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Specification of the Protocol for IPFIX Mediations
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Abstract

This document specifies the IP Flow Information Export (IPFIX) protocol specific to the Mediation.

Status of this Memo

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Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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1. Introduction

The IPFIX architectural components in [RFC5470] consist of IPFIX Devices and IPFIX Collectors communicating using the IPFIX protocol [RFC5101], which specifies how to export IP Flow information. This protocol is designed to export information about IP traffic Flows and related measurement data, where a Flow is defined by a set of key attributes (e.g. source and destination IP address, source and destination port, etc.).

However, thanks to its Template mechanism, the IPFIX protocol can export any type of information, as long as the relevant Information Element is specified in the IPFIX Information Model [RFC5102], registered with IANA, or specified as an enterprise-specific Information Element. The specifications in the IPFIX protocol [RFC5101] have not been defined in the context of an IPFIX Mediator receiving, aggregating, correlating, anonymizing, etc... Flow Records from the one or multiple Exporters. Indeed, the IPFIX protocol must be adapted for Intermediate Processes, as defined in the IPFIX Mediation Reference Model as specified in the Figure A of [IPFIX-MED-FMWK], which is based on the IPFIX Mediation Problem Statement [RFC5982].

This document specifies the IP Flow Information Export (IPFIX) protocol in the context of the implementation and deployment of IPFIX Mediators. The use of the IPFIX protocol within a Mediator -- a device which contains both as an Exporting Process and a Collecting Process -- has an impact on the technical details of the usage of the protocol. An overview of the technical problem is covered in section 6 of the [RFC5982]: loss of original exporter information, loss of base time information, transport sessions management, loss of Options Template Information, Template Id management, considerations for network topology, and IPFIX Mediation interpretation, and considerations for aggregation.

The specifications in this document are based on the IPFIX protocol specifications but adapted according to the IPFIX Mediation Framework [IPFIX-MED-FMWK].

1.1. IPFIX Documents Overview

The IPFIX Protocol [RFC5101] provides network administrators with access to IP Flow information.

The architecture for the export of measured IP Flow information out of an IPFIX Exporting Process to a Collecting Process is defined in the IPFIX Architecture [RFC5470], per the requirements defined in RFC 3917 [RFC3917].

The IPFIX Architecture [RFC5470] specifies how IPFIX Data Records and Templates are carried via a congestion-aware transport protocol from IPFIX Exporting Processes to IPFIX Collecting Processes.

IPFIX has a formal description of IPFIX Information Elements, their name, type and additional semantic information, as specified in the IPFIX Information Model [RFC5102].

The IPFIX Applicability Statement [RFC5472] describes what type of applications can use the IPFIX protocol and how they can use the information provided. It furthermore shows how the IPFIX framework relates to other architectures and frameworks.

"IPFIX Mediation: Problem Statement" [RFC5982], describing the IPFIX Mediation applicability examples, along with some problems that network administrators have been facing, is the basis for the "IPFIX Mediation: Framework" [IPFIX-MED-FMWK]. This framework details the IPFIX Mediation reference model and the components of an IPFIX Mediator.

1.2. IPFIX Mediator Documents Overview

The "IPFIX Mediation: Problem Statement" [RFC5982] provides an overview of the applicability of Mediators, and defines requirements for Mediators in general terms. This document is of use largely to define the problems to be solved through the deployment of IPFIX Mediators, and to provide scope to the role of Mediators within an IPFIX collection infrastructure.

The "IPFIX Mediation: Framework" [IPFIX-MED-FMWK] provides more architectural details of the arrangement of Intermediate Processes within a Mediator.

The details of specific Intermediate Processes, when these have additional export specifications (e.g., metadata about the intermediate processing conveyed through IPFIX Options Templates), are each treated in their own document (e.g., the "IP Flow Anonymization Support" [RFC6235]). Documents specifying the operations of specific Intermediate Processes cover the operation of these Processes within the Mediator framework, and complying to the specifications given in this document; they may additionally specify the operation of the process independently, outside the context of a Mediator, when this is appropriate. As of today, these documents are:

1. "IP Flow Anonymization Support", [RFC6235], which describes Anonymization techniques for IP flow data and the export of Anonymized data using the IPFIX protocol.

2. "Flow Selection Techniques" [IPFIX-MED-FLOWSEL], which described the process of selecting a subset of flows from all flows observed at an observation point, along with the motivations, and some specific flow selection techniques.

3. "Exporting Aggregated Flow Data using the IP Flow Information Export" [IPFIX-MED-AGGR] which describes Aggregated Flow export within the framework of IPFIX Mediators and defines an interoperable, implementation-independent method for Aggregated Flow export.

1.3. Relationship with IPFIX and PSAMP

The specification in this document applies to the IPFIX protocol specifications [RFC5101]. All specifications from [RFC5101] apply unless specified otherwise in this document.

As the Packet Sampling (PSAMP) protocol specifications [RFC5476] are based on the IPFIX protocol specifications, the specifications in this document are also valid for the PSAMP protocol. Therefore, the method specified by this document also applies to PSAMP.

2. Terminology

The IPFIX-specific terms, such as Observation Domain, Flow, Flow Key, Metering Process, Exporting Process, Exporter, IPFIX Device, Collecting Process, Collector, Template, IPFIX Message, Message Header, Template Record, Data Record, Options Template Record, Set, Data Set, Information Element, and Transport Session, used in this document are defined in [RFC5101]. The PSAMP-specific terms used in this document, such as Filtering and Sampling are defined in [RFC5476].

The IPFIX Mediation terms related to the aggregation, such as the Interval, Aggregated Flow, and Aggregated Fonction are defined in [IPFIX-MED-AGGR].

The IPFIX Mediation-specific terminology used in this document is defined in "IPFIX Mediation: Problem Statement" [RFC5982], and reuse in "IPFIX Mediation: Framework" [IPFIX-MED-FMWK]. However, since those two documents are an informational RFC, the definitions have been reproduced here along with additional definitions.

Similarly, since the [RFC6235] is an experimental RFC, the Anonymization Record, Anonymized Data Record, and Intermediate Anonymization Process terms, specified in [RFC6235], are also reproduced here.

In this document, as in [RFC5101], [RFC5476], [IPFIX-MED-AGGR , and [RFC6235], the first letter of each IPFIX-specific and PSAMP-specific term is capitalized along with the IPFIX Mediation-specific term defined here. In this document, we call "record stream" a stream of records carrying flow- or packet-based information. The records may be encoded as IPFIX Data Records in any other format.

Transport Session Information

The Transport Session is specified in [RFC5101]. In SCTP, the Transport Session Information is the SCTP association. In TCP and UDP, the Transport Session Information corresponds to a 5-tuple {Exporter IP address, Collector IP address, Exporter transport port, Collector transport port, transport protocol}.

Original Exporter

An Original Exporter is an IPFIX Device that hosts the Observation Points where the metered IP packets are observed.

Original Observation Point

An Observation Point of the Original Exporter(s). In the case of the Intermediate Aggregation Process on an IPFIX Mediator, the Original Observation Point can be composed of a (set of) specific exporter(s), a (set of) specific interface(s) on an Exporter, a (set of) line card(s) on an Exporter, or any combinations of these.

IPFIX Mediation

IPFIX Mediation is the manipulation and conversion of a record stream for subsequent export using the IPFIX protocol.

The following terms are used in this document to describe the architectural entities used by IPFIX Mediation.

Intermediate Process

An Intermediate Process takes a record stream as its input from Collecting Processes, Metering Processes, IPFIX File Readers, other Intermediate Processes, or other record sources; performs some transformations on this stream, based upon the content of each record, states maintained across multiple records, or other data sources; and passes the transformed record stream as its output to Exporting Processes, IPFIX File Writers, or other Intermediate Processes, in order to perform IPFIX Mediation. Typically, an Intermediate Process is hosted by an IPFIX Mediator. Alternatively, an Intermediate Process may be hosted by an Original Exporter.

Specific Intermediate Processes are described below. However, this is not an exhaustive list.

Intermediate Conversion Process

An Intermediate Conversion Process is an Intermediate Process that transforms non-IPFIX into IPFIX, or manages the relation among Templates and states of incoming/outgoing Transport Sessions (or equivalent for non IPFIX protocols) in the case of transport protocol conversion (e.g., from UDP to SCTP).

Intermediate Aggregation Process

An Intermediate Aggregation Process is an Intermediate Process that aggregates records based upon a set of Flow Keys or functions applied to fields from the record (e.g., binning and subnet aggregation).

Intermediate Correlation Process

An Intermediate Correlation Process is an Intermediate Process that adds information to records, noting correlations among them, or generates new records with correlated data from multiple records (e.g., the production of bidirectional flow records from unidirectional flow records).

Intermediate Selection Process

An Intermediate Selection Process is an Intermediate Process that selects records from a sequence based upon criteria-evaluated record values and passes only those records that match the criteria (e.g., Filtering only records from a given network to a given Collector).

Intermediate Anonymization Process

An Intermediate Anonymization Process is an Intermediate Process that transforms records in order to anonymize them, to protect the identity of the entities described by the records (e.g., by applying prefix-preserving pseudonymization of IP addresses).

IPFIX Mediator

An IPFIX Mediator is an IPFIX Device that provides IPFIX Mediation by receiving a record stream from some data sources, hosting one or more Intermediate Processes to transform that stream, and exporting the transformed record stream into IPFIX Messages via an Exporting Process. In the common case, an IPFIX Mediator receives a record stream from a Collecting Process, but it could also receive a record stream from data sources not encoded using IPFIX, e.g., in the case of conversion from the NetFlow V9 protocol [RFC3954] to IPFIX protocol.

Template Mapping

A mapping from Template Records and/or Options Template Records received by a Mediator to Template Records and/or Options Template Records sent by that IPFIX Mediator. Each

entry in a Template Mapping is scoped by incoming or outgoing Transport Session and Observation Domain, as with Templates and Options Templates in the IPFIX Protocol.

Anonymization Record

A record, defined by the Anonymization Options Template in section Section 6.1, that defines the properties of the Anonymization applied to a single Information Element within a single Template or Options Template.

Anonymized Data Record

A Data Record within a Data Set containing at least one Information Element with Anonymized values. The Information Element(s) within the Template or Options Template describing this Data Record SHOULD have a corresponding Anonymization Record.

3. Specifications

This section describes the IPFIX specifications for Mediation: more specifically, specifications for generic Intermediate Processes. Possible specific Intermediate Processes are: Intermediate Conversion Process, Intermediate Aggregation Process, Intermediate Correlation Process, Intermediate Selection Process, Intermediate Anonymization Process.

For a specific Intermediate Process, the specifications in the following reference MUST be followed, on the top of the specifications in this document:

- For the Intermediate Aggregation Process, the specifications in [IPFIX-MED-AGGR] MUST be followed.
- For the Intermediate Selection Process, the specifications in [IPFIX-MED-FLOWSEL] MUST be followed.
- For the Intermediate Anonymization Process, the specifications in [RFC6235] should be considered as guidelines as [RFC6235] is an experimental RFC.

Note that no specific document deals with the Intermediate Conversion Process at the time of this publication.

These new specifications, which are more specific compared to [RFC5101], are described with the key words described in [RFC2119].

3.1. Encoding of IPFIX Message Header

The format of the IPFIX Message Header is shown in Figure A. Note that the format is similar to the IPFIX Message in [RFC5101], but some field definitions (for the example, the Export Time) have been updated in the context of the IPFIX Mediator.

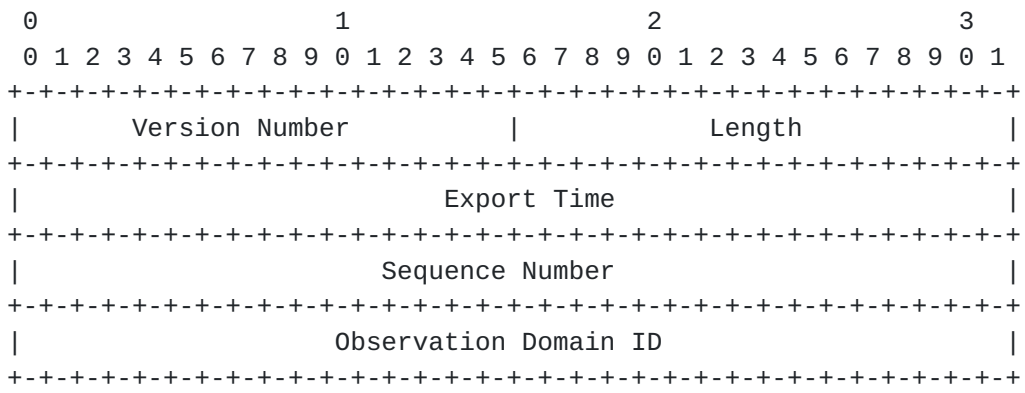


Figure A: IPFIX Message Header format

Message Header Field Descriptions

Version

Version of Flow Record format exported in this message. The value of this field is 0x000a for the current version, incrementing by one the version used in the NetFlow services export version 9 [RFC3954].

Length

Total length of the IPFIX Message, measured in octets, including Message Header and Set(s).

Export Time

Time in seconds since 0000 UTC Jan 1st 1970, at which the IPFIX Message Header leaves the IPFIX Mediator.

Sequence Number

Incremental sequence counter modulo 2^32 of all IPFIX Data Records sent on this PR-SCTP stream from the current Observation Domain by the Exporting Process. Check the specific meaning of this field in the sub-sections of section 10 when UDP or TCP is selected as the transport protocol. This value SHOULD be used by the Collecting Process to identify whether any IPFIX Data Records have been missed. Template and Options Template Records do not increase the Sequence Number.

Observation Domain ID

A 32-bit identifier of the Observation Domain that is locally unique to the Exporting Process. The Exporting Process uses the Observation Domain ID to uniquely identify to the Collecting Process the Observation Domain that metered the Flows. It is RECOMMENDED that this identifier is also unique per IPFIX Device. Collecting Processes SHOULD use the Transport Session and the Observation Domain ID field to separate different export streams originating from the same Exporting Process. The Observation Domain ID SHOULD be 0 when no specific Observation Domain ID is relevant for the entire IPFIX Message. For example, when exporting the Exporting Process Statistics, or in case of hierarchy of Collector when aggregated Data Records are exported.
Note: the Observation Domain Management is discussed in section 3.4.1.

3.2. Template Management

3.2.1. Template Management Without Template Records Change

The first case is a situation where the IPFIX Mediator doesn't modify the (Options) Template Record(s) content. A typical example is an Intermediate Selection Process acting as distributor, which collects Flow Records from one or multiple Exporters, and based on the Information Elements content, redirects the Flow Records to the appropriate Collector. This example is a typical case of a single network operation center managing multiple universities: an unique IPFIX Collector collects all Flow Records for the common infrastructure, but might be re-exporting specific university Flow Records to the responsible system administrator.

As specified in [RFC5101], the Template IDs are unique per Exporter, per Transport Session, and per Observation Domain. As there is no guarantee that, for similar Template Records, the Template IDs received on the incoming Transport Session and exported to the outgoing Transport Session would be same, the IPFIX Mediator MUST maintain a Template Mapping composed of similar received and exported (Options) Template Records:

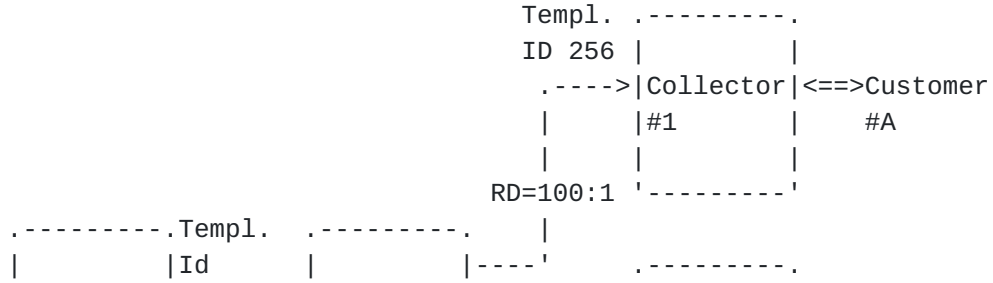
- for each received (Options) Template Record: Template Record Flow Keys and non Flow Keys, Template ID, Observation Domain Id, and Transport Session Information
- for each exported (Options) Template Record: Template Record Flow Keys and non Flow Keys, Template ID, Collector, Observation Domain Id, and Transport Session Information

If an IPFIX Mediator receives an IPFIX Withdrawal Message for a (Options) Template Record that is not used anymore in any outgoing Transport Sessions, the IPFIX Mediator SHOULD export the appropriate IPFIX Withdrawal Message(s) on the outgoing Transport Session, and remove the corresponding entry in the Template Mapping.

If a (Options) Template Record is not used anymore in an outgoing Transport Session, it MUST be withdrawn with an IPFIX Template Withdrawal Message on that specific outgoing Transport Session, and its entry MUST be removed from the Template Mapping.

If an incoming or outgoing Transport Session is gracefully shutdown or reset, the (Options) Template Records corresponding to that Transport Session MUST be removed from the Template Mapping.

Figure B displays an example of an Intermediate Selection Process, re-distributing Data Records to Collectors on the basis of the customer networks, i.e. the Route Distinguisher (RD). In this example, the Template Record received from the Exporter#1 is reused towards the Collector#1, Collector#2, and Collector#3.



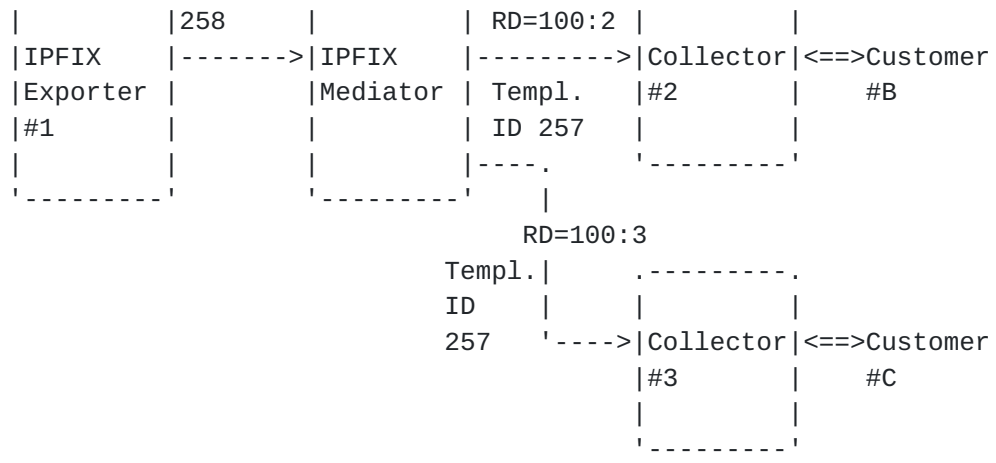


Figure B: Intermediate Aggregation Process Example

Template Entry A:
 Incoming Transport Session Information (from Exporter#1):
   Source IP: <Exporter#1 export IP address>
   Destination IP: <IPFIX Mediator IP address>
   Protocol: SCTP
   Source Port: <source port>
   Destination Port: 4739 (IPFIX)
 Observation Domain Id: <Observation Domain ID>
 Template Id: 258
   Flow Keys: <series of Flow Keys>
   Non Flow Keys: <series of non Flow Keys>

Template Entry B:
 Outgoing Transport Session Information (to Collector#1):
   Source IP: <IPFIX Mediator IP address>
   Destination IP: <IPFIX Collector#1 IP address>
   Protocol: SCTP
   Source Port: <source port>
   Destination Port: 4739 (IPFIX)
 Observation Domain Id: <Observation Domain ID>
 Template Id: 256
   Flow Keys: <series of Flow Keys>
   Non Flow Keys: <series of non Flow Keys>

Template Entry C:
 Outgoing Transport Session Information (to Collector#2):
   Source IP: <IPFIX Mediator IP address>
   Destination IP: <IPFIX Collector#2 IP address>
   Protocol: SCTP
   Source Port: <source port>

```
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
    Template Id: 257
      Flow Keys: <series of Flow Keys>
      Non Flow Keys: <series of non Flow Keys>

  Template Entry D:
    Outgoing Transport Session Information (to Collector#3):
      Source IP: <IPFIX Mediator IP address>
      Destination IP: <IPFIX Collector#3 IP address>
      Protocol: SCTP
      Source Port: <source port>
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
      Template Id: 257
      Flow Keys: <series of Flow Keys>
      Non Flow Keys: <series of non Flow Keys>
```

The Template Mapping corresponding to the figure B can be displayed as:

```
   Template Entry A   <----> Template Entry B
   Template Entry A   <----> Template Entry C
   Template Entry A   <----> Template Entry D
```

Note that all examples use Transport Sessions based on the SCTP protocol, as simplified use cases. However, the protocol would be important in situations such as an Intermediate Conversion Process doing transport protocol conversion.

3.2.2. Template Management With New Template Records

The second case is a situation where the IPFIX Mediator generates new (Options) Template Records compared to the received ones.

In such a situation, the IPFIX Mediator doesn't need to maintain a Template Mapping, as it generates its own series of (Options) Template Records. However, the following special case might still require a Template Mapping, i.e. a situation where the IPFIX Mediator, typically containing an Intermediate Conversion Process, Intermediate Aggregation Process [IPFIX-MED-AGGR], or Intermediate Anonymization Process in case of black-marker Anonymization [RFC6235], generates new (Options) Template Records based on what it receives from the Exporter(s), and based on the Intermediate Process function. In such a case,

it's interesting to keep the correlation between the received (Options) Template Records and exported Derived Options) Template Records in the Template Mapping.

Therefore, the IPFIX Mediator MAY maintain a Template Mapping composed of received (Options) Template Records and exported derived Options) Template Records:

- for each received (Options) Template Record: Template Record Flow Keys and non Flow Keys, Template ID, Observation Domain, and Transport Session Information
- for each exported derived Options) Template Record: Template Record Flow Keys and non Flow Keys, Template ID, Collector, Observation Domain, and Transport Session Information

If an IPFIX Mediator receives an IPFIX Withdrawal Message for a (Options) Template Record that is not used anymore as the basis of an inferred (Options) Template Records, the IPFIX Mediator SHOULD export the appropriate IPFIX Withdrawal Message(s) for the inferred (Options) Template Record on the outgoing Transport Session, and remove the corresponding entry in the Template Mapping.

The following two examples illustrate this.

First, consider an IPFIX Mediator hosting an Intermediate Aggregation Process that generates time-series traffic octet counts per source IP address (as in the example in section 8.1 of [IPFIX-MED-AGGR]). Here, the Intermediate Process accepts Flow Records fitting any Template, discards all Information Elements other than the sourceIPv[46]Address and octetDeltaCount, aggregates these across all original Exporters in a given regular time interval, and exports Flow Records according to a Template Record containing flowStartTimeMilliseconds, flowEndTimeMilliseconds, sourceIPv[46]Address, and octetDeltaCount.

In this case, no Template Mapping is necessary. New Templates and Template Withdrawals in the Transport Sessions from the Original Exporters are handled as they would be at any Collecting Process. Records according to Templates which do not contain at least a timestamp, sourceIPv[46]Address, and octetDeltaCount IE are simply discarded by the Collector.

Next, consider a more generic case of this Intermediate Aggregation Process, which creates time-series aggregates across all Original Exporters, imposing a time interval but keeping a subset of the incoming Flow Key received from the Original

Exporter. In this case, a Template Mapping is necessary, as there is a relationship between incoming and outgoing Templates.

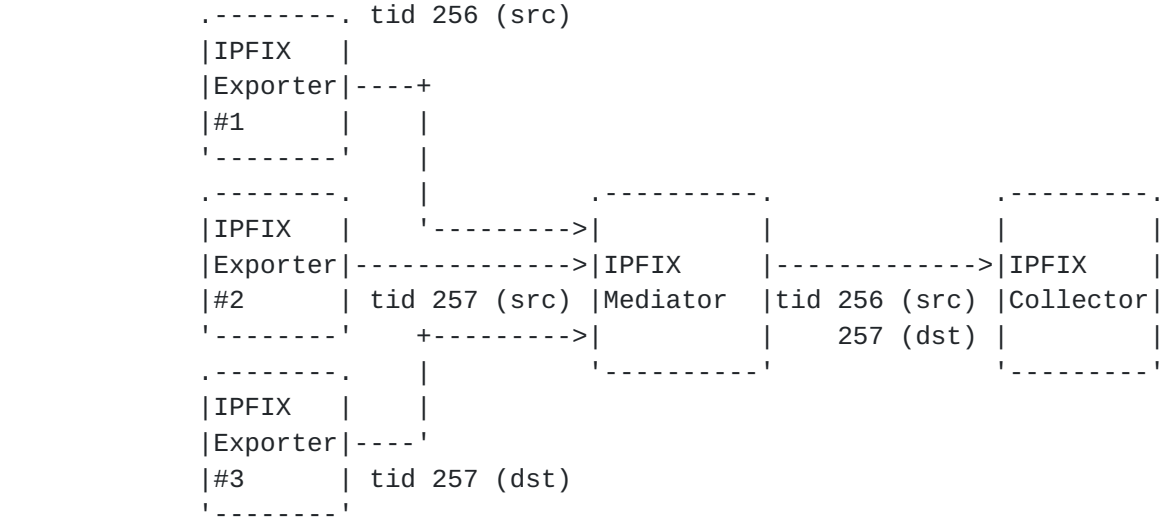


Figure C: Intermediate Aggregation Process Example

In Figure C, above, the Mediator accepts a Template Record containing only the sourceIPv4Address as the Flow Key from Exporters 1 and 2, and a Template Record containing only the destinationIPv4Address as the Flow Key from exporter 3. It exports time-series source aggregates as Template ID 256, and time-series destination aggregates as Template ID 257. The Template Entries in this case are as follows:

```
 Template Entry A:
  Incoming Transport Session Information (from Exporter#1):
    Source IP: <Exporter#1 export IP address>
    Destination IP: <IPFIX Mediator IP address>
    Protocol: SCTP
    Source Port: <source port>
    Destination Port: 4739 (IPFIX)
  Observation Domain Id: <Observation Domain ID>
  Template Id: 256
    Flow Keys: sourceIPv4Address
    Non Flow Keys: octetDeltaCount, [others]

 Template Entry B:
  Incoming Transport Session Information (from Exporter#2):
    Source IP: <Exporter#2 export IP address>
    Destination IP: <IPFIX Mediator IP address>
    Protocol: SCTP
    Source Port: <source port>
```

```
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
    Template Id: 257
      Flow Keys: sourceIPv4Address
      Non Flow Keys: octetDeltaCount, [others]

   Template Entry C:
    Incoming Transport Session Information (from Exporter#3):
      Source IP: <Exporter#3 export IP address>
      Destination IP: <IPFIX Mediator IP address>
      Protocol: SCTP
      Source Port: <source port>
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
    Template Id: 257
      Flow Keys: destinationIPv4Address
      Non Flow Keys: octetDeltaCount, [others]

   Template Entry D:
    Outgoing Transport Session Information (to IPFIX Collector):
      Source IP: <IPFIX Mediator export IP address>
      Destination IP: <IPFIX Collector IP address>
      Protocol: SCTP
      Source Port: <source port>
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
      Template Id: 256
      Flow Keys: sourceIPv4Address
      Non Flow Keys: octetDeltaCount

   Template Entry E:
    Outgoing Transport Session Information (to IPFIX Collector):
      Source IP: <IPFIX Mediator export IP address>
      Destination IP: <IPFIX Collector IP address>
      Protocol: SCTP
      Source Port: <source port>
      Destination Port: 4739 (IPFIX)
    Observation Domain Id: <Observation Domain ID>
      Template Id: 257
      Flow Keys: destinationIPv4Address
      Non Flow Keys: octetDeltaCount

   The Template Mapping corresponding to the figure C can be
   displayed as:

      Template Entry A   <----> Template Entry D
      Template Entry B   <----> Template Entry D
```

Template Entry C <----> Template Entry E

Note that all examples use Transport Sessions based on the SCTP protocol, as simplified use cases. However, the protocol would be important in situations such as an Intermediate Conversion Process doing transport protocol conversion.

3.3. Time Management

The IPFIX Message Header "Export Time" field is the time in seconds since 0000 UTC Jan 1, 1970, at which the IPFIX Message Header leaves the IPFIX Mediator. However, in the specific case of an IPFIX Mediator containing an Intermediate Conversion Process, the IPFIX Mediator MAY keep the export time received from the incoming Transport Session.

It is RECOMMENDED that Mediators handle time using absolute timestamps (e.g. flowStartSeconds, flowStartMilliseconds, flowStartNanoseconds), which are specified relative to the UNIX epoch (00:00 UTC 1 Jan 1970), where possible, rather than relative timestamps (e.g. flowStartSysUpTime, flowStartDeltaMicroseconds), which are specified relative to protocol structures such as system initialization or message export time.

The latter are difficult to manage for two reasons. First, they require constant translation, as the system initialization time of an intermediate system and the export time of an intermediate message will change across mediation operations. Further, relative timestamps introduce range problems. For example, when using the flowStartDeltaMicroseconds and flowEndDeltaMicroseconds Information Elements [RFC5102], the Data Record must be exported within a maximum of 71 minutes after its creation. Otherwise, the 32-bit counter would not be sufficient to contain the flow start time offset. Those time constraints might be incompatible with some of the Intermediate Processes: Intermediate Aggregation Process (temporal) and Intermediate Correlation Process, for example.

When an Intermediate Aggregation Process aggregates information from different Flow Records, the typical reporting times SHOULD BE the minimum of the start times and the maximum of the end times. However, if the Flow Records do not overlap, i.e. if there is a time gap between the times in the Flow Records, then the report may be inaccurate. The IPFIX Mediator is only reporting what it knows, on the basis of the information made

available to it - and there may not have been any data to observe during the gap. Then again, if there is an overlap in timestamps, there's the potential of double-accounting: different Observation Points may have observed the same traffic simultaneously. Therefore, as there is not a single rule that fits all different situations, the precise rules of applying the Flow Record timestamps in IPFIX Mediators is out of the scope of this document. However, some more specifications related to the specific case of aggregation in space and time are specified in [IPFIX-MED-AGGR], and MUST be followed.

3.4. Observation Point Management

Depending on the use case, top Collectors may need to receive the Original Observation Point(s), otherwise it may wrongly conclude that the IPFIX Device exporting the Flow Records to him, i.e. the IPFIX Mediator, directly observed the packets that generated the Flow Records. Two new Information Element are introduced to solve this use case: originalExporterIPv4Address and originalExporterIPv6Address.

In the IPFIX Mediator, the Observation Point(s) may be represented by:

- A single Original Exporter (represented by the originalExporterIPv4Address or originalExporterIPv6Address Information Elements)
- A list of Original Exporter (represented by the originalExporterIPv4Address or originalExporterIPv6Address Information Elements_)
- A list of Original Exporter (represented by the originalExporterIPv4Address or originalExporterIPv6Address Information Elements), along with the associated interface (represented by the ingressInterface and/or egressInterface)
- A list of Original Exporter (represented by the originalExporterIPv4Address or originalExporterIPv6Address Information Elements), along with the associated line card id (represented by the lineCardId)
- Any combination or list of Information Elements representing Observation Points.

Some Information Elements characterizing the Observation Point may be added. For example, the flowDirection Information Element specifies the direction of the observation, and, as such, characterizes the Observation Point.

Any combination of the above examples is possible. For example, in case of an Intermediate Aggregation Process, an Original Observation Point can be composed of:

```
exporterIPv4Address 192.0.2.1
exporterIPv4Address 192.0.2.2,
         interface ethernet 0, direction ingress
         interface ethernet 1, direction ingress
         interface serial 1, direction egress
         interface serial 2, direction egress
exporterIPv4Address 192.0.2.3,
         lineCardId 1, direction ingress
```

If the Original Observation Point is composed of a list, then the IPFIX Structured Data [IPFIX-STRUCT] MUST be used to export it from the IPFIX Mediator.

The most generic way to export the Original Observation Point is to use a subTemplateMultiList, with the semantic "exactlyOneOf". Taking back the previous example, the following encoding can be used:

```
Template Record 257: exporterIPv4Address
Template Record 258: exporterIPv4Address, basicList of
                     ingressInterface, flowDirecdtion
Template Record 259: exporterIPv4Address, lineCardId,
                     flowDirection
```

The Original Observation Point is modeled with the Data Records corresponding to either Template Record 1, Template Record 2, or Template Record 3 but not more than one of these ("exactlyOneOf" semantic). This implies that the Flow was observed at exactly one of the Observation Points reported.

When an IPFIX Mediator receives Flow Records containing the Original Observation Point Information Element, i.e. originalExporterIPv6Address or originalExporterIPv4Address, the IPFIX Mediator SHOULD NOT modify its value(s) when composing new Flow Records in the general case. Known exceptions include anonymization per [RFC6235] section 7.2.4 and an Intermediate Correlation Process rewriting addresses across NAT.

In other words, the Original Observation Point should not be replaced the IPFIX Mediator Observation Point. The daisy chain of (Exporter, Observation Point) representing the path the Flow

Records took from the Exporter to the top Collector, via the IPFIX Mediator(s) is out of the scope of this specification.

3.4.1. Observation Domain Management

In any case, the Observation Domain ID of any IPFIX Message containing Flow Records relevant to no particular Observation Domain, or to multiple Observation Domains, MUST have an Observation Domain ID of 0, as in section 3.1 above, and section 3.1 of [RFC5101].

IPFIX Mediators that do not change (Options) Template Records MUST maintain a Template Mapping, as detailed in section 3.2.1, to ensure that the combination of Observation Domain IDs and Template IDs do not collide on export.

For IPFIX Mediators that export New (Options) Template Records unchanged, as in section 3.2.2, there are two options for Observation Domain ID management. The first and simplest of these is to completely decouple exported Observation Domain IDs from received Observation Domain IDs; the IPFIX Mediator, in this case, comprises its own set of Observation Domain(s) independent of the Observation Domain(s) of the Original Exporters.

The second option is to provide or maintain a Template Mapping for received (Options) Template Records and exported inferred (Options) Template Records, along with the appropriate Observation Domain IDs per Transport Session, which ensures that the combination of Observation Domain IDs and Template IDs do not collide on export.

In some cases where the IPFIX Message Header can't contain a consistent Observation Domain for the entire IPFIX Message, but the Flow Records exported from the IPFIX Mediator should anyway contain the Observation Domain of the Original Exporter, the (Options) Template Record must contain the originalObservationDomainId Information Element. When an IPFIX Mediator receives Flow Records containing the originalObservationDomainId Information Element, the IPFIX Mediator MUST NOT modify its value(s) when composing new Flow Records with the originalObservationDomainId Information Element.

3.5. Specific Reporting Requirements

Some specific Options Templates and Options Template Records are necessary to provide extra information about the Flow Records and about the Metering Process.

The Options Template Records defined in these subsections, which impose some constraints on the Metering Process and Exporting Process implementations in Intermediate Processes, MAY be implemented. If implemented, the specific Option Templates SHOULD be implemented as specified in these subsections.

The minimum set of Information Elements is always specified in these Specific IPFIX Options Templates. Nevertheless, extra Information Elements may be used in these specific Options Templates.

3.5.1. The Flow Keys Options Template

Exactly like the IPFIX protocol [RFC5101], the Flow Keys Option Template specifies the structure of a Data Record for reporting the Flow Keys of reported Flows. A Flow Keys Data Record extends a particular Template Record that is referenced by its templateId identifier. The Template Record is extended by specifying which of the Information Elements contained in the corresponding Data Records describe Flow properties that serve as Flow Keys of the reported Flow.

The Flow Keys Option Template SHOULD contain the following Information Elements that are defined in [RFC5102]

templateId	An identifier of a Template. This Information Element MUST be defined as a Scope Field.
flowKeyIndicator	Bitmap with the positions of the Flow Keys in the Data Records.

When any Intermediate Process changes the Flow Keys, the Flow Keys Option Template MUST include the new set of Flow Keys. Typically, an Intermediate Aggregation Process keeps or reduces the number of Flow Keys

3.5.2. IPFIX Protocol Options Template

The "Metering Process Statistics Options Template", "The Metering Process Reliability Statistics Options Template", and "The Exporting Process Reliability Statistics Options Template",

as specified in [RFC5101], SHOULD be implemented on the IFPIX Mediator.

Refer to the document specifying a particular Intermediate Process type for specific values for these Options Template Records. For example, in case of an Intermediate Aggregation Process, [IPFIX-MED-AGGR] must specify which values to insert into the fields of "Metering Process Statistics Options Template", "The Metering Process Reliability Statistics Options Template", and "The Exporting Process Reliability Statistics Options Template"

3.5.3. IPFIX Mediator Options Template

There is no need for a specific Options Template for the IPFIX Mediator; instead, each Intermediate Process type requires some particular metadata. For example, a specification of IPFIX flow Anonymization including an Options Template for the export of metadata about Anonymized flows is described in [RFC6235]; when Anonymizing Flows Records, IPFIX Mediators SHOULD add the Options Template specified therein to annotate the exported data.

Transport Session Management SCTP [RFC4960] using the PR-SCTP extension specified in [RFC3758] MUST be implemented by all compliant IPFIX Mediator implementations. UDP [UDP] MAY also be implemented by compliant IPFIX Mediator implementations. TCP [TCP] MAY also be implemented by IPFIX Mediator compliant implementations.

PR-SCTP SHOULD be used in deployments where IPFIX Mediators and Collectors are communicating over links that are susceptible to congestion. PR-SCTP is capable of providing any required degree of reliability.

TCP MAY be used in deployments where IPFIX Mediators and Collectors communicate over links that are susceptible to congestion, but PR-SCTP is preferred due to its ability to limit back pressure on Exporters and its message versus stream orientation.

UDP MAY be used, although it is not a congestion-aware protocol. However, the IPFIX traffic between IPFIX Mediator and Collector MUST run in an environment where IPFIX traffic has been provisioned for, or is contained through some other means.

3.6. The Collecting Process's Side

An IPFIX Mediator MUST produce IPFIX Messages understandable by a RFC5101-compliant IPFIX Collector, with the additional specification in the IPFIX Structured Data [IPFIX-STRUCT].

Therefore the Collecting Process on the top Collector MUST support the IPFIX protocol [RFC5101] and the IPFIX Structured Data [IPFIX-STRUCT].

3.7. Configuration Management

In some cases such as an Intermediate Aggregation Process aggregating Flow Records from multiple Original Exporters, a consistent configuration of the Metering Processes and Exporting Processes on these Original offers some advantages. For example, consistent active timeout, inactive timeout, and/or consistent export time allows to compare the number of the Flow Records per period of time. For example, consistent Sampling algorithm and parameters might allow to compare Flow Records accuracy.

While this is tempting to include all configuration parameters in Flow Records for the IPFIX Mediator to draw its own conclusion, the consistency of the configuration should be verified out of band, with the MIB modules ([RFC5815] and [PSAMP-MIB] or with the Configuration Data Model for IPFIX and PSAMP [IPFIX-CONF]

4. New Information Elements

EDITOR NOTE: please change the TBD1, TBD2, and TBD3, with the IANA newly assigned numbers.

4.1. - originalExporterIPv4Address

Description: The IPv4 address used by the Exporting Process on the Original Exporter. This is used by an IPFIX Mediator Exporting Process to identify the Original Exporter.

Abstract Data Type: ipv4Address

ElementId: TBD3

Status: Proposed

4.2. originalExporterIPv6Address

Description: The IPv6 address used by the Exporting Process on the Original Exporter. This is used by the IPFIX Mediator Exporting Process to identify the Original Exporter.

Abstract Data Type: ipv6Address

ElementId: TBD2

Status: Proposed

4.3. originalObservationDomainId

Description: An identifier of the Observation Domain on the Original Exporter, where the metered IP packets are observed. This is used by the IPFIX Mediator Exporting Process to identify an Observation Domain as received from the Original Exporter.

Abstract Data Type: unsigned32

ElementId: TBD3

Status: Proposed

5. Security Considerations

The same security considerations as for the IPFIX Protocol [RFC5101] apply.

As they act as both IPFIX Collecting Processes and Exporting Processes, the Security Considerations for IPFIX [RFC5101] apply as well to Mediators. The Security Considerations for IPFIX Files [RFC5655] apply as well to IPFIX Mediators that write IPFIX Files or use them for internal storage. However, there are a few specific considerations that IPFIX Mediator implementations must take into account in addition.

By design, IPFIX Mediators are "men-in-the-middle": they intercede in the communication between an Original Exporter (or another upstream Mediator) and a downstream Collecting Process. This has two important implications for the level of

confidentiality provided across an IPFIX Mediator, and the ability to protect data integrity and Original Exporter authenticity across a Mediator. These are addressed in more detail in the Security Considerations for Mediators in [IPFIX-MED-FMWK].

Note that, while Mediators can use the exporterCertificate and collectorCertificate Information Elements defined in [RFC5655] as described in section 9.3 of [IPFIX-MED-FMWK] to export information about X.509 identities in upstream TLS-protected Transport Sessions, this mechanism cannot be used to provide true end-to-end assertions about a chain of IPFIX Mediators: any Mediator in the chain can simply falsify the information about upstream Transport Sessions In situations where information about the chain of mediation is important, it must be determined out of band.

6. IANA Considerations

This document specifies three new IPFIX Information Elements: the applicationDescription, applicationTag and the applicationName.

New Information Elements to be added to the IPFIX Information Element registry at [IANA-IPFIX] are listed below.

EDITOR'S NOTE: the XML specification in Appendix A must be updated with the elementID values allocated, i.e. TBD1, TBD2, and TDB3, must be replaced.

6.1. originalExporterIPv4Address

Name: originalExporterIPv4Address
Description:
The IPv4 address used by the Exporting Process on the Original Exporter. This is used by an IPFIX Mediator Exporting Process to identify the Original Exporter.
Abstract Data Type: ipv4Address
Data Type Semantics: identifier
ElementId: TBD1
Status: current

6.2. originalExporterIPv6Address

```
 Name: originalExporterIPv6Address
 Description:
   The IPv6 address used by the Exporting Process on the Original
   Exporter. This is used by the IPFIX Mediator Exporting Process
   to identify the Original Exporter.
 Abstract Data Type: ipv6Address
 Data Type Semantics: identifier
 ElementId: TBD2
 Status: current
```

6.3. originalObservationDomainId

```
 Name: originalObservationDomainId
 Description:
    An identifier of the Observation Domain on the Original
    Exporter, where the metered IP packets are observed. This is
    used by the IPFIX Mediator Exporting Process to identify an
    Observation Domain as received from the Original Exporter.
 Abstract Data Type: unsigned32
Data Type Semantics: identifier
ElementId: TBD3
Status: current
```

7. References

7.1. Normative References

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7.2. Informative References

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

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9. Appendix A. Additions to XML Specification of IPFIX Information Elements

This appendix contains additions to the machine-readable description of the IPFIX information model coded in XML in Appendix A and Appendix B in [RFC5102]. Note that this appendix is of informational nature, while the text in Section 6. (generated from this appendix) is normative.

The following field definitions are appended to the IPFIX information model in Appendix A of [RFC5102].

```
<field name="originalExporterIPv4Address"
         dataType="ipv4Address"
         group="config"
         elementId="TBD1" applicability="all" status="current">
    <description>
      <paragraph>
        The IPv4 address used by the Exporting Process on the
        Original Exporter. This is used by an IPFIX Mediator
        Exporting Process to identify the Original Exporter.
      </paragraph>
    </description>
  </field>


<field name="originalExporterIPv6Address"
         dataType="ipv6Address"
         group="config"
```

```
            elementId="TBD2" applicability="all" status="current">
      <description>
        <paragraph>
          The IPv6 address used by the Exporting Process on the
          Original Exporter. This is used by the IPFIX Mediator
          Exporting Process to identify the Original Exporter.
        </paragraph>
      </description>
    </field>

  <field name="originalObservationDomainId"
           dataType="unsigned32"
           group="config"
           elementId="TBD3" applicability="all" status="current">
      <description>
        <paragraph>
          An identifier of the Observation Domain on the Original
          Exporter, where the metered IP packets are observed.
          This is used by the IPFIX Mediator Exporting Process to
          identify an Observation Domain as received from the
          Original Exporter.
        </paragraph>
      </description>
    </field>
```