



Interested in learning  
more about security?

# SANS Institute InfoSec Reading Room

This paper is from the SANS Institute Reading Room site. Reposting is not permitted without express written permission.

## IDMEF "Lingua Franca" for Security Incident Management

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 ...

Copyright SANS Institute  
Author Retains Full Rights

AD

DEEPAARMOR®

***IDMEF – “Lingua Franca” for Security Incident  
Management***

***Tutorial and Review of Standards Development***

***Submitted in fulfillment of the  
practical assignment for the***

***SANS GIAC Security Certification***

***Version 1.4b***

Douglas S. Corner

# Table of Contents

I. Abstract .....	2
II. Introduction.....	3
III. Overview of Protocols.....	6
III.A. IDMEF.....	6
III.B. IDXP .....	9
III.C. BEEP .....	9
III.D. IODEF and INCH.....	10
IV. Status of Protocol Development and Standardization.....	11
IV.A. IDMEF.....	11
IV.B. IDXP.....	11
IV.C. BEEP.....	11
IV.D. IODEF and INCH.....	11
V. Implementation Efforts.....	12
VI. Examples.....	13
References.....	16

## 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.

© SANS Institute 2003, Author retains full rights.

## 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.

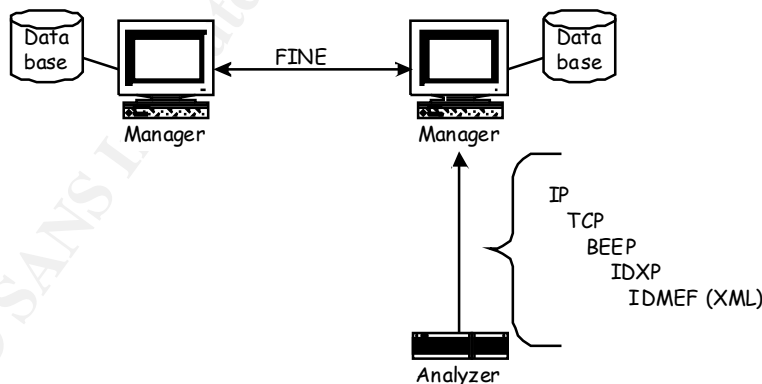
- IODEF – Incident Object Detection Exchange Format

The initial work done on IODEF has been superseded 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.

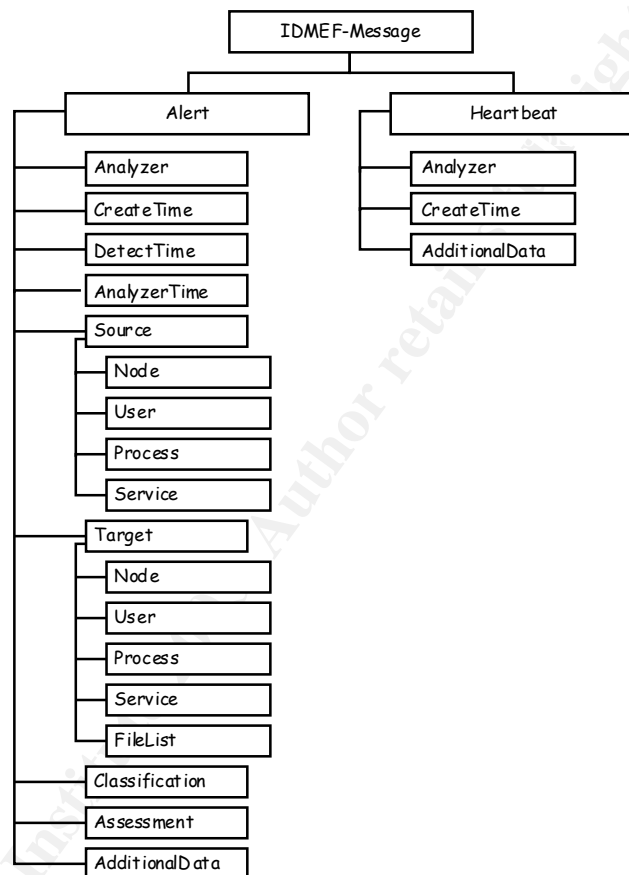
*Service*  
*Name of service*  
*Port used*  
*Portlist*  
*protocol*

*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 manager 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
- Confidentiality 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 IODEF. 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.netforensics.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 – Vigilant 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
    </CreateTime>
  </Alert>
</IDMEF-Message>

```



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

## **References**

- [1] Bray, T., Paoli, J., Sperberg-McQueen, C.M., Maler, E. "Extensible Markup Language (XML) 1.0 (Second Edition)", October 6, 2000, URL: <http://www.w3.org/TR/2000/REC-xml-20001006>
- [2] WWW Consortium "Definition of an XML DTD" from Extensible Markup Language (XML) 1.0 (Second Edition), October 6, 2000, URL: <http://www.w3.org/TR/REC-xml.html#dt-doctype>
- [3] Mills, D. "Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI" October 1996, URL: <http://www.ietf.org/rfc/rfc2030.txt?number=2030>
- [4] Feinstein, B., Mathews, G., White J., "The Intrusion Detection Exchange Protocol (IDXP) draft-ietf-idwg-beep-idxp-07", October 22, 2002 URL: <http://www.ietf.org/internet-drafts/draft-ietf-idwg-beep-idxp-07.txt>
- [5] "Rose, M. The Blocks Extensible Exchange Protocol Core", March 2001, URL: <http://www.ietf.org/rfc/rfc3080.txt?number=3080>
- [6] Sollins, K.R. "The TCP Protocol (Version 2)" June 1981 URL: <http://www.ietf.org/rfc/rfc0783.txt?number=783>
- [7] Borenstein, N., Freed, N. "MIME (Multipurpose Internet Mail Extensions) Part One: Mechanisms for Specifying and Describing the Format of Internet Message Bodies" September 1993 URL: <http://www.ietf.org/rfc/rfc1521.txt?number=1521>
- [8] Demchenko, Y., "Incident Object Description and Exchange Format Requirements <draft-ietf-inch-iodef-rfc3067bis-requirements-00.txt>" October 2002 URL: <http://www.ietf.org/internet-drafts/draft-ietf-inch-iodef-rfc3067bis-requirements-00.txt>
- [9] Demchenko, Y., Ohno, H., Keeni, G. "Requirements for Format for INcident Report Exchange (FINE) <draft-ietf-inch-requirements-00.txt>" February 2003 URL: <http://www.ietf.org/internet-drafts/draft-ietf-inch-requirements-00.txt>
- [10] Rose, M. "Mapping the BEEP Core onto TCP" March 2001 URL: <http://www.ietf.org/rfc/rfc3081.txt?number=3081>
- [11] Cuff, A. "Intrusion Detection Systems " URL: <http://www.networkintrusion.co.uk/ids.htm>

[12] Curry D., Debar, H. "Intrusion Detection Message Exchange Format Data Model and Extensible Markup Language (XML) Document Type Definition" January 30, 2003

URL:<http://www.ietf.org/internet-drafts/draft-ietf-idwg-idmef-xml-10.txt>

[13] New, D. "The TUNNEL Profile draft-ietf-idwg-beep-tunnel-05" December 5, 2002

URL:<http://www.ietf.org/internet-drafts/draft-ietf-idwg-beep-tunnel-05.txt>

[14] Zaraska, K. "Prelude IDS: current state and development perspectives", K March 14, 2003 URL:[www.prelude-ids.com](http://www.prelude-ids.com) ,

[15] e.Security Corporation, "e Security Agent Technology", Version 1.0, July 8, 2002.

[16] "IDMEF XML plugin for the Snort IDS"

<http://www.silicondefense.com/idwg/snort-idmef>

© SANS Institute 2003, Author retains full rights



# Upcoming SANS Training

[Click Here for a full list of all Upcoming SANS Events by Location](#)

Blue Team Summit & Training 2018	Louisville, KYUS	Apr 23, 2018 - Apr 30, 2018	Live Event
SANS Riyadh April 2018	Riyadh, SA	Apr 28, 2018 - May 03, 2018	Live Event
SANS Doha 2018	Doha, QA	Apr 28, 2018 - May 03, 2018	Live Event
SANS SEC460: Enterprise Threat Beta Two	Crystal City, VAUS	Apr 30, 2018 - May 05, 2018	Live Event
Automotive Cybersecurity Summit & Training 2018	Chicago, ILUS	May 01, 2018 - May 08, 2018	Live Event
SANS SEC504 in Thai 2018	Bangkok, TH	May 07, 2018 - May 12, 2018	Live Event
SANS Security West 2018	San Diego, CAUS	May 11, 2018 - May 18, 2018	Live Event
SANS Melbourne 2018	Melbourne, AU	May 14, 2018 - May 26, 2018	Live Event
SANS Northern VA Reston Spring 2018	Reston, VAUS	May 20, 2018 - May 25, 2018	Live Event
SANS Amsterdam May 2018	Amsterdam, NL	May 28, 2018 - Jun 02, 2018	Live Event
SANS Atlanta 2018	Atlanta, GAUS	May 29, 2018 - Jun 03, 2018	Live Event
SANS London June 2018	London, GB	Jun 04, 2018 - Jun 12, 2018	Live Event
SANS Rocky Mountain 2018	Denver, COUS	Jun 04, 2018 - Jun 09, 2018	Live Event
SEC487: Open-Source Intel Beta Two	Denver, COUS	Jun 04, 2018 - Jun 09, 2018	Live Event
DFIR Summit & Training 2018	Austin, TXUS	Jun 07, 2018 - Jun 14, 2018	Live Event
Cloud INsecurity Summit - Washington DC	Crystal City, VAUS	Jun 08, 2018 - Jun 08, 2018	Live Event
SANS Milan June 2018	Milan, IT	Jun 11, 2018 - Jun 16, 2018	Live Event
Cloud INsecurity Summit - Austin	Austin, TXUS	Jun 11, 2018 - Jun 11, 2018	Live Event
SANS Oslo June 2018	Oslo, NO	Jun 18, 2018 - Jun 23, 2018	Live Event
SANS ICS Europe Summit and Training 2018	Munich, DE	Jun 18, 2018 - Jun 23, 2018	Live Event
SANS Cyber Defence Japan 2018	Tokyo, JP	Jun 18, 2018 - Jun 30, 2018	Live Event
SANS Crystal City 2018	Arlington, VAUS	Jun 18, 2018 - Jun 23, 2018	Live Event
SANS Philippines 2018	Manila, PH	Jun 18, 2018 - Jun 23, 2018	Live Event
SANS Vancouver 2018	Vancouver, BCCA	Jun 25, 2018 - Jun 30, 2018	Live Event
SANS Paris June 2018	Paris, FR	Jun 25, 2018 - Jun 30, 2018	Live Event
SANS Cyber Defence Canberra 2018	Canberra, AU	Jun 25, 2018 - Jul 07, 2018	Live Event
SANS Minneapolis 2018	Minneapolis, MNUS	Jun 25, 2018 - Jun 30, 2018	Live Event
SANS London July 2018	London, GB	Jul 02, 2018 - Jul 07, 2018	Live Event
SANS Cyber Defence Singapore 2018	Singapore, SG	Jul 09, 2018 - Jul 14, 2018	Live Event
SANS Charlotte 2018	Charlotte, NCUS	Jul 09, 2018 - Jul 14, 2018	Live Event
SANSFIRE 2018	Washington, DCUS	Jul 14, 2018 - Jul 21, 2018	Live Event
SANS Malaysia 2018	Kuala Lumpur, MY	Jul 16, 2018 - Jul 21, 2018	Live Event
SANS Seattle Spring 2018	OnlineWAUS	Apr 23, 2018 - Apr 28, 2018	Live Event
SANS OnDemand	Books & MP3s OnlyUS	Anytime	Self Paced