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# The State of Standardization Efforts to support Data Exchange in the Security Domain

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## Overview

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- Flow and Packet Formats
- Alert and Event Formats
- Context-relevant Formats



## Dimensions in Representation

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- Usage of representation
  - Transport vs. analysis vs. storage vs. archive
- Volume of data informs representation choice
  - Raw vs. Summaries
    - Choice often dictates a binary vs. text implementation
- Policy Scope
  - Intra-Organizational
    - Little consensus from outsiders necessary
    - Interoperation focus
  - Inter-Organizational
    - Privacy issues more acute (sanitization, filtering)
    - Common semantics are more relevant
    - Efficiency of representation is more significant



## Formats of interest

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- Flow and Packet Formats
  - IPFIX
  - PSAMP
- Alert and Event Formats
  - IDWG
  - INCH
- Context-relevant Formats
  - Vulnerability Report
  - CRISP



## Flow and Packet Formats (*de facto*)

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- PCAP (tcpdump)
  - <http://www.tcpdump.org>
- Cisco NetFlow



## IETF IP Flow Information Export (IPFIX) WG

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<http://www.ietf.org/html.charters/ipfix-charter.html>

- Binary, extensible information model for IP flows exported from a given *observation point* (i.e., router line-card) to a *collector*
  - Based on Cisco Netflow v9
- Designates a mandatory protocol (SCTP) to use in the transport of these flows

(Note: Various text and figures were taken from the IPFIX I-Ds)



## IPFIX Flow Definition

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- “... [A] set of IP packets passing an observation point ... during a certain time interval. All packets belonging to a particular flow have a set of common properties [named flow keys].”
  - One or more packet header field (e.g. destination IP address), transport header field (e.g. destination port number), or application header field (e.g. RTP header fields)
  - One or more characteristics of the packet itself (e.g. number of MPLS labels)
  - One or more fields derived from packet treatment (e.g. next hop IP address, output interface)



## IPFIX Flow Definition

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(2)

- A flow is defined by a *flow type* function that considers the various *flow keys*
- Flexible definition provides support for:
  - Filtering
  - Sampling
  - Bi-directional and unidirectional flows



## IPFIX Information Model

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- Template-based format
  - IPFIX merely specifies the possible
    - data types (e.g., IPv4 address, octet) and the
    - information items (e.g., icmpTypeCode, egressInterface)
  - Information items are unique identifiers registered with IANA or escaped via a vendor code
  - A template is merely an ordered list of pairs:  
<information items (i.e., fieldID), data length>
    - No static format; can be dynamically generated during the export process



## IPFIX Information Model

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(2)

- Two classes of records
  - Template Records
    - Describe a format
  - Data Records
    - Contain data encoded and formatted according to a Template record
- Two flavors of Data Records; those that encode the:
  - Data stream (e.g., observed flows), and
  - Control Information (e.g., selection criteria)



## IPFIX Information Model

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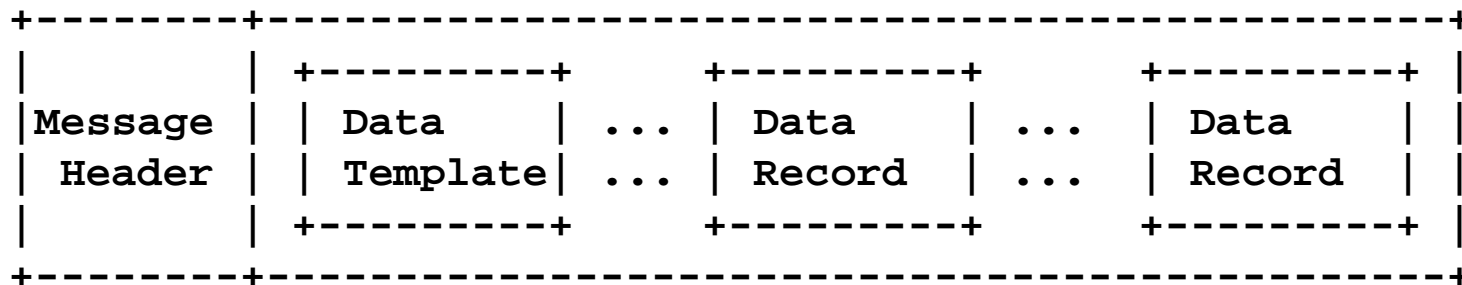
(3)

- 4-basic record types
  - Flow Data Template
    - A description for data record structure
  - Flow Data Record
    - IP flows formatted according to the Flow Data Template
  - Option Template
    - A description of the option record structure
  - Option Record
    - Control information formatted according to the Option Template Record



# IPFIX Messaging

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- Template records are sent inline with the data records
  - Frequency dictated by the quality of transport
  - Possible to send no template in an export, and reference a previously sent template in the data record
    - Collector must cache data templates





# IPFIX Example

Src IP addr.	Dst IP addr.	Packet Number	Bytes Number
198.168.1.12	10.5.12.254	5009	5344385
192.168.1.27	10.5.12.23	748	388934

Flow  
Information  
to Export

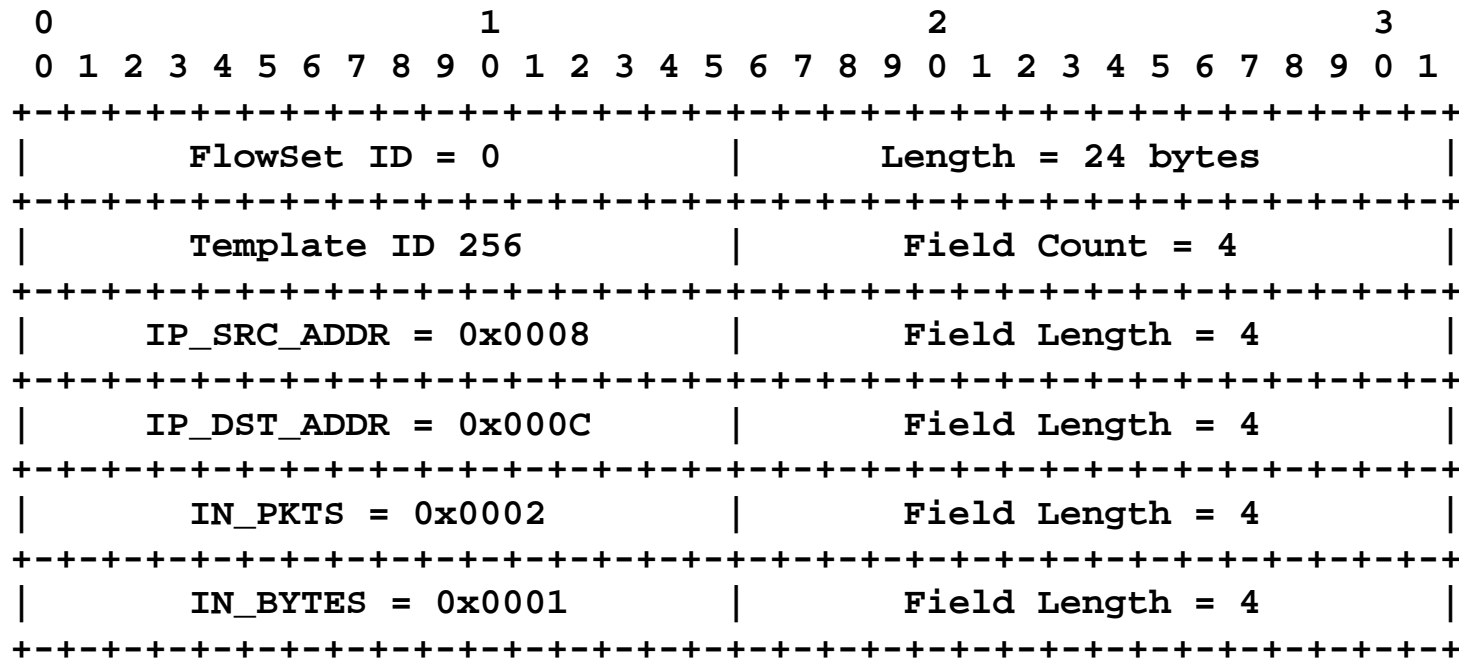
Message Header	Data Template (1 Template)	Data Records (2 Flow Data Records)

IPFIX  
Encoding  
Format



# IPFIX Example: Template

(2)







## IPFIX Transport Protocol: SCTP

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- Reliable service
  - TCP equivalent
- “Partially reliable” service
  - During un-congested periods, all the records marked for deletion under congestion will be reliably delivered
  - During congested periods, the exporter will drop packets to protect the network



## IPFIX I-Ds

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- Requirements for IP Flow Information Export
  - draft-ietf-ipfix-reqs-16
- Architecture Model for IP Flow Information Export
  - draft-ietf-ipfix-architecture-03
- Information Model for IP Flow Information Export
  - draft-ietf-ipfix-info-03
- IPFIX Protocol Specifications
  - draft-ietf-ipfix-protocol-03



## IETF Packet Sampling (PSAMP) WG

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<http://www.ietf.org/html.charters/psamp-charter.html>

- Binary, extensible information model for specifying
  - Selection operations (sampling and filtering) on a packet stream, and
  - Packets yielded by the selection operation
- Designates a mandatory protocol (IPFIX) to use in the transport of these packets



## Relationship between IPFIX and PSAMP

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- PSAMP extends the IPFIX data model
  - A PSAMP data record is a special instance of an IPFIX flow record with different semantics
    - i.e., a flow record with only a single packet
  - Augments the IPFIX data model to support *Selection Process*
- PSAMP reuses the IPFIX transport protocol



## PSAMP Selection

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- Sampling
  - “Provisioning of information about a specific characteristic of the parent population at a lower cost than a full census would demand”
- Filtering
  - Deterministic selection of packets based on the
    - packet content
    - treatment of the packet at the observation point, or
    - functions operating on the selection state.
- Possible to create schemes combining of both sampling and filtering selections



## PSAMP Sampling

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- Systematic Sampling (deterministic function)
  - Count-based (spatial packet position; e.g., packet count)
  - Time-based (temporal packet position; e.g., arrival time)
- Random Sampling
  - n-out-of-N
  - Probabilistic
    - Uniform Probabilistic (same probability for each packet)
    - Non-Uniform Probabilistic (probability depends on input)
    - Flow State Probabilistic
  - Sampling probability depends on flow state



## PSAMP Filtering

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- Match/Mask
  - Apply bit mask to the header or the first N-bytes
- Hashing
  - Apply a hash function to the header or first N-byte
- Packet Features
  - Properties of the packet header
- Router-state selection
  - Properties of the route or packet treatment



## PSAMP I-Ds

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- A Framework for Passive Packet Measurement
  - draft-ietf-psamp-framework-05
- Sampling and Filtering Techniques for IP Packet Selection
  - draft-ietf-psamp-sample-tech-04
- Packet Sampling (PSAMP) Protocol Specifications
  - draft-ietf-psamp-protocol-01
- Information Model for Packet Sampling Exports
  - draft-ietf-psamp-info-01



## IETF Intrusion Detection WG (IDWG)

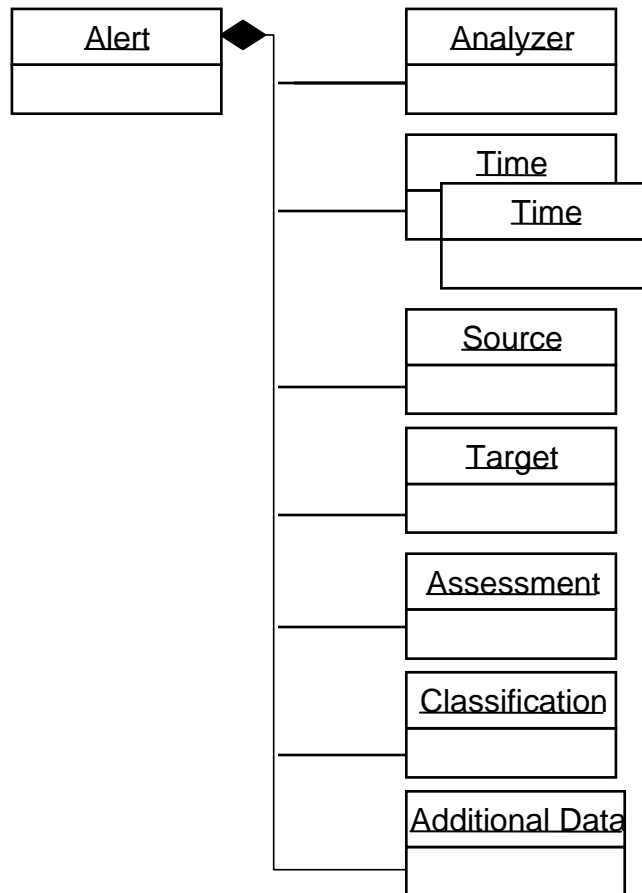
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<http://www.ietf.org/html.charters/idwg-charter.html>

- XML information model for network and host-based Intrusion Detection System alerts
  - Intrusion Detection Message Exchange Format (IDMEF)
- Defines a protocol to exchange these alerts
  - Intrusion Detection Exchange Protocol (IDXP)
  - BEEP-based profile to exchange IDMEF



# IDMEF Data Model



- Sensor properties
- Timestamps
- Source/Target characteristics
  - IP address, ports
- Impact assessment
- Event classification
- Extension mechanism



## IDWG I-Ds

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- Intrusion Detection Message Exchange Requirements
  - draft-ietf-idwg-requirements-10
- The Intrusion Detection Message Exchange Format
  - draft-ietf-idwg-idmef-xml-12
- The Intrusion Detection Exchange Protocol (IDXP)
  - draft-ietf-idwg-beep-idxp-07
- The TUNNEL Profile
  - Rfc3620



## IETF Incident Handling WG (INCH)

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<http://www.ietf.org/html.charters/inch-charter.html>

- XML information model for exchanging “incident data” among CSIRTs
  - Incident Object Description Exchange Format (IODEF)
- No exchange protocol specified



# INCH IODEF Data Model

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- Extensible framework to exchange information between CSIRTs
  - Workflow
    - incident identifiers, conveying expectations, data usage restrictions
  - Incident description and conclusions
    - Source/Destination information
    - Contact information
    - References to vulnerabilities, advisories, and artifacts
    - Classification and impact assessments
- Extensions
  - RID: DoS traceback for ISPs
  - (possible) Anti-Spam lists



## INCH I-Ds

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- Requirements for Format for INcident Report Exchange (FINE)
  - draft-ietf-inch-requirements-03
- The Incident Data Exchange Format Data Model
  - draft-ietf-inch-iodef-02
- The Incident Object Description Exchange Format (IODEF) Implementation Guide
  - draft-ietf-inch-implement-00
- Real-Time Inter-Network Defense
  - draft-ietf-inch-rid-00



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## IETF Cross-Registry Information Service Protocol (CRISP) WG

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<http://www.ietf.org/html.charters/crisp-charter.html>

- XML, extensible information model for global registry information
  - i.e., Whois with structure
- Designates a mandatory protocol (BEEP) for the query/response exchange



## Vulnerability Information (*de facto*)

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- Mitre CVE
  - <http://cve.mitre.org/>
- Mitre OVAL
  - <http://oval.mitre.org/>
- NIST iCAT
  - <http://icat.nist.gov/icat.cfm>



## Vulnerability (Report) Formats

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- Common Advisory Interchange Format (CAIF)
  - RUS-CERT
  - <http://cert.uni-stuttgart.de/projects/caif/>
- Advisory and Notification Markup Language (ANML)
  - OpenSec
  - <http://www.opensec.org/anml/>
- Application Vulnerability Description Language (AVDL)
  - OASIS
  - [http://www.oasis-open.org/committees/tc\\_home.php?wg\\_abbrev=avdl](http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=avdl)



## Relevance of the Formats to Flows

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- IPFIX
  - Storage and transport format for flows
- PSAMP
  - Describe acquisition process of the flows
- IDMEF
  - Describe events created from flows
- IODEF (with/without extensions)
  - Describe flow summaries, baselines, etc.



## Adoption

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- Packets and Flow Formats
  - IPFIX: implementations exist (e.g., Argus)
  - PSAMP: work in progress
- Alerts and Events Formats
  - IDMEF: adoption only in Snort, Prelude, Arcsight
  - IODEF: adoption by 5-15 CSIRTs in Europe, Asia, and the US
- Context Formats
  - Vulnerability formats: work in progress, some used in closed communities
  - CRISP: work in progress