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

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Overview

- Flow and Packet Formats
- Alert and Event Formats
- Context-relevant Formats
Dimensions in Representation

• 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

• Flow and Packet Formats
  – IPFIX
  – PSAMP

• Alert and Event Formats
  – IDWG
  – INCH

• Context-relevant Formats
  – Vulnerability Report
  – CRISP
Flow and Packet Formats *(de facto)*

- PCAP (tcpdump)
  - http://www.tcpdump.org
- Cisco NetFlow
IETF IP Flow Information Export (IPFIX) WG


- 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

- “… [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

• 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

• 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

- 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

- 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

- 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 Message Header

- 128-byte preamble sent with each export
### IPFIX Example

<table>
<thead>
<tr>
<th>Src IP addr.</th>
<th>Dst IP addr.</th>
<th>Packet</th>
<th>Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>198.168.1.12</td>
<td>10.5.12.254</td>
<td>5009</td>
<td>5344385</td>
</tr>
<tr>
<td>192.168.1.27</td>
<td>10.5.12.23</td>
<td>748</td>
<td>388934</td>
</tr>
</tbody>
</table>

#### Flow Information to Export

```
+--------+---------------------------------------------+
|        | +--------------+ +-----------------------+          |
| Message| | Data         | | Data                  |          |
| Header | | Template     | | Records               |          |
|        | +--------------+ +-----------------------+          |
+--------+---------------------------------------------+
```

#### IPFIX Encoding Format

```
+---------------------------------------------+---------------------------------------------+          |
|                                           |                                           |          |
|                                           |                                           |          |
+---------------------------------------------+---------------------------------------------+          |
```
IPFIX Example: Template

0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       FlowSet ID = 0          |      Length = 24 bytes        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Template ID 256         |       Field Count = 4      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     IP_SRC_ADDR = 0x0008      |       Field Length = 4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     IP_DST_ADDR = 0x000C      |       Field Length = 4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       IN_PKTS = 0x0002        |       Field Length = 4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       IN_BYTES = 0x0001       |       Field Length = 4     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
### IPFIX Example: Data

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1</td>
<td></td>
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<tr>
<td>+-----------------+-----------------+-----------------+-----------------</td>
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<tr>
<td>FlowSet ID = 256</td>
<td>Length = 36</td>
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IPFIX Transport Protocol: SCTP

• 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

- 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


• 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

• PSAMP extends the IPFIX data model
  – A PSAMP data record is an 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

• 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 combing of both sampling and filtering selections
PSAMP Sampling

• 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

- **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

• 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)


- 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

- 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)


• XML information model for exchanging “incident data” among CSIRTs
  – Incident Object Description Exchange Format (IODEF)

• No exchange protocol specified
INCH IODEF Data Model

• 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

• 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
• 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)

- Mitre CVE
  - http://cve.mitre.org/
- Mitre OVAL
  - http://oval.mitre.org/
- NIST iCAT
  - http://icat.nist.gov/icat.cfm
Vulnerability (Report) Formats

- 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

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Relevance of the Formats to Flows

- **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

• 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