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IDMEF "Lingua Franca" for Security Incident Management

Douglas Corner

IDMEF – "Lingua Franca" for Security Incident Management

Tutorial and Review of Standards Development

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Douglas S. Corner

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I. Abstract

The Intrusion Detection Working Group, chartered by the IETF has been working for some time on a set of specifications that will allow the transfer of intrusion detection information between the detection device (Analyzer) and a management station (Manager). These specifications provide for the format and structure of the messages and the protocols used to do the actual transfer.

The relationship of these protocols is discussed as well as an overview of the specifications themselves. The importance of this development is also discussed as well as the current status of the protocols and a number of implementations.

II. Introduction

The three principle components used to provide enterprise security are:

- Control – Insure that only authorized users are granted access to the resources of the organization. This includes firewalls to keep external user off the internal network. It also includes access control mechanisms, which identify users and allow them to access only those resources that they have been granted access to through administrative policy. In a perfect world the control mechanisms should be both necessary and sufficient to provide full security. They are not perfect and other mechanisms are necessary to insure that critical information systems are protected.

- Vulnerability Assessment – On a regular basis VA tools scan the organizations security sub systems looking for ways that unauthorized intruders might gain unauthorized access to protected resources. VA (Vulnerability Assessment) systems make periodic scans (Usually not frequently enough) and report vulnerabilities found. Again, in perfect world one would run regular scans, fix the problems found, and be well protected.

- Intrusion Detection – In spite of the efforts to control access and to perform checks of the control systems, intrusions will happen. It is the function of IDS (Intrusion Detection Systems) to detect these break-ins and to inform security personnel that unauthorized access may have taken place and that 1) The control systems and VA systems need to be adjusted and 2) That damage may have occurred. IDS systems are the last line of defense in the "Defense in Depth" philosophy of enterprise security.

There are two primary types of intrusion detection systems, network based and host based. Network based IDSs promiscuously monitor network traffic looking for attempted or successful attacks. Host based IDSs monitor from inside the host looking at event logs, file accesses, processes and other indications of improper activity. In most cases IDSs report attacks that have already taken place and have limited capability to provide actual protection although there is a class of newer intrusion prevention systems that can (or claim to) stop attacks when they are detected.

A variety of IDS systems, combinations of the two principle types of systems exist on the market today. A list of the various types has been compiled by Andy Cuff at NetworkIntrusion [11]:

- Host based IDS / Event Log Viewers – Monitors events from inside the host.

- Network Based IDS – Promiscuously monitors network traffic on a network segment

- Network Node IDS – Monitors network traffic from inside a network node. This is important for switched networks where it is impractical to provide network IDSs on every switched segment.

- Event Log Viewer – Systems that collect event logs to a central site and then analyze them there.

- HoneyPots – Systems with no real data on them designed to attract attackers.

Because of the number and sophistication of attacks being seen, single IDS systems cannot be relied on to provide adequate protection. It is increasingly necessary to build hybrid systems that can collect information from a variety of sources and to correlate attack information gathered from multiple detection tools. In order to do this it is essential to develop standard protocols and formats that will enable the transfer and normalization of event data necessary for cross platform capture and analysis of intrusion detection data.

This paper discusses a family of protocols, which have been developed to answer the growing need to exchange intrusion detection information among various security systems and devices. These protocols and standards will enable the following:

- Forwarding data from NIDs (Network Intrusion Detection devices) to incident management stations.

- The development of databases based on standards

- The development of cross-product event correlation tools

- A common language used to discuss intrusion detection events

The protocols to be discussed are:

- IDMEF – Intrusion Detection Message Exchange Format

IDMEF defines data formats and exchange procedures used to exchange data between intrusion detection devices and incident response and management stations.

- IDXP – Intrusion Detection Exchange Protocol

  IDMEF stations use the IDXP protocol to perform the physical transfer of intrusion detection information

- BEEP – Blocks Extensible Exchange Protocol

  BEEP is a generic application layer protocol used for reliable bi-directional transfers.

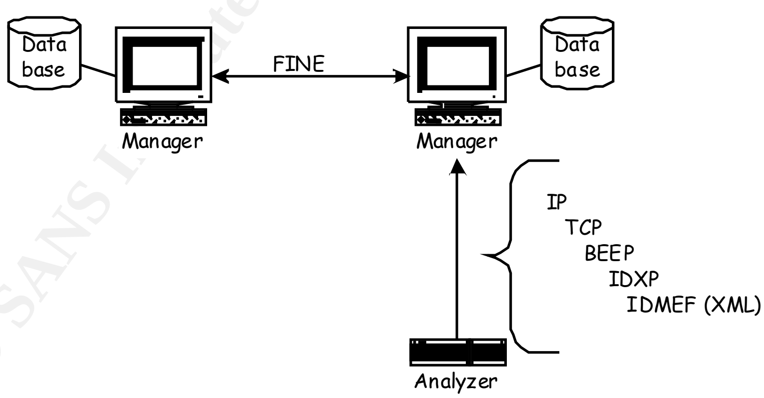
- IODEF – Incident Object Detection Exchange Format

  The initial work done on IODEF has been superceded by the INCH project.

- FINE – Format for Incident Report Exchange

  FINE is being developed under the INCH working group of the IETF and is an effort to define formats and procedures for the exchange of security incident information between CSIRTs (Computer Security Incident Response Teams)

The principle components and layering of protocols is described below:



The purpose of this paper is to principally describe for "common language", the IDMEF [12] specification, to tie it to the other associated protocols and to discuss ways to make use of this important capability.

III. Overview of Protocols

III.A. IDMEF

The purpose of IDMEF is to define formats for the exchange of intrusion detection information and to define a structure for the storage of this information. It is to foster interchange of data between commercial and open source intrusion detection equipment and incident management stations. Data exchanges are done using XML [1] (Extended Markup Language). The data formats are specified using an XML DTD [2] (Document Type Declaration).

The data structure is defined as a series of modular classes used to logically segment the data. The overall class structure is described in the following paragraphs. Class names are given in *italics*. Indentations imply subclassing. Classes are conceptual and meant to describe the relationship of elements of the data to other elements. The class structure defined by IDMEF is not necessarily but could be the basis for a database schema.

Root Class The top level class is *IDMEF-Message.* An *IDMEF-Message* is either an *Alert* or a *Heartbeat.*

Core Classes *Analyzer, Source, Target, Classification and AdditionalData* are known as Core Classes that make up the *Heartbeat* and *Alert* classes.

- *Heartbeat* – Used to inform manager that the analyzer is “alive”
  - *Analyzer* – Identifies the analyzer
  - *CreateTime* – Time the heartbeat message was created
  - *AdditionalData* – Miscellaneous data not covered by the model

- *Alert* – An event that the analyzer has been configured to look for
  - *Analyzer* – Identifies the analyzer
  - *CreateTime* – Time the alert message was created
  - *DetectTime* – Time the event was detected
  - *AnalyzerTime* – The time the message was sent
  - *Source* – Identifies the possible source(s) of the event
    - *Node* – Information about the host that appears to have caused the event
    - *User*- Information about the attacking user
    - *Process* – Process that caused the event
    - *Service* – Network service that caused the event
  - *Target* – Identifies the possible target(s) of the event
    - *Node* – Identifies target node being attacked
    - *User* – Identifies user being attacked
    - *Process* – Identifies target process
    - *Service* – Identifies target network service
    - *FileList* – Identifies file(s) involved in attack.

Classification – Identifies known alerts or attacks
Assessment – Provides the analyzer's assessment of the state of the event
AdditionalData – Information not provided by data model

Time Classes – The time classes are *CreateTime, DetectTime and AnalyzerTime*. These are described with the core classes. Time is kept as NTP (Network Time Protocol) time [3]. This time format is two 32 bit words. The first word gives the seconds since 1/1/1970. The second word contains fractions of a second. ($1 / 2^{32} – 1$) yielding a precision of roughly 500 picoseconds.

Assessment Classes – These classes support the *Assessment* class. The subclasses are:

Impact – The severity of the event (low, medium, high)
Action – Actions taken in response to the event. (block-installed, notification sent, …)
Confidence – The validity of the data in the event as measured by the analyzer.

Support Classes – These classes are used primarily by the core classes and consist of:

Node (*Source* or *Target*)
Location – Location of the source, target, …
Name – Name if known
Address – Address of hardware.

User (*Source* or *Target)*
UserID – User name, group name, user number, …

Process
Name – Name of process
pid – Process identifier
path – To executable
arg – Arguments
env – Environment string associated with process.

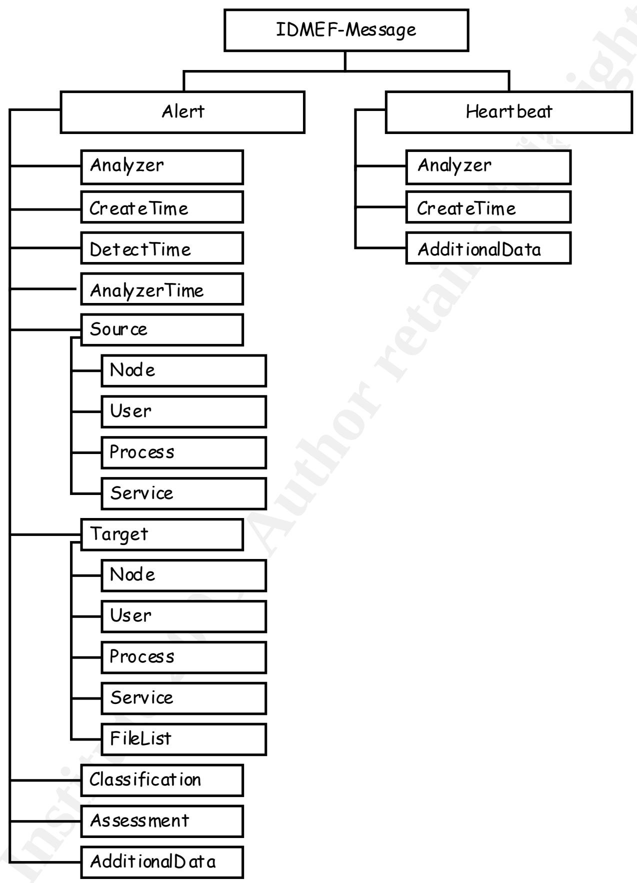
Service
Name of service
Port used
Portlist
protocol

WebService – url, cgi, http-method, arg

SNMPService – oid, community, securityName, contextName, contextEngineID, command

FileList – name, path, create-time, ….

The relationships between the core classes and many of the support classes of the data model is shown below:



Aggregation Classes

There are a set of classes that are not subclassed from *Alert* or from *Heartbeat.* These aggregate a number of alerts giving them classifications that apply across multiple alerts. These are:

ToolAlert – This describes information about the use of a particular attack tool such as Trojan horses that may have caused multiple alerts.

CorrelationAlert – This groups a number of alerts together that are somehow related.

OverflowAlert – This provides specific information about particular buffer overflow attacks.

III.B. IDXP

IDXP [4] (Intrusion Detection Exchange Protocol) is used for exchanging data between intrusion detection analyzers and managers. IDXP uses BEEP [5] (Blocks Extensible Exchange Protocol) which in turn is layered over TCP [10]. In reality IDXP is a specification and profile for a BEEP implementation rather than a separate protocol. The IDXP profiles provide the parameters that will be used by BEEP during the setup and transfer of IDMEF data. The specific profile used is identified as http://iana.org/beep/transient/idwg/idxp.

During session setup the analyzer and manger exchange BEEP "greeting" messages. The greeting identifies each entity as either an analyzer or manager. Other options may also be present to specify channel priority, stream type (Alert, Heartbeat, config) and the security profile to be used

Data transfer takes place over full duplex stream oriented BEEP connections, which in turn use the underlying TCP protocol for reliable transfer of data.

The BEEP security profiles provide the following additional capabilities:

- Authentication of analyzer and manager
- Confidentially of messages
- Integrity of messages
- Protection from denial of service attacks
- Protection from message duplication

III.C. BEEP

BEEP (Blocks Extensible Exchange Protocol) is a generic application protocol for connection oriented data transfer. BEEP is layered over TCP [6]. BEEP provides substantial flexibility through the use of "profiles" which make the protocol quite extensible.

BEEP first sets up a *session* between two peered TCP stations. The two stations then set up and tear down channels within the TCP connection as needed. A capacity of up to 257 channels within the single session may be provided. Each channel set up specifies its own profile so that the same TCP connection may be used for substantially different types of data. BEEP supports two different security profiles. Messages use MIME [7] content and are usually structured using XML.

III.D. IODEF and INCH

The IODEF [8] (Incident Object Description and Exchange Format) effort was originally intended to provide a protocol for the exchange of information about security incidents between CSIRTs. This work was done at TERENA, a European based network research group. The initial requirements and an initial draft of an XML implementation of a data model were developed. This work has concluded and had been taken over by the FINE (Format for Incident Report Exchange) [9] effort sponsored by the INCH (Extended Incident Handling) working group within the IETF.

The FINE effort will produce protocols for the exchange of incident information and statistics between managers in different organizations and management domains, between for example

- A CSIRT and its users
- A CSIRT and law enforcement organizations
- Collaborating CSIRTS

Draft RFCs have been released and are presently under review.

IV. Status or Protocol Development and Standardization

IV.A. IDMEF

This development is under control by the IDWG (Intrusion Detection Working Group) under the IETF. There have been numerous drafts of the IDMEF RFC. As of January 30, 2003 the draft RFC had been submitted to the IESG. IDMEF has been approved by the IESG as an Informational RFC.

The IDWG official web page is located at http://www.ietf.org/html.charters/idwg-charter.html. Additional information on IDMEF including the mailing list archive is located at http://www.silicondefense.com/idwg/

IV.B. IDXP

IDXP is also under control of the IDWG. The latest draft RFC [4] was released on October 22, 2002 and expired on April 22, 2003. The IESG has approved IDXP as a proposed standard.

IV.C. BEEP

BEEP is specified in RFC 3080 and is an approved Internet standard protocol.

IV.D. IODEF and INCH

Work has stopped on IODF. Similar work is being carried on under the INCH working group.

V. Implementation Efforts

NOTE: The author of this paper is an employee of a developer of network security software. As such it is difficult to discuss product implementation with companies that may be considered competitors. Only published product information has been used. No effort has been made to contact any vendors directly.

To date, most implementations of IDMEF are experimental. Few commercial efforts are being actively marketed.

eSecurity (http://www.esecurityinc.com) states that their agent technology uses a *superset* of the IDMEF standard [15].

NetForensics (http://www.networensics.com) indicates that they transport event information using XML over TCP but doesn't state that the IDMEF standard is being used.

Cisco – A search of the Cisco web site retrieved no references to IDMEF.

NetIQ – (http://www.netiq.com)– Product – Vigilent Log Analyzer (VLA) - A Universal Agent is used to capture event information from devices for which a NetIQ agent is not available. Communications from the Universal Agent to the VLA server encodes the event information with IDMEF. The IDMEF/XML messages are transported over TCP but neither IDXP nor BEEP is used.

SNORT (http://www.snort.org) - An IDMEF plugin [16] has been developed for the widely used SNORT IDS. This plug-in has been cited frequently in research studies. The documentation indicates that it is compatible with Snort 1.8.x. The original developer of SNORT founded SourceFire (http://www.sourcefire.com), a "for profit" company and has released a commercial version of SNORT 2.0. There is no mention of internal support for IDMEF at this time.

The Prelude Project (http://www.prelude-ide.org [14] is developing an open source hybrid network/host IDS and is using IDMEF. Although an IDMEF-like data model is used the data is not transmitted in IDMEF format. They state that this is because of the overhead of XML, a common criticism.

It is expected that as the standards settle that other implementations will appear. The growing need for centralized security event management will certainly fuel this development.

VI. Examples

Several examples have been taken from the IDMEF draft RFC [12] to show the formatting possible.

Portscan Attack

Highlights:

- The alert was received from the hq-dma-analyzer62 located at the Headquarters Web server.
- The attack was instituted by abc01 (192.0.2.200). The system being attacked was a DNS server named def01 (192.0.2.50) (Obviously an inside job!)
- The list of ports that were scanned is 5-25,37,42,43,53,69-119,123-514
- The analyzer has characterized the attack as a portscan attack. More information may be found at http://www.vendor.com/portscan.

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

  <!DOCTYPE IDMEF-Message PUBLIC "-//IETF//DTD RFC XXXX IDMEF
v1.0//EN"
    "idmef-message.dtd">

  <IDMEF-Message version="1.0">
    <Alert ident="abc123456789">
      <Analyzer analyzerid="hq-dmz-analyzer62">
        <Node category="dns">
          <location>Headquarters Web Server</location>
          <name>analyzer62.example.com</name>
        </Node>
      </Analyzer>
      <CreateTime ntpstamp="0xbc72b2b4.0x00000000">
        2000-03-09T15:31:00-08:00
      </CreateTime>
      <Source ident="abc01">
        <Node ident="abc01-01">
          <Address ident="abc01-02" category="ipv4-addr">
            <address>192.0.2.200</address>
          </Address>
        </Node>
      </Source>
      <Target ident="def01">
```

```
      <Node ident="def01-01" category="dns">
        <name>www.example.com</name>
        <Address ident="def01-02" category="ipv4-addr">
          <address>192.0.2.50</address>
        </Address>
      </Node>
      <Service ident="def01-03">
        <portlist>5-25,37,42,43,53,69-119,123-514</portlist>
      </Service>
    </Target>
    <Classification origin="vendor-specific">
      <name>portscan</name>
      <url>http://www.vendor.com/portscan</url>
    </Classification>
  </Alert>
</IDMEF-Message>
```

Denial of Service “Teardrop Attack”

Highlights:

- The attack was detected by “hq-dmz-analyzer01” in the Headquarters DMZ
- The attack appears to have come from badguy.example.net (192.0.2.50)
- The attack has been characterized as BugTraq ID 124

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

<!DOCTYPE IDMEF-Message PUBLIC "-//IETF//DTD RFC XXXX IDMEF
v1.0//EN"

    "idmef-message.dtd">

 <IDMEF-Message version="1.0">
    <Alert ident="abc123456789">
      <Analyzer analyzerid="hq-dmz-analyzer01">
        <Node category="dns">
          <location>Headquarters DMZ Network</location>
          <name>analyzer01.example.com</name>
        </Node>
      </Analyzer>
      <CreateTime ntpstamp="0xbc723b45.0xef449129">
        2000-03-09T10:01:25.93464-05:00
```

```
    &lt;/CreateTime&gt;
    &lt;Source ident="a1b2c3d4"&gt;
      &lt;Node ident="a1b2c3d4-001" category="dns"&gt;
        &lt;name&gt;badguy.example.net&lt;/name&gt;
        &lt;Address ident="a1b2c3d4-002" category="ipv4-net-mask"&gt;
          &lt;address&gt;192.0.2.50&lt;/address&gt;
          &lt;netmask&gt;255.255.255.255&lt;/netmask&gt;
        &lt;/Address&gt;
      &lt;/Node&gt;
    &lt;/Source&gt;
    &lt;Target ident="d1c2b3a4"&gt;
      &lt;Node ident="d1c2b3a4-001" category="dns"&gt;
        &lt;Address category="ipv4-addr-hex"&gt;
          &lt;address&gt;0xde796f70&lt;/address&gt;
        &lt;/Address&gt;
      &lt;/Node&gt;
    &lt;/Target&gt;
    &lt;Classification origin="bugtraqid"&gt;
      &lt;name&gt;124&lt;/name&gt;
      &lt;url&gt;http://www.securityfocus.com&lt;/url&gt;
    &lt;/Classification&gt;
  &lt;/Alert&gt;
&lt;/IDMEF-Message&gt;
```

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