of this Flow.
      </paragraph>
      <artwork>
       0     1     2     3     4     5     6     7
   +-----+-----+-----+-----+-----+-----+-----+-----+
   |  Reserved | URG | ACK | PSH | RST | SYN | FIN |
   +-----+-----+-----+-----+-----+-----+-----+-----+

   Reserved:  Reserved for future use by TCP.  Must be zero.
        URG:  Urgent Pointer field significant
        ACK:  Acknowledgment field significant
        PSH:  Push Function
        RST:  Reset the connection
        SYN:  Synchronize sequence numbers
        FIN:  No more data from sender
      </artwork>
    </description>
    <reference>
      <paragraph>
      See RFC 793 for the definition of
      the TCP control bits in the TCP header.
      </paragraph>
    </reference>
  </field>
```

```
<field name="tcpOptions" dataType="unsigned64"
       dataTypeSemantics="flags"
       group="minMax"
       elementId="209" applicability="all" status="current">
  <description>
    <paragraph>
   TCP options in packets of this Flow.
   The information is encoded in a set of bit fields.  For
   each TCP option, there is a bit in this set.
   The bit is set to 1 if any observed packet of this Flow
   contains the corresponding TCP option.
   Otherwise, if no observed packet of this Flow contained
   the respective TCP option, the value of the
   corresponding bit is 0.
    </paragraph>
    <paragraph>
    Options are mapped to bits according to their option
    numbers.  Option number X is mapped to bit X.
    TCP option numbers are maintained by IANA.
    </paragraph>
    <artwork>
         0     1     2     3     4     5     6     7
     +-----+-----+-----+-----+-----+-----+-----+-----+
     |   0 |   1 |   2 |   3 |   4 |   5 |   6 |   7 |  ...
     +-----+-----+-----+-----+-----+-----+-----+-----+

         8     9    10    11    12    13    14    15
     +-----+-----+-----+-----+-----+-----+-----+-----+
 ... |   8 |   9 |  10 |  11 |  12 |  13 |  14 |  15 |...
     +-----+-----+-----+-----+-----+-----+-----+-----+

        16    17    18    19    20    21    22    23
     +-----+-----+-----+-----+-----+-----+-----+-----+
 ... |  16 |  17 |  18 |  19 |  20 |  21 |  22 |  23 |...
     +-----+-----+-----+-----+-----+-----+-----+-----+

                          . . .

        56    57    58    59    60    61    62    63
     +-----+-----+-----+-----+-----+-----+-----+-----+
 ... |  56 |  57 |  58 |  59 |  60 |  61 |  62 |  63 |
     +-----+-----+-----+-----+-----+-----+-----+-----+
    </artwork>
  </description>
  <reference>
    <paragraph>
    See RFC 793 for the definition of TCP options.
    See the list of TCP option numbers assigned by IANA
```

```
        at http://www.iana.org/assignments/tcp-parameters.
        </paragraph>
      </reference>
    </field>

    <field name="flowStartSeconds" dataType="dateTimeSeconds"
           group="timestamp"
           elementId="150" applicability="data" status="current">
      <description>
        <paragraph>
        The absolute timestamp of the first packet of this Flow.
        </paragraph>
      </description>
      <units>seconds</units>
    </field>

    <field name="flowEndSeconds" dataType="dateTimeSeconds"
           group="timestamp"
           elementId="151" applicability="data" status="current">
      <description>
        <paragraph>
        The absolute timestamp of the last packet of this Flow.
        </paragraph>
      </description>
      <units>seconds</units>
    </field>

    <field name="flowStartMilliseconds" dataType="dateTimeMilliseconds"
           group="timestamp"
           elementId="152" applicability="data" status="current">
      <description>
        <paragraph>
        The absolute timestamp of the first packet of this Flow.
        </paragraph>
      </description>
      <units>milliseconds</units>
    </field>

    <field name="flowEndMilliseconds" dataType="dateTimeMilliseconds"
           group="timestamp"
           elementId="153" applicability="data" status="current">
      <description>
        <paragraph>
        The absolute timestamp of the last packet of this Flow.
        </paragraph>
      </description>
      <units>milliseconds</units>
    </field>
```

```
<field name="flowStartMicroseconds" dataType="dateTimeMicroseconds"
       group="timestamp"
       elementId="154" applicability="data" status="current">
  <description>
    <paragraph>
    The absolute timestamp of the first packet of this Flow.
    </paragraph>
  </description>
  <units>microseconds</units>
</field>

<field name="flowEndMicroseconds" dataType="dateTimeMicroseconds"
       group="timestamp"
       elementId="155" applicability="data" status="current">
  <description>
    <paragraph>
    The absolute timestamp of the last packet of this Flow.
    </paragraph>
  </description>
  <units>microseconds</units>
</field>

<field name="flowStartNanoseconds" dataType="dateTimeNanoseconds"
       group="timestamp"
       elementId="156" applicability="data" status="current">
  <description>
    <paragraph>
    The absolute timestamp of the first packet of this Flow.
    </paragraph>
  </description>
  <units>nanoseconds</units>
</field>

<field name="flowEndNanoseconds" dataType="dateTimeNanoseconds"
       group="timestamp"
       elementId="157" applicability="data" status="current">
  <description>
    <paragraph>
    The absolute timestamp of the last packet of this Flow.
    </paragraph>
  </description>
  <units>nanoseconds</units>
</field>

<field name="flowStartDeltaMicroseconds" dataType="unsigned32"
       group="timestamp"
       elementId="158" applicability="data" status="current">
  <description>
```

```
        <paragraph>
        This is a relative timestamp only valid within the scope
        of a single IPFIX Message.  It contains the negative time
        offset of the first observed packet of this Flow relative
        to the export time specified in the IPFIX Message Header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See the IPFIX protocol specification [RFC5101] for the
        definition of the IPFIX Message Header.
        </paragraph>
      </reference>
      <units>microseconds</units>
    </field>

    <field name="flowEndDeltaMicroseconds" dataType="unsigned32"
           group="timestamp"
           elementId="159" applicability="data" status="current">
      <description>
        <paragraph>
        This is a relative timestamp only valid within the scope
        of a single IPFIX Message.  It contains the negative time
        offset of the last observed packet of this Flow relative
        to the export time specified in the IPFIX Message Header.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See the IPFIX protocol specification [RFC5101] for the
        definition of the IPFIX Message Header.
        </paragraph>
      </reference>
      <units>microseconds</units>
    </field>

    <field name="systemInitTimeMilliseconds"
           dataType="dateTimeMilliseconds"
           group="timestamp"
           elementId="160" applicability="data" status="current">
      <description>
        <paragraph>
        The absolute timestamp of the last (re-)initialization of the
        IPFIX Device.
        </paragraph>
      </description>
      <units>milliseconds</units>
    </field>
```

```
<field name="flowStartSysUpTime" dataType="unsigned32"
       group="timestamp"
       elementId="22" applicability="data" status="current">
  <description>
    <paragraph>
    The relative timestamp of the first packet of this Flow.
    It indicates the number of milliseconds since the
    last (re-)initialization of the IPFIX Device (sysUpTime).
    </paragraph>
  </description>
  <units>milliseconds</units>
</field>

<field name="flowEndSysUpTime" dataType="unsigned32"
       group="timestamp"
       elementId="21" applicability="data" status="current">
  <description>
    <paragraph>
    The relative timestamp of the last packet of this Flow.
    It indicates the number of milliseconds since the
    last (re-)initialization of the IPFIX Device (sysUpTime).
    </paragraph>
  </description>
  <units>milliseconds</units>
</field>

<field name="octetDeltaCount" dataType="unsigned64"
       dataTypeSemantics="deltaCounter"
       group="flowCounter"
       elementId="1" applicability="data" status="current">
  <description>
    <paragraph>
    The number of octets since the previous report (if any)
    in incoming packets for this Flow at the Observation Point.
    The number of octets includes IP header(s) and IP payload.
    </paragraph>
  </description>
  <units>octets</units>
</field>

<field name="postOctetDeltaCount" dataType="unsigned64"
       dataTypeSemantics="deltaCounter"
       group="flowCounter"
       elementId="23" applicability="data" status="current">
  <description>
    <paragraph>
    The definition of this Information Element is identical
    to the definition of Information Element
```

```
        'octetDeltaCount', except that it reports a
        potentially modified value caused by a middlebox
        function after the packet passed the Observation Point.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="octetDeltaSumOfSquares" dataType="unsigned64"
           group="flowCounter"
           elementId="198" applicability="data" status="current">
      <description>
        <paragraph>
        The sum of the squared numbers of octets per incoming
        packet since the previous report (if any) for this
        Flow at the Observation Point.
        The number of octets includes IP header(s) and IP payload.
        </paragraph>
      </description>
    </field>

    <field name="octetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="85" applicability="all" status="current">
      <description>
        <paragraph>
        The total number of octets in incoming packets
        for this Flow at the Observation Point since the Metering
        Process (re-)initialization for this Observation Point.  The
        number of octets includes IP header(s) and IP payload.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="postOctetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="171" applicability="all" status="current">
      <description>
        <paragraph>
        The definition of this Information Element is identical
        to the definition of Information Element
        'octetTotalCount', except that it reports a
        potentially modified value caused by a middlebox
        function after the packet passed the Observation Point.
        </paragraph>
```

```
      </description>
      <units>octets</units>
    </field>

    <field name="octetTotalSumOfSquares" dataType="unsigned64"
           group="flowCounter"
           elementId="199" applicability="all" status="current">
      <description>
        <paragraph>
        The total sum of the squared numbers of octets in incoming
        packets for this Flow at the Observation Point since the
        Metering Process (re-)initialization for this Observation
        Point.  The number of octets includes IP header(s) and IP
        payload.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="packetDeltaCount" dataType="unsigned64"
           dataTypeSemantics="deltaCounter"
           group="flowCounter"
           elementId="2" applicability="data" status="current">
      <description>
        <paragraph>
        The number of incoming packets since the previous report
        (if any) for this Flow at the Observation Point.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="postPacketDeltaCount" dataType="unsigned64"
           dataTypeSemantics="deltaCounter"
           group="flowCounter"
           elementId="24" applicability="data" status="current">
      <description>
        <paragraph>
        The definition of this Information Element is identical
        to the definition of Information Element
        'packetDeltaCount', except that it reports a
        potentially modified value caused by a middlebox
        function after the packet passed the Observation Point.
        </paragraph>
      </description>
      <units>packets</units>
    </field>
```

```
<field name="packetTotalCount" dataType="unsigned64"
       dataTypeSemantics="totalCounter"
       group="flowCounter"
       elementId="86" applicability="all" status="current">
  <description>
    <paragraph>
    The total number of incoming packets for this Flow
    at the Observation Point since the Metering Process
    (re-)initialization for this Observation Point.
    </paragraph>
  </description>
  <units>packets</units>
</field>

<field name="postPacketTotalCount" dataType="unsigned64"
       dataTypeSemantics="totalCounter"
       group="flowCounter"
       elementId="172" applicability="all" status="current">
  <description>
    <paragraph>
    The definition of this Information Element is identical
    to the definition of Information Element
    'packetTotalCount', except that it reports a
    potentially modified value caused by a middlebox
    function after the packet passed the Observation Point.
    </paragraph>
  </description>
  <units>packets</units>
</field>

<field name="droppedOctetDeltaCount" dataType="unsigned64"
       dataTypeSemantics="deltaCounter"
       group="flowCounter"
       elementId="132" applicability="data" status="current">
  <description>
    <paragraph>
    The number of octets since the previous report (if any)
    in packets of this Flow dropped by packet treatment.
    The number of octets includes IP header(s) and IP payload.
    </paragraph>
  </description>
  <units>octets</units>
</field>

<field name="droppedPacketDeltaCount" dataType="unsigned64"
       dataTypeSemantics="deltaCounter"
       group="flowCounter"
       elementId="133" applicability="data" status="current">
```

```
      <description>
        <paragraph>
        The number of packets since the previous report (if any)
        of this Flow dropped by packet treatment.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="droppedOctetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="134" applicability="data" status="current">
      <description>
        <paragraph>
        The total number of octets in packets of this Flow dropped
        by packet treatment since the Metering Process
        (re-)initialization for this Observation Point.
        The number of octets includes IP header(s) and IP payload.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="droppedPacketTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="135" applicability="data" status="current">
      <description>
        <paragraph>
        The number of packets of this Flow dropped by packet
        treatment since the Metering Process
        (re-)initialization for this Observation Point.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="postMCastPacketDeltaCount" dataType="unsigned64"
           dataTypeSemantics="deltaCounter"
           group="flowCounter"
           elementId="19" applicability="data" status="current">
      <description>
        <paragraph>
        The number of outgoing multicast packets since the
        previous report (if any) sent for packets of this Flow
        by a multicast daemon within the Observation Domain.
        This property cannot necessarily be observed at the
```

```
        Observation Point, but may be retrieved by other means.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="postMCastOctetDeltaCount" dataType="unsigned64"
           dataTypeSemantics="deltaCounter"
           group="flowCounter"
           elementId="20" applicability="data" status="current">
      <description>
        <paragraph>
        The number of octets since the previous report (if any)
        in outgoing multicast packets sent for packets of this
        Flow by a multicast daemon within the Observation Domain.
        This property cannot necessarily be observed at the
        Observation Point, but may be retrieved by other means.
        The number of octets includes IP header(s) and IP payload.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="postMCastPacketTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="174" applicability="data" status="current">
      <description>
        <paragraph>
        The total number of outgoing multicast packets sent for
        packets of this Flow by a multicast daemon within the
        Observation Domain since the Metering Process
        (re-)initialization.  This property cannot necessarily
        be observed at the Observation Point, but may be retrieved
        by other means.
        </paragraph>
      </description>
      <units>packets</units>
    </field>

    <field name="postMCastOctetTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="175" applicability="data" status="current">
      <description>
        <paragraph>
        The total number of octets in outgoing multicast packets
        sent for packets of this Flow by a multicast daemon in the
```

```
        Observation Domain since the Metering Process
        (re-)initialization.  This property cannot necessarily be
        observed at the Observation Point, but may be retrieved by
        other means.
        The number of octets includes IP header(s) and IP payload.
        </paragraph>
      </description>
      <units>octets</units>
    </field>

    <field name="tcpSynTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="218" applicability="data" status="current">
      <description>
        <paragraph>
         The total number of packets of this Flow with
         TCP "Synchronize sequence numbers" (SYN) flag set.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP SYN flag.
        </paragraph>
      </reference>
      <units>packets</units>
    </field>

    <field name="tcpFinTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="219" applicability="data" status="current">
      <description>
        <paragraph>
         The total number of packets of this Flow with
         TCP "No more data from sender" (FIN) flag set.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP FIN flag.
        </paragraph>
      </reference>
      <units>packets</units>
    </field>

    <field name="tcpRstTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
```

```
            group="flowCounter"
            elementId="220" applicability="data" status="current">
        <description>
          <paragraph>
           The total number of packets of this Flow with
           TCP "Reset the connection" (RST) flag set.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 793 for the definition of the TCP RST flag.
          </paragraph>
        </reference>
        <units>packets</units>
      </field>

      <field name="tcpPshTotalCount" dataType="unsigned64"
            dataTypeSemantics="totalCounter"
            group="flowCounter"
            elementId="221" applicability="data" status="current">
        <description>
          <paragraph>
           The total number of packets of this Flow with
           TCP "Push Function" (PSH) flag set.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 793 for the definition of the TCP PSH flag.
          </paragraph>
        </reference>
        <units>packets</units>
      </field>

      <field name="tcpAckTotalCount" dataType="unsigned64"
            dataTypeSemantics="totalCounter"
            group="flowCounter"
            elementId="222" applicability="data" status="current">
        <description>
          <paragraph>
           The total number of packets of this Flow with
           TCP "Acknowledgment field significant" (ACK) flag set.
          </paragraph>
        </description>
        <reference>
          <paragraph>
          See RFC 793 for the definition of the TCP ACK flag.
          </paragraph>
```

```
      </reference>
      <units>packets</units>
    </field>

    <field name="tcpUrgTotalCount" dataType="unsigned64"
           dataTypeSemantics="totalCounter"
           group="flowCounter"
           elementId="223" applicability="data" status="current">
      <description>
        <paragraph>
         The total number of packets of this Flow with
         TCP "Urgent Pointer field significant" (URG) flag set.
        </paragraph>
      </description>
      <reference>
        <paragraph>
        See RFC 793 for the definition of the TCP URG flag.
        </paragraph>
      </reference>
      <units>packets</units>
    </field>

    <field name="flowActiveTimeout" dataType="unsigned16"
           group="misc"
           elementId="36" applicability="all" status="current">
      <description>
        <paragraph>
        The number of seconds after which an active Flow is timed out
        anyway, even if there is still a continuous flow of packets.
        </paragraph>
      </description>
      <units>seconds</units>
    </field>

    <field name="flowIdleTimeout" dataType="unsigned16"
           group="misc"
           elementId="37" applicability="all" status="current">
      <description>
        <paragraph>
         A Flow is considered to be timed out if no packets belonging
         to the Flow have been observed for the number of seconds
         specified by this field.
        </paragraph>
      </description>
      <units>seconds</units>
    </field>

    <field name="flowEndReason" dataType="unsigned8"
```

```
            group="misc"
            dataTypeSemantics="identifier"
            elementId="136" applicability="data" status="current">
        <description>
          <paragraph>
          The reason for Flow termination.  The range of values includes
          the following:
          </paragraph>
          <artwork>
       0x01: idle timeout
             The Flow was terminated because it was considered to be
             idle.
       0x02: active timeout
             The Flow was terminated for reporting purposes while it was
             still active, for example, after the maximum lifetime of
             unreported Flows was reached.
       0x03: end of Flow detected
             The Flow was terminated because the Metering Process
             detected signals indicating the end of the Flow,
             for example, the TCP FIN flag.
       0x04: forced end
             The Flow was terminated because of some external event,
             for example, a shutdown of the Metering Process initiated
             by a network management application.
       0x05: lack of resources
             The Flow was terminated because of lack of resources
             available to the Metering Process and/or the Exporting
             Process.
          </artwork>
        </description>
      </field>

      <field name="flowDurationMilliseconds" dataType="unsigned32"
             group="misc"
             elementId="161" applicability="data" status="current">
        <description>
          <paragraph>
          The difference in time between the first observed packet
          of this Flow and the last observed packet of this Flow.
          </paragraph>
        </description>
        <units>milliseconds</units>
      </field>

      <field name="flowDurationMicroseconds" dataType="unsigned32"
             group="misc"
             elementId="162" applicability="data" status="current">
        <description>
```

```
        <paragraph>
        The difference in time between the first observed packet
        of this Flow and the last observed packet of this Flow.
        </paragraph>
      </description>
      <units>microseconds</units>
    </field>

    <field name="flowDirection" dataType="unsigned8"
           dataTypeSemantics="identifier"
           group="misc"
           elementId="61" applicability="data" status="current">
      <description>
        <paragraph>
        The direction of the Flow observed at the Observation
        Point.  There are only two values defined.
        </paragraph>
        <artwork>
        0x00: ingress flow
        0x01: egress flow
        </artwork>
      </description>
    </field>

    <field name="paddingOctets" dataType="octetArray"
           group="padding"
           elementId="210" applicability="option" status="current">
      <description>
        <paragraph>
          The value of this Information Element is always a sequence of
          0x00 values.
        </paragraph>
      </description>
    </field>

  </fieldDefinitions>
```

Appendix B. XML Specification of Abstract Data Types

This appendix contains a machine-readable description of the abstract data types to be used for IPFIX Information Elements and a machine-readable description of the template used for defining IPFIX Information Elements. Note that this appendix is of informational nature, while the text in Sections 2 and 3 (generated from this appendix) is normative.

At the same time, this appendix is also an XML schema that was used for creating the XML specification of Information Elements in

Appendix A. It may also be used for specifying further Information Elements in extensions of the IPFIX information model. This schema and its namespace are registered by IANA at http://www.iana.org/assignments/xml-registry/schema/ipfix.xsd.

```
<?xml version="1.0" encoding="UTF-8"?>

<schema targetNamespace="urn:ietf:params:xml:ns:ipfix-info"
        xmlns:ipfix="urn:ietf:params:xml:ns:ipfix-info"
        xmlns="http://www.w3.org/2001/XMLSchema"
        elementFormDefault="qualified">

  <simpleType name="dataType">
    <restriction base="string">
      <enumeration value="unsigned8">
        <annotation>
          <documentation>The type "unsigned8" represents a
            non-negative integer value in the range of 0 to 255.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="unsigned16">
        <annotation>
          <documentation>The type "unsigned16" represents a
            non-negative integer value in the range of 0 to 65535.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="unsigned32">
        <annotation>
          <documentation>The type "unsigned32" represents a
             non-negative integer value in the range of 0 to
             4294967295.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="unsigned64">
        <annotation>
          <documentation>The type "unsigned64" represents a
            non-negative integer value in the range of 0 to
            18446744073709551615.
          </documentation>
        </annotation>
      </enumeration>
```

```
        <enumeration value="signed8">
          <annotation>
            <documentation>The type "signed8" represents
              an integer value in the range of -128 to 127.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="signed16">
          <annotation>
            <documentation>The type "signed16" represents an
              integer value in the range of -32768 to 32767.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="signed32">
          <annotation>
            <documentation>The type "signed32" represents an
               integer value in the range of -2147483648 to
               2147483647.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="signed64">
          <annotation>
            <documentation>The type "signed64" represents an
               integer value in the range of -9223372036854775808
               to 9223372036854775807.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="float32">
          <annotation>
            <documentation>The type "float32" corresponds to an IEEE
              single-precision 32-bit floating point type as defined
              in [IEEE.754.1985].
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="float64">
          <annotation>
            <documentation>The type "float64" corresponds to an IEEE
              double-precision 64-bit floating point type as defined
              in [IEEE.754.1985].
```

```
      </documentation>
    </annotation>
  </enumeration>

  <enumeration value="boolean">
    <annotation>
      <documentation>The type "boolean" represents a binary
        value.  The only allowed values are "true" and "false".
      </documentation>
    </annotation>
  </enumeration>

  <enumeration value="macAddress">
    <annotation>
      <documentation>The type "macAddress" represents a
        string of 6 octets.
      </documentation>
    </annotation>
  </enumeration>

  <enumeration value="octetArray">
    <annotation>
      <documentation>The type "octetArray" represents a
     finite-length string of octets.
      </documentation>
    </annotation>
  </enumeration>

  <enumeration value="string">
    <annotation>
      <documentation>
        The type "string" represents a finite-length string
        of valid characters from the Unicode character encoding
        set [ISO.10646-1.1993].  Unicode allows for ASCII
        [ISO.646.1991] and many other international character
        sets to be used.
      </documentation>
    </annotation>
  </enumeration>

  <enumeration value="dateTimeSeconds">
    <annotation>
      <documentation>
        The type "dateTimeSeconds" represents a time value
        in units of seconds based on coordinated universal time
        (UTC).  The choice of an epoch, for example, 00:00 UTC,
        January 1, 1970, is left to corresponding encoding
        specifications for this type, for example, the IPFIX
```

```
            protocol specification.  Leap seconds are excluded.
            Note that transformation of values might be required
            between different encodings if different epoch values
            are used.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="dateTimeMilliseconds">
        <annotation>
          <documentation>The type "dateTimeMilliseconds" represents
            a time value in units of milliseconds
            based on coordinated universal time (UTC).
            The choice of an epoch, for example,  00:00 UTC,
            January 1, 1970, is left to corresponding encoding
            specifications for this type, for example, the IPFIX
            protocol specification.  Leap seconds are excluded.
            Note that transformation of values might be required
            between different encodings if different epoch values
            are used.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="dateTimeMicroseconds">
        <annotation>
          <documentation>The type "dateTimeMicroseconds" represents
            a time value in units of microseconds
            based on coordinated universal time (UTC).
            The choice of an epoch, for example,  00:00 UTC,
            January 1, 1970, is left to corresponding encoding
            specifications for this type, for example, the IPFIX
            protocol specification.  Leap seconds are excluded.
            Note that transformation of values might be required
            between different encodings if different epoch values
            are used.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="dateTimeNanoseconds">
        <annotation>
          <documentation>The type "dateTimeNanoseconds" represents
            a time value in units of nanoseconds
            based on coordinated universal time (UTC).
            The choice of an epoch, for example,  00:00 UTC,
            January 1, 1970, is left to corresponding encoding
            specifications for this type, for example, the IPFIX
```

```
              protocol specification.  Leap seconds are excluded.
              Note that transformation of values might be required
              between different encodings if different epoch values
              are used.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="ipv4Address">
          <annotation>
            <documentation>The type "ipv4Address" represents a value
              of an IPv4 address.
            </documentation>
          </annotation>
        </enumeration>
        <enumeration value="ipv6Address">
          <annotation>
            <documentation>The type "ipv6Address" represents a value
              of an IPv6 address.
            </documentation>
          </annotation>
        </enumeration>
      </restriction>
    </simpleType>

    <simpleType name="dataTypeSemantics">
      <restriction base="string">
        <enumeration value="quantity">
          <annotation>
            <documentation>
              A quantity value represents a discrete
              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.  If no semantic qualifier is
              given, the Information Elements that have an integral
              data type should behave as a quantity.
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="totalCounter">
          <annotation>
            <documentation>
              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 SNMP, such as Counter32 defined in
            RFC 2578 [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.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="deltaCounter">
        <annotation>
          <documentation>
            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 defined in
            RFC 2578 [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 its value is exported.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="identifier">
        <annotation>
          <documentation>
            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.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="flags">
        <annotation>
          <documentation>
```

```
            An integral value that actually represents a set of
            bit fields.  Logical operations are appropriate on
            such values, but not other mathematical operations.
            Flags should always be of an unsigned type.
          </documentation>
        </annotation>
      </enumeration>
    </restriction>
  </simpleType>

  <simpleType name="applicability">
    <restriction base="string">
      <enumeration value="data">
        <annotation>
          <documentation>
            Used for Information Elements that are applicable to
            Flow Records only.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="option">
        <annotation>
          <documentation>
            Used for Information Elements that are applicable to
            option records only.
          </documentation>
        </annotation>
      </enumeration>

      <enumeration value="all">
        <annotation>
          <documentation>
            Used for Information Elements that are applicable to
            Flow Records as well as to option records.
          </documentation>
        </annotation>
      </enumeration>
    </restriction>
  </simpleType>

  <simpleType name="status">
    <restriction base="string">
      <enumeration value="current">
        <annotation>
          <documentation>
            Indicates that the Information Element definition
            is current and valid.
```

```
            </documentation>
          </annotation>
        </enumeration>

        <enumeration value="deprecated">
          <annotation>
            <documentation>
              Indicates that the Information Element definition is
              obsolete, but it permits new/continued implementation
              in order to foster interoperability with older/existing
              implementations.
            </documentation>
          </annotation>
        </enumeration>
        <enumeration value="obsolete">
          <annotation>
            <documentation>
              Indicates that the Information Element definition is
              obsolete and should not be implemented and/or can be
              removed if previously implemented.
            </documentation>
          </annotation>
        </enumeration>
      </restriction>
    </simpleType>

    <complexType name="text">
      <choice maxOccurs="unbounded" minOccurs="0">
        <element name="paragraph">
          <complexType mixed="true">
            <sequence>
               <element maxOccurs="unbounded" minOccurs="0"
                 name="xref">
                 <complexType>
                   <attribute name="target" type="string"
                     use="required"/>
                 </complexType>
               </element>
            </sequence>
          </complexType>
        </element>
        <element name="artwork">
          <simpleType>
            <restriction base="string"/>
          </simpleType>
        </element>
      </choice>
    </complexType>
```

```
<simpleType name="range">
  <restriction base="string"/>
</simpleType>
<element name="fieldDefinitions">
  <complexType>
    <sequence>
      <element maxOccurs="unbounded" minOccurs="1" name="field">
        <complexType>
          <sequence>
            <element maxOccurs="1" minOccurs="1" name="description"
                     type="ipfix:text">
              <annotation>
                <documentation>
                  The semantics of this Information Element.
                  Describes how this Information Element is
                  derived from the Flow or other information
                  available to the observer.
                </documentation>
              </annotation>
            </element>

            <element maxOccurs="1" minOccurs="0" name="reference"
                     type="ipfix:text">
              <annotation>
                <documentation>
                  Identifies additional specifications that more
                  precisely define this item or provide additional
                  context for its use.
                </documentation>
              </annotation>
            </element>

            <element maxOccurs="1" minOccurs="0" name="units"
                     type="string">
              <annotation>
                <documentation>
                  If the Information Element is a measure of some
                  kind, the units identify what the measure is.
                </documentation>
              </annotation>
            </element>

            <element maxOccurs="1" minOccurs="0" name="range"
                     type="ipfix:range">
              <annotation>
                <documentation>
                  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.
          </documentation>
        </annotation>
      </element>
    </sequence>

    <attribute name="name" type="string" use="required">
      <annotation>
        <documentation>
          A unique and meaningful name for the Information
          Element.
        </documentation>
      </annotation>
    </attribute>

    <attribute name="dataType" type="ipfix:dataType"
               use="required">
      <annotation>
        <documentation>
          One of the types listed in Section 3.1 of this
          document or in a future extension of the
          information model.  The type space for attributes
          is constrained to facilitate implementation.  The
          existing type space does however encompass most
          basic types used in modern programming languages,
          as well as some derived types (such as ipv4Address)
          that are common to this domain and useful
          to distinguish.
        </documentation>
      </annotation>
    </attribute>

    <attribute name="dataTypeSemantics"
               type="ipfix:dataTypeSemantics" use="optional">
      <annotation>
        <documentation>
          The integral types may be qualified by additional
          semantic details.  Valid values for the data type
          semantics are specified in Section 3.2 of this
          document or in a future extension of the
          information model.
        </documentation>
      </annotation>
    </attribute>

    <attribute name="elementId" type="nonNegativeInteger"
```

```
                use="required">
      <annotation>
        <documentation>
          A numeric identifier of the Information Element.
          If this identifier is used without an enterprise
          identifier (see [RFC5101] and
          enterpriseId 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.
        </documentation>
      </annotation>
    </attribute>

    <attribute name="enterpriseId" type="nonNegativeInteger"
                use="optional">
      <annotation>
        <documentation>
          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 codes.  They are defined at
          http://www.iana.org/assignments/enterprise-numbers.
        </documentation>
      </annotation>
    </attribute>

    <attribute name="applicability"
                type="ipfix:applicability" use="optional">
      <annotation>
        <documentation>
          This property of an Information
          Element indicates in which kind of records the
          Information Element can be used.
```

```
                    Allowed values for this property are 'data',
                    'option', and 'all'.
                  </documentation>
                </annotation>
              </attribute>

              <attribute name="status" type="ipfix:status"
                         use="required">
                <annotation>
                  <documentation>
                    The status of the specification of this
                    Information Element.  Allowed values are 'current',
                    'deprecated', and 'obsolete'.
                  </documentation>
                </annotation>
              </attribute>
              <attribute name="group" type="string"
                         use="required">
                <annotation>
                  <documentation>to be done ...</documentation>
                </annotation>
              </attribute>

            </complexType>
          </element>
        </sequence>
      </complexType>

      <unique name="infoElementIdUnique">
        <selector xpath="field"/>

        <field xpath="elementId"/>
      </unique>
    </element>
  </schema>
```

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