CybOX™ Version 2.1.1 Part 01: Overview

Working Draft 01

15 December 2015

Technical Committee:

[OASIS Cyber Threat Intelligence (CTI) TC](https://www.oasis-open.org/committees/cti/)

Chair:

Richard Struse ([Richard.Struse@HQ.DHS.GOV](mailto:Richard.Struse@HQ.DHS.GOV)), [DHS Office of Cybersecurity and Communications (CS&C)](http://www.dhs.gov/office-cybersecurity-and-communications)

Editors:

Trey Darley ([trey@soltra.com](mailto:trey@soltra.com)), [Soltra](http://www.soltra.com/)

Ivan Kirillov ([ikirillov@mitre.org](mailto:ikirillov@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

Rich Piazza ([rpiazza@mitre.org](mailto:rpiazza@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

Desiree Beck ([dbeck@mitre.org](mailto:dbeck@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

Additional artifacts:

This prose specification is one component of a Work Product which consists of:

* *CybOX™ Version 2.1.1 Part 01: Overview*.
* *CybOX™ Version 2.1.1 Part 02: Common*. [URI]
* *CybOX™ Version 2.1.1 Part 03: Core*. [URI]
* *CybOX™ Version 2.1.1 Part 04: Default Extensions*. [URI]
* *CybOX™ Version 2.1.1 Part 05: Default Vocabularies*. [URI]
* *CybOX™ Version 2.1.1 Part 06: UML Model*. [URI]
* *CybOX™ Version 2.1.1 Part 07: API Object*. [URI]
* *CybOX™ Version 2.1.1 Part 08: ARP Cache Object*. [URI]
* *CybOX™ Version 2.1.1 Part 09: AS Object*. [URI]
* *CybOX™ Version 2.1.1 Part 10: Account Object*. [URI]
* *CybOX™ Version 2.1.1 Part 11: Address Object*. [URI]
* *CybOX™ Version 2.1.1 Part 12: Archive File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 13: Artifact Object*. [URI]
* *CybOX™ Version 2.1.1 Part 14: Code Object*. [URI]
* *CybOX™ Version 2.1.1 Part 15: Custom Object*. [URI]
* *CybOX™ Version 2.1.1 Part 16: DNS Cache Object*. [URI]
* *CybOX™ Version 2.1.1 Part 17: DNS Query Object*. [URI]
* *CybOX™ Version 2.1.1 Part 18: DNS Record Object*. [URI]
* *CybOX™ Version 2.1.1 Part 19: Device Object*. [URI]
* *CybOX™ Version 2.1.1 Part 20: Disk Object*. [URI]
* *CybOX™ Version 2.1.1 Part 21: Disk Partition Object*. [URI]
* *CybOX™ Version 2.1.1 Part 22: Domain Name Object*. [URI]
* *CybOX™ Version 2.1.1 Part 23: Email Message Object*. [URI]
* *CybOX™ Version 2.1.1 Part 24: File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 25: GUI Dialogbox Object*. [URI]
* *CybOX™ Version 2.1.1 Part 26: GUI Object*. [URI]
* *CybOX™ Version 2.1.1 Part 27: GUI Window Object*. [URI]
* *CybOX™ Version 2.1.1 Part 28: HTTP Session Object*. [URI]
* *CybOX™ Version 2.1.1 Part 29: Hostname Object*. [URI]
* *CybOX™ Version 2.1.1 Part 30: Image File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 31: Library File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 32: Link Object*. [URI]
* *CybOX™ Version 2.1.1 Part 33: Linux Package Object*. [URI]
* *CybOX™ Version 2.1.1 Part 34: Memory Object*. [URI]
* *CybOX™ Version 2.1.1 Part 35: Mutex Object*. [URI]
* *CybOX™ Version 2.1.1 Part 36: Network Connection Object*. [URI]
* *CybOX™ Version 2.1.1 Part 37: Network Flow Object*. [URI]
* *CybOX™ Version 2.1.1 Part 38: Network Packet Object*. [URI]
* *CybOX™ Version 2.1.1 Part 39: Network Route Entry Object*. [URI]
* *CybOX™ Version 2.1.1 Part 40: Network Route Object*. [URI]
* *CybOX™ Version 2.1.1 Part 41: Network Socket Object*. [URI]
* *CybOX™ Version 2.1.1 Part 42: Network Subnet Object*. [URI]
* *CybOX™ Version 2.1.1 Part 43: PDF File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 44: Pipe Object*. [URI]
* *CybOX™ Version 2.1.1 Part 45: Port Object*. [URI]
* *CybOX™ Version 2.1.1 Part 46: Process Object*. [URI]
* *CybOX™ Version 2.1.1 Part 47: Product Object*. [URI]
* *CybOX™ Version 2.1.1 Part 48: SMS Message Object*. [URI]
* *CybOX™ Version 2.1.1 Part 49: Semaphore Object*. [URI]
* *CybOX™ Version 2.1.1 Part 50: Socket Address Object*. [URI]
* *CybOX™ Version 2.1.1 Part 51: System Object*. [URI]
* *CybOX™ Version 2.1.1 Part 52: URI Object*. [URI]
* *CybOX™ Version 2.1.1 Part 53: URL History Object*. [URI]
* *CybOX™ Version 2.1.1 Part 54: Unix File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 55: Unix Network Route Entry Object*. [URI]
* *CybOX™ Version 2.1.1 Part 56: Unix Pipe Object*. [URI]
* *CybOX™ Version 2.1.1 Part 57: Unix Process Object*. [URI]
* *CybOX™ Version 2.1.1 Part 58: Unix User Account Object*. [URI]
* *CybOX™ Version 2.1.1 Part 59: Unix Volume Object*. [URI]
* *CybOX™ Version 2.1.1 Part 60: User Account Object*. [URI]
* *CybOX™ Version 2.1.1 Part 61: User Session Object*. [URI]
* *CybOX™ Version 2.1.1 Part 62: Volume Object*. [URI]
* *CybOX™ Version 2.1.1 Part 63: Whois Object*. [URI]
* *CybOX™ Version 2.1.1 Part 64: Win Computer Account Object*. [URI]
* *CybOX™ Version 2.1.1 Part 65: Win Critical Section Object*. [URI]
* *CybOX™ Version 2.1.1 Part 66: Win Driver Object*. [URI]
* *CybOX™ Version 2.1.1 Part 67: Win Event Log Object*. [URI]
* *CybOX™ Version 2.1.1 Part 68: Win Event Object*. [URI]
* *CybOX™ Version 2.1.1 Part 69: Win Executable File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 70: Win File Object*. [URI]
* *CybOX™ Version 2.1.1 Part 71: Win Filemapping Object*. [URI]
* *CybOX™ Version 2.1.1 Part 72: Win Handle Object*. [URI]
* *CybOX™ Version 2.1.1 Part 73: Win Hook Object*. [URI]
* *CybOX™ Version 2.1.1 Part 74: Win Kernel Hook Object*. [URI]
* *CybOX™ Version 2.1.1 Part 75: Win Kernel Object*. [URI]
* *CybOX™ Version 2.1.1 Part 76: Win Mailslot Object*. [URI]
* *CybOX™ Version 2.1.1 Part 77: Win Memory Page Region Object*. [URI]
* *CybOX™ Version 2.1.1 Part 78: Win Mutex Object*. [URI]
* *CybOX™ Version 2.1.1 Part 79: Win Network Route Entry Object*. [URI]
* *CybOX™ Version 2.1.1 Part 80: Win Network Share Object*. [URI]
* *CybOX™ Version 2.1.1 Part 81: Win Pipe Object*. [URI]
* *CybOX™ Version 2.1.1 Part 82: Win Prefetch Object*. [URI]
* *CybOX™ Version 2.1.1 Part 83: Win Process Object*. [URI]
* *CybOX™ Version 2.1.1 Part 84: Win Registry Key Object*. [URI]
* *CybOX™ Version 2.1.1 Part 85: Win Semaphore Object*. [URI]
* *CybOX™ Version 2.1.1 Part 86: Win Service Object*. [URI]
* *CybOX™ Version 2.1.1 Part 87: Win System Object*. [URI]
* *CybOX™ Version 2.1.1 Part 88: Win System Restore Object*. [URI]
* *CybOX™ Version 2.1.1 Part 89: Win Task Object*. [URI]
* *CybOX™ Version 2.1.1 Part 90: Win Thread Object*. [URI]
* *CybOX™ Version 2.1.1 Part 91: Win User Account Object*. [URI]
* *CybOX™ Version 2.1.1 Part 92: Win Volume Object*. [URI]
* *CybOX™ Version 2.1.1 Part 93: Win Waitable Timer Object*. [URI]
* *CybOX™ Version 2.1.1 Part 94: X509 Certificate Object*. [URI]

Related work:

This specification is related to:

* *STIX*™ *Version 1.2.1 (placeholder)*

Abstract:

The Cyber Observable Expression (CybOX) is a standardized language for encoding and communicating high-fidelity information about cyber observables, whether dynamic events or stateful measures that are observable in the operational cyber domain. By specifying a common structured schematic mechanism for these cyber observables, the intent is to enable the potential for detailed automatable sharing, mapping, detection and analysis heuristics. This document serves as an overview of those specifications and defines how they are used within the broader CybOX framework.

Status:

This [Working Draft](https://www.oasis-open.org/policies-guidelines/tc-process#dWorkingDraft) (WD) has been produced by one or more TC Members; it has not yet been voted on by the TC or [approved](https://www.oasis-open.org/policies-guidelines/tc-process#committeeDraft) as a Committee Draft (Committee Specification Draft or a Committee Note Draft). The OASIS document [Approval Process](https://www.oasis-open.org/policies-guidelines/tc-process#standApprovProcess) begins officially with a TC vote to approve a WD as a Committee Draft. A TC may approve a Working Draft, revise it, and re-approve it any number of times as a Committee Draft.

URI patterns:

Initial publication URI:  
http://docs.oasis-open.org/cti/stix/v1.2.1/csd01/part9-coa/stix-v1.2.1-csd01-part9-coa.docx

Permanent “Latest version” URI:  
http://docs.oasis-open.org/cti/stix/v1.2.1/stix-v1.2.1-part9-coa.docx

(Managed by OASIS TC Administration; please don’t modify.)

Copyright © OASIS Open 2016. All Rights Reserved.

All capitalized terms in the following text have the meanings assigned to them in the OASIS Intellectual Property Rights Policy (the "OASIS IPR Policy"). The full [Policy](https://www.oasis-open.org/policies-guidelines/ipr) may be found at the OASIS website.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published, and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this section are included on all such copies and derivative works However, this document itself may not be modified in any way, including by removing the copyright notice or references to OASIS, except as needed for the purpose of developing any document or deliverable produced by an OASIS Technical Committee (in which case the rules applicable to copyrights, as set forth in the OASIS IPR Policy, must be followed) or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by OASIS or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and OASIS DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY OWNERSHIP RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Portions copyright © United States Government 2012-2016.  All Rights Reserved.  
  
STIX™, TAXII™, AND CybOX™ (STANDARD OR STANDARDS) AND THEIR COMPONENT PARTS ARE PROVIDED “AS IS” WITHOUT ANY WARRANTY OF ANY KIND, EITHER EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTY THAT THESE STANDARDS OR ANY OF THEIR COMPONENT PARTS WILL CONFORM TO SPECIFICATIONS, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR FREEDOM FROM INFRINGEMENT, ANY WARRANTY THAT THE STANDARDS OR THEIR COMPONENT PARTS WILL BE ERROR FREE, OR ANY WARRANTY THAT THE DOCUMENTATION, IF PROVIDED, WILL CONFORM TO THE STANDARDS OR THEIR COMPONENT PARTS. IN NO EVENT SHALL THE UNITED STATES GOVERNMENT OR ITS CONTRACTORS OR SUBCONTRACTORS BE LIABLE FOR ANY DAMAGES, INCLUDING, BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES, ARISING OUT OF, RESULTING FROM, OR IN ANY WAY CONNECTED WITH THESE STANDARDS OR THEIR COMPONENT PARTS OR ANY PROVIDED DOCUMENTATION, WHETHER OR NOT BASED UPON WARRANTY, CONTRACT, TORT, OR OTHERWISE, WHETHER OR NOT INJURY WAS SUSTAINED BY PERSONS OR PROPERTY OR OTHERWISE, AND WHETHER OR NOT LOSS WAS SUSTAINED FROM, OR AROSE OUT OF THE RESULTS OF, OR USE OF, THE STANDARDS, THEIR COMPONENT PARTS, AND ANY PROVIDED DOCUMENTATION. THE UNITED STATES GOVERNMENT DISCLAIMS ALL WARRANTIES AND LIABILITIES REGARDING THE STANDARDS OR THEIR COMPONENT PARTS ATTRIBUTABLE TO ANY THIRD PARTY, IF PRESENT IN THE STANDARDS OR THEIR COMPONENT PARTS AND DISTRIBUTES IT OR THEM “AS IS.”

Table of Contents

[1 Introduction 6](#_Toc449948855)

[1.1 CybOX Specification Documents 6](#_Toc449948856)

[1.2 Document Conventions 6](#_Toc449948857)

[1.2.1 Fonts 6](#_Toc449948858)

[1.2.2 UML Package References 7](#_Toc449948859)

[1.2.3 UML Diagrams 7](#_Toc449948860)

[1.2.3.1 Class Properties 7](#_Toc449948861)

[1.2.3.2 Diagram Icons and Arrow Types 7](#_Toc449948862)

[1.3 Terminology 8](#_Toc449948863)

[1.4 Normative References 8](#_Toc449948864)

[1.5 Non-Normative References 8](#_Toc449948865)

[2 Language Modularity 9](#_Toc449948866)

[2.1 Core Data Model 9](#_Toc449948867)

[2.2 Object Models 9](#_Toc449948868)

[2.3 Events and Actions Data Models 11](#_Toc449948869)

[2.4 Common Data Model 11](#_Toc449948870)

[2.4.1 Object Property Model 11](#_Toc449948871)

[2.5 Default Extensions Data Model 13](#_Toc449948872)

[2.6 Default Vocabularies 14](#_Toc449948873)

[2.7 Basic Data Types 14](#_Toc449948874)

[2.7.1 Common Basic Data Types 14](#_Toc449948875)

[2.7.2 Specializations of the BasicString Data Type 15](#_Toc449948876)

[3 Data Model Conventions 17](#_Toc449948877)

[3.1 UML Packages 17](#_Toc449948878)

[3.2 Naming Conventions 18](#_Toc449948879)

[3.3 Identifiers 18](#_Toc449948880)

[4 Relationships to Other Externally-defined Data Models 19](#_Toc449948881)

[4.1 Customer Information Quality (CIQ) 19](#_Toc449948882)

[4.2 Common Platform Enumeration (CPE) 19](#_Toc449948883)

[5 Conformance 20](#_Toc449948884)

[Appendix A. Acknowledgments 21](#_Toc449948885)

[Appendix B. Revision History 22](#_Toc449948886)

# Introduction

[All text is normative unless otherwise labeled]

The Cyber Observable Expression (CybOX™) provides a common structure for representing cyber observables across and among the operational areas of enterprise cyber security. CybOX improves the consistency, efficiency, and interoperability of deployed tools and processes, and it increases overall situational awareness by enabling the potential for detailed automatable sharing, mapping, detection, and analysis heuristics.

This CybOX specification overview document serves as a unifying document for the full set of [CybOX specification documents](#AdditionalArtifacts). In Section **1.1,** we discuss additional specification documents, in Section **1.2,** we provide document conventions, and in Section **1.3,** we provide terminology. References are given in Sections **1.4** and **1.5**. In Section **2** we discusses the modularity of CybOX, and summarizes the relationship of CybOX to other languages. In section **3**, we discuss conventions common across all of the data models. Conformance information is also provided in Section **4**.

## CybOX Specification Documents

The CybOX specification consists of a formal UML model and a set of textual specification documents that explain the UML model. Specification documents have been written for each of the individual data models that compose the full CybOX UML model.

CybOX has a modular design comprising two fundamental data models and a collection of Object data models. The fundamental data models – CybOX Core and CybOX Common – provide essential CybOX structure and functionality. The CybOX Objects, defined in individual data models, are precise characterizations of particular types of observable cyber entities (e.g., HTTP session, Windows registry key, DNS query). Additionally, the full CybOX data model includes various extension data models and a set of default controlled vocabularies.

Use of the CybOX Core and Common data models is required; however, use of the CybOX Object data models is purely optional: users select and use only those Objects and corresponding data models that are needed. Importing the entire [CybOX suite of data models](#AdditionalArtifacts) is not necessary.

## Document Conventions

The following conventions are used in this document.

### Fonts

The following font and font style conventions are used in the document:

* Capitalization is used for CybOX high level concepts, which are defined in [*CybOX™ Version 2.1.1 Part 1: Overview*](#AdditionalArtifacts).

Examples: Action, Object, Event, Property

* The Courier New font is used for writing UML objects.

Examples: ActionType, cyboxCommon:BaseObjectPropertyType

Note that all high level concepts have a corresponding UML object. For example, the Action high level concept is associated with a UML class named, ActionType.

* The ‘*italic’* font (withsingle quotes) is used for noting actual, explicit values for CybOX Language properties. The *italic* font (without quotes) is used for noting example values.

Example:  *‘HashNameVocab-1.0,’ high, medium, low*

### UML Package References

Each CybOX data model is captured in a different UML package (e.g., Core package) where the packages together compose the full [CybOX UML model](#AdditionalArtifacts). To refer to a particular class of a specific package, we use the format package\_prefix:class, where package\_prefix corresponds to the appropriate UML package.

### UML Diagrams

This specification makes use of UML diagrams to visually depict relationships between CybOX Language constructs. Note that the diagrams have been extracted directly from the full UML model for CybOX; they have not been constructed purely for inclusion in the specification documents.  Typically, diagrams are included for the primary class of a data model, and for any other class where the visualization of its relationships between other classes would be useful.  This implies that there will be very few diagrams for classes whose only properties are either a data type or a class from the CybOX Common data model.  Other diagrams that are included correspond to classes that specialize a superclass and abstract or generalized classes that are extended by one or more subclasses.

In UML diagrams, classes are often presented with their attributes elided, to avoid clutter. A class presented with an empty section at the bottom of the icon indicates that there are no attributes other than those that are visualized using associations.

#### Class Properties

Generally, a class property can be shown in a UML diagram as either an attribute or an association (i.e., the distinction between attributes and associations is somewhat subjective). In order to make the size of UML diagrams in the specifications manageable, we have chosen to capture most properties as attributes and to capture only higher level properties as associations, especially in the main top-level component diagrams. In particular, we will always capture properties of UML data types as attributes.

#### Diagram Icons and Arrow Types

Diagram icons are used in a UML diagram to indicate whether a shape is a class, enumeration, or a data type, and decorative icons are used to indicate whether an element is an attribute of a class or an enumeration literal. In addition, two different arrow styles indicate either a directed association relationship (regular arrowhead) or a generalization relationship (triangle-shaped arrowhead). The icons and arrow styles we use are shown and described in **Table 1‑1**.

Table ‑. UML diagram icons

|  |  |
| --- | --- |
| **Icon** | **Description** |
| cid:image003.gif@01D05428.2B30AE20 | This diagram icon indicates a class. If the name is in italics, it is an abstract class. |
|  | This diagram icon indicates an enumeration. |
|  | This diagram icon indicates a data type. |
|  | This decorator icon indicates an attribute of a class. The green circle means its visibility is public. If the circle is red or yellow, it means its visibility is private or protected. |
|  | This decorator icon indicates an enumeration literal. |
|  | This arrow type indicates a directed association relationship. |
|  | This arrow type indicates a generalization relationship. |

## Terminology

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 [RFC2119].

## Normative References

[RFC2119] Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels”, BCP 14, RFC 2119, March 1997. <http://www.ietf.org/rfc/rfc2119.txt>.

[CPE] Common Platform Enumeration (CPE). (2014, Nov. 28). The MITRE Corporation. [Online]. Available: <http://cpe.mitre.org>.

**[CIQ]** *Customer Information Quality (CIQ) Specifications Version 3.0*. Edited by Ram Kumar. 8 April 2008. OASIS Public Review Draft 03. Available: <http://docs.oasis-open.org/ciq/v3.0/specs/ciq-specs-v3.html>.

**[****W3DT] “**XML Schema Part 2: Datatypes Second Edition,” W3C Recommendation, 28 October 2004. Available: <http://www.w3.org/TR/xmlschema-2>.

[CAPEC] Common Attack Pattern Enumeration and Classification (CAPEC). (2014, Nov. 7). The MITRE Corporation. [Online]. Available: [http://capec.mitre.org](http://capec.mitre.org/).

[CEE] Common Event Expression (CEE). (2014, Nov. 28). The MITRE Corporation. [Online]. Available: <http://cee.mitre.org>.

**[****CVE]** Common Vulnerabilities and Exposures (CVE). (2015, Jul. 28). The MITRE Corporation. [Online]. Available: <http://cve.mitre.org>.

**[****CWE]** Common Weakness Enumeration (CWE). (2014, Jul. 31). The MITRE Corporation. [Online]. Available: <http://cwe.mitre.org>.

**[****ISO8601]** Date and time format – ISO 8601 (n.d.). International Organization for Standardization (ISO). [Online]. Available: <http://www.iso.org/iso/home/standards/iso8601.htm>. Accessed Aug. 23, 2015.

[RFC3986] Berners-Lee, T., Fielding, R. and Masinter, L., “Uniform Resource Identifier (URI): Generic Syntax,” STD 66, RFC 3986, January 2005. Available: <https://www.ietf.org/rfc/rfc3986.txt>.

**[****RFC5646]** Phillips, A. and Davis, M., “Tags for Identifying Languages,” BCP 47, RFC 5646, September 2009. Available: <http://www.ietf.org/rfc/rfc5646.txt>.

**[****W3Name] “**Namespaces in XML 1.0 (Third Edition),” W3C Recommendation, 8 December 2009. Available: <http://www.w3.org/TR/REC-xml-names>.

## Non-Normative References

**[****UML-2.4.1**] Documents associated with Unified Modeling Language (UML), V2.4.1. (Aug. 2011). The Object Management Group (OMG). [Online]. Available: <http://www.omg.org/spec/UML/2.4.1/>.

# Language Modularity

## Core Data Model

The CybOX Core data model defines the four main classes: Action, Event, Observable and Object which corresponds to the primary structure characterized in CybOX. Please see [*CybOX™ Version 2.1.1 Part 3: Core*](#AdditionalArtifacts) for complete information on the CybOX Core data model.

## Object Models

Each release of the CybOX language includes a particular set of Objects that are part of the release. There are eighty-eight different Object data models in CybOX 2.1.1. They cover a varied collection of artifacts that are pertinent to the cyber threat domain. The data model for each of these Objects is defined by its own UML package that describes the context-specific classes and properties that comprise the Object. As stated in the introduction, the use of any particular CybOX Object data models is purely optional: users select and use only those Objects and corresponding data models that are needed.

The grouping of Objects below is for expository purposes only. It does not suggest or imply the need to use of any particular Object data model.

* **Host-based Artifacts**
  + **File-related**
    - Library
    - Windows Pipe
    - Pipe
    - Unix Pipe
    - Windows Filemapping
    - **File**
      * File
      * Image File
      * PDF File
      * Archive File
      * Windows File
      * Unix File
      * Windows Executable File
  + **Memory-related**
    - Windows Critical Section
    - Semaphore
    - Windows Semaphore
    - Windows Waitable Timer
    - Mutex
    - Windows Mutex
    - Windows Hook
    - Windows Kernel Hook
    - Windows Memory Page Region
    - Windows Handle
    - Memory
    - Windows Mailslot
  + **Mobile**
    - SMS Message
  + **Process-related**
    - Process
    - Windows Thread
    - Unix Process
    - Windows Process
  + **Disk-related**
    - Disk
    - Disk Partition
    - Volume
    - Unix Volume
    - Windows Volume
  + **Network-related**
    - Network Socket
    - Socket Address
    - Network Route Entry
    - Windows Network Route Entry
    - Unix Network Route Entry
    - Windows Network Share
    - Hostname
    - ARP Cache
    - URL History
  + **Device/System**
    - Device
    - System
    - Windows System
  + **OS Metadata**
    - Account
    - User Account
    - **GUI**
      * GUI
      * GUI Window
      * GUI Dialog Box
    - **Unix/Linux**
      * Unix User Account
      * Linux Package
    - **Windows**
      * Windows Prefetch
      * Windows Task
      * Windows Service
      * Windows System Restore
      * Windows Computer Account
      * Windows User Account
      * Windows Driver
      * Windows Service
      * Windows Event
      * Windows Event Log
      * Windows Registry Key
      * Windows Kernel
* **Network-based Artifacts**
  + Email Message
  + **DNS**
    - DNS Record
    - DNS Query
    - DNS Cache
  + Network Route
  + Network Subnet
  + Network Connection
  + Network Flow
  + Network Packet
  + HTTP Session
  + AS
  + Address
  + Email Message
  + URI
  + Port
  + Domain Name
  + Whois
* **Misc.**
  + Code
  + User Session
  + API
  + Custom
  + Link
  + Product
  + X509 Certificate
  + Artifact

The Object data models are split into three major categories: Host-based artifacts, Network-based artifacts, and the catch-all miscellaneous artifacts. Among the Host-based artifacts, there are many data models that are extensions of others in order to define properties specific to the Windows or Unix operating systems. Some of the Object data models are very simple (e.g. DNS\_Cache), containing one or two UML classes or data types; others are quite complex, encompassing many UML classes (e.g., PDF\_File). Each individual Object data model has a main toplevel class, which is usually named after the UML package name (e.g., the main class in the PDF File Object data model is PDFFileObjectType).

## Events and Actions Data Models

The Event and Action data models are designed to support modular expression of any event made up of one or more actions with the ability to relate actions to one another and to relate actions to relevant objects. The Action data model allows expression of the nature of the action, any relevant arguments and relationships to any relevant objects including the nature of the relationship and any specific effects the action has on the object.

## Common Data Model

The CybOX Common data model defines object classes that are shared across the various CybOX data models. At a high level, the CybOX Common data model provides object property classes, content aggregation classes, shared classes, and a pattern class for permitting complex (i.e. regular-expression based) specifications. Please see [*CybOX™ Version 2.1.1 Part 2: Common*](#AdditionalArtifacts) for complete information on the CybOX Common data model.

### Object Property Model

The Object Property data model in CybOX is sophisticated, enabling the description of complex Observables. Observables can be made up of Objects or Events. In this section, we will concentrate on the Object aspect of an Observable.

Objects have two main properties, Properties and Related\_Objects. This is shown in **Figure 2‑1**.

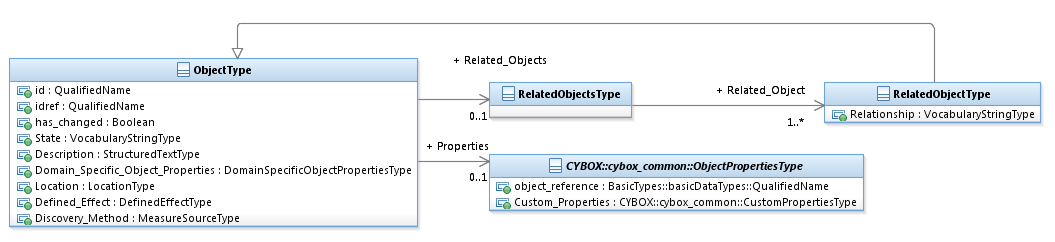


Figure ‑. UML diagram for ObjectType class

The Object data models, described in **Section 2.2**, are not extensions of ObjectType, but instead are used in an ObjectType class instance via the Properties property. Accordingly, they are extensions of ObjectPropertiesType, an abstract class. Notice that only a single toplevel instance from one of the Object data models is specified in the Properties property. Instances of other Objects can be referred to via the Related\_Objects property.

Once the Object data model to be used in an ObjectType instance is selected, its properties can be assigned values. Such Object properties are based on one of four different kinds of property types:

* BasicTypes
* ObjectPropertyType extension classes
* Other classes defined in the same Object domain model
* Other toplevel classes from other Object domain models.

The following figures provide an example.

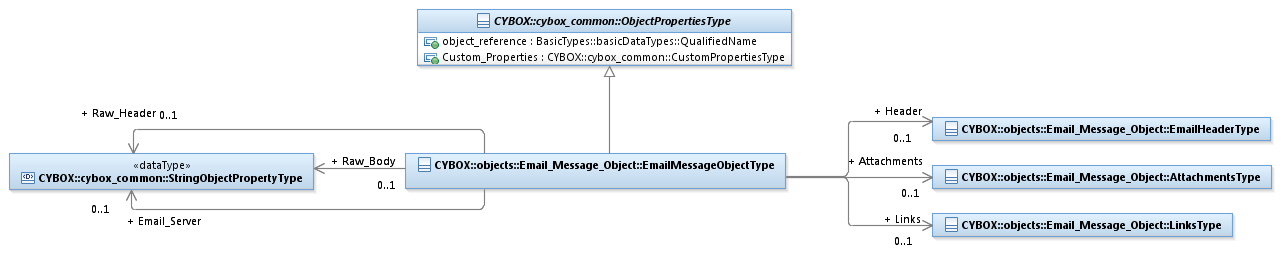


Figure ‑. Toplevel class of the Email\_Message\_Object data model

The EmailMessageObjectType class extends the ObjectPropertiesType, and therefore can be used in the ObjectType class (**Figure 2‑2**). The properties of EmailMessageObjectType use other classes from the same UML package as well as StringObjectPropertyType, an extension of ObjectPropertyType.

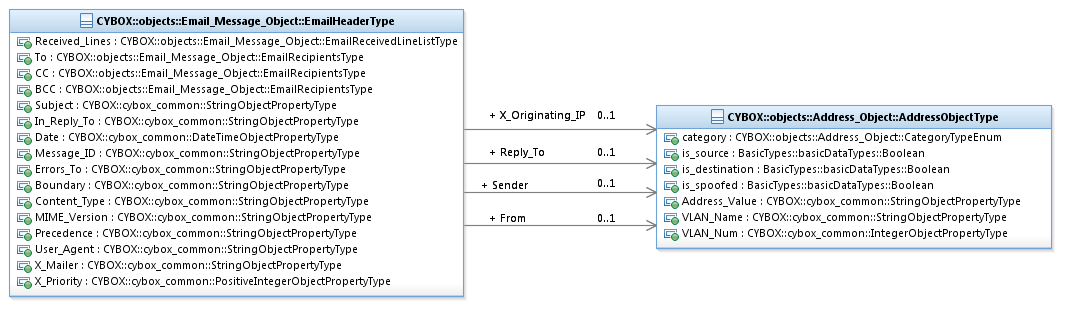


Figure ‑. Details of other classes of the Email\_Message\_Object data model

Expanding the detail of the EmailHeaderType class (**Figure 2‑3**), one can see that in addition to data type-based properties extended from the ObjectPropertyType class (e.g., IntegerObjectPropertyType) it also makes use of a class from the domain model of another Object (AddressObjectType). Notice that AddressObjectType contains properties that use data types from the BasicTypes package (see **Section 2.6**).



Figure ‑. UML diagram of the BaseObjectPropertyType data type

Use of UML data types that extend from BaseObjectPropertyType enables a producer of content to include much more detail about the value of an Object’s property (**Figure 2‑4**). BaseObjectPropertyType data type extends from BaseObjectPropertyGroup, which is an abstract data type that contains the auxiliary metadata properties associated with the main property value being represented. For example, when using StringObjectPropertyType to describe the File\_Name property of a File Object, one might want to include that the observed encoding of the string is “windows-1251”.

In addition, the BaseObjectPropertyType data type also inherits from PatternFieldGroup data type. This data type incorporates pattern matching capabilities to all specializations of BaseObjectPropertyType. An example of using properties from PatternFieldGroup would be to use a StringObjectPropertyType to specify that the File Object’s File\_Extension property satisfied the condition: not equal to “exe”.

Accordingly, it follows that properties from BaseObjectPropertyGroup are used only when specifying an actual observation and properties from PatternFieldGroup are used only when specifying an observable pattern.

## Default Extensions Data Model

A primary design principle of CybOX is to avoid duplicating data models that already exist for capturing cyber threat information. Therefore, CybOX leverages a number of other structured languages and identifiers through the use of default extensions.

More precisely, the CybOX Default Extensions data model provides loose-coupling mechanisms and default extensions for leveraging constituent data models such as the Common Platform Enumeration [**[CPE]**](#cpe) and OASIS Customer Information Quality model [**[CIQ]**](#CIQ).

Please see [*CybOX™ Version 2.1.1 Part 4: Default Extensions*](#AdditionalArtifacts) for complete information on the CybOX Default Extensions data model.

## Default Vocabularies

For some properties captured in CybOX, a content creator may choose to constrain the set of possible values by referencing an externally-defined vocabulary or by leveraging a default vocabulary class defined within CybOX. Alternatively, the content creator may use an arbitrary value without specifying any vocabulary. Please see  [*CybOX™ Version 2.1.1 Part 5: Vocabularies*](#AdditionalArtifacts) for more information about the default vocabularies defined in CybOX.

## Basic Data Types

The Basic Data Types data model defines basic UML data types used in CybOX. As stated in the [**[UML 2.4.1]**](#UML241) specification, UML data types are similar to UML classes, but also different:

“A data type is a special kind of classifier, similar to a class. It differs from a class in that instances of a data type are identified only by their value. All copies of an instance of a data type and any instances of that data type with the same value are considered to be equal instances. Instances of a data type that have attributes (i.e., is a structured data type) are considered to be equal if the structure is the same and the values of the corresponding attributes are equal. If a data type has attributes, then instances of that data type will contain attribute values matching the attributes.”

Although four of the requisite primitive data types (Boolean, Integer, String, UnlimitedNatural) are defined in UML, the need for a broader set in CybOX drove the decision to define a complete set of basic data types in a separate, stand-alone UML package (the Basic Data Types data model). We explicitly define the data types in the Basic Data Types data model in Sections **2.6.1** and **2.6.2**.

Note, that the use of UML data types from the Basic Data Types data model (e.g., BasicString, Boolean) is not the same as using UML data types defined as specializations of BaseObjectPropertyType (e.g., StringObjectPropertyType, HexBinaryObjectPropertyType, etc.). The latter data types permits the use of properties from BaseObjectPropertyGroup and PatternFieldGroup, which allow for a much richer characterization of cyber observables. Also, it’s worth noting that not all data types defined in the Basic Data Types data model are used in CybOX.

### Common Basic Data Types

Common data types, such as string and integer, are defined in the Basic DataTypes data model and adhere to the following definitions shown in **Table 2‑1**. These definitions are based on the specification of the corresponding data types found in [**[W3DT]**](#W3DT).

Table ‑. Common basic data types

|  |  |
| --- | --- |
| **Data Type** | **Definition** |
| BasicString | The BasicString data type is a sequence of characters. Currently, characters are defined using the UTF-8 character encoding. The number of characters allowed is finite, but unbounded. |
| Boolean | The Boolean data type is defined with two possible literals: ‘*true*’ and ‘*false*’. |
| Decimal | The Decimal data type is a sequence of decimal digits, with perhaps an intervening decimal point, “.”. The number of digits on either side of the decimal point is finite, but unbounded. Often used to express currency amounts. |
| Integer | The Integer data type is a sequence of decimal digits, with perhaps a leading minus sign “-“. The number of decimal digits allowed is finite, but unbounded. |
| NonNegativeInteger | The NonNegativeInteger data type is a restriction on the Integer data type such that the leading minus sign is not allowed. |
| PositiveInteger | The PositiveInteger data type is a restriction on the NonNegativeInteger data type that disallows zero (0). |

### Specializations of the BasicString Data Type

The data types in **Table 3‑2** correspond to strings that have semantics associated with them. Because of this, they usually are restricted to a certain pattern, defined via a regular expression, and/or more formally defined in a standardization document.

Table ‑. Specializations of the BasicString Data Type

|  |  |
| --- | --- |
| **Data Type** | **Definition** |
| CAPEC\_ID | The CAPEC\_ID data type is a restriction on the BasicString data type, such that it adheres to the regular expression “CAPEC-\d+”. The CAPEC\_ID values should correspond to those defined at [**[CAPEC]**](#capec). |
| CCE\_ID | The CCE\_ID data type is a restriction on the BasicString data type such that it adheres to the regular expression “CCE-\d+\d”. The CCE\_ID values should correspond to those defined at [**[CEE]**](#cee). |
| CVE\_ID | The CVE\_ID data type is a restriction on the BasicString data type such that it adheres to the regular expression “CVE-\d\d\d\d+\d+”. The CVE\_ID values should correspond to those defined at [**[CVE]**](#cve). |
| CWE\_ID | The CWE\_ID data type is a restriction on the BasicString data type such that it adheres to the regular expression “CWE-\d+”. The CWE\_ID values should correspond to those defined at [**[CWE]**](#cwe). |
| DateTime | The DateTime data type is a restriction on the BasicString data type such that it adheres to the standard defined in [**[ISO8601]**](#iso8601). |
| HexBinary | The HexBinary data type is a restriction on the BasicString data type such that it adheres to the regular expression [0-9A-Fa-f]\*. The number of characters allowed is finite but unbounded. The number of digits must be even in length. |
| LanguageCode | The LanguageCode data type is a restriction on the BasicString data type, such that it adheres to the standard defined in [**[RFC5646]**](#rfc5646). |
| QualifiedName | The QualifiedName data type is a restriction on the BasicString data type such that it adheres to the requirements specified in [**[W3Name]**](#W3Name). |
| NoEmbeddedQuoteString | The NoEmbeddedQuoteString data type is a restriction on the BasicString data type such that it does not include any double quote characters. This data type captures properties that were attributes in the XML model. |
| URI | The URI data type is a restriction on the BasicString data type such that it adheres to the standard defined at [**[RFC3986]**](#rfc3986). |

# Data Model Conventions

The following general information and conventions are used to define the individual data models in [*CybOX™ Version 2.1.1 Part 6: UML Model*](#AdditionalArtifacts). It should be noted that the CybOX data models actually evolved as XML schemas, and as a consequence, our UML model follows some conventions so as to be compatible with the preexisting XML implementation. However, we have abstracted away from the XML implementation as much as possible.

## UML Packages

Each CybOX data model is captured in a different UML package (e.g., Core package, File\_Object package, etc.). To refer to a particular class of a specific package, we use the format package\_prefix:class, where package\_prefix corresponds to the appropriate UML package. **Table 3‑1** lists the basic packages used throughout the CybOX data model specification documents, along with the prefix notation and an example. Descriptions of the packages are provided in Section **2**.

Table ‑. Package prefixes used by the CybOX Language

|  |  |
| --- | --- |
| Package | CybOX Core |
| **Prefix** | **cybox** |
| Description | The CybOX Core data model defines the main classes of the CybOX data model, such as ActionType, EventType, ObservableType and ObjectType. |
| Example | cyboxCore:ObservableType |
|  | |
| Package | CybOX Common |
| **Prefix** | **cyboxCommon** |
| Description | The CybOX Common data model defines classes that are shared across the various CybOX data models. |
| Example | cyboxCommon:ConfidenceType |
|  |  |
| Package | CybOX Default Vocabularies |
| **Prefix** | **cyboxVocabs** |
| Description | The CybOX default vocabularies define the classes for default controlled vocabularies used within CybOX. |
| Example | cyboxVocabs:ActionTypeVocab |
|  | |
| Package | CybOX Basic Data Types |
| **Prefix** | **basicDataTypes** |
| Description | The Basic Data Types data model defines the types used within CybOX. |
| Example | basicDataTypes:URI |
|  |  |

## Naming Conventions

The UML classes, enumerations, and properties defined in CybOX follow the particular naming conventions outlined in **Table 3‑2**.

Table ‑. Naming formats of different object types

|  |  |  |
| --- | --- | --- |
| **Object Type** | **Format** | **Example** |
| Class | CamelCase ending with “Type” | IndicatorBaseType |
| Property (simple) | Lowercase with underscores between words | capec\_id |
| Property (complex) | Capitalized with underscores between words | Associated\_Actor |
| Enumeration | CamelCase ending with “Enum” | DateTimePrecisionEnum |
| Enumeration value | *varies* | Flash drive; Public Disclosure; Externally-Located |
| Data type | CamelCase or if the words are acronyms, all capitalized with underscores between words. | PositiveInteger; CVE\_ID |

## Identifiers

Optional identifiers (IDs) can be assigned to several CybOX constructs so that the constructs can be unambiguously referenced. Technically, the decision to specify an ID on a given construct is optional based on the specifics of the usage context. As a general rule, specifying IDs on particular instances of constructs enables clear referencing, relating, and pivoting.

In CybOX v2.1.1, each CybOX ID is a fully qualified name, which consists of a producer namespace and a unique identifier. The producer namespace is a short-hand prefix, which is separated from the unique identifier by a colon (“:”):

[producer namespace]:[unique identifier]

This format provides high assurance that IDs will be both meaningful and unique. Meaning comes from producer namespace, which denotes who is producing it, and uniqueness comes from the unique identifier.

# Relationships to Other Externally-defined Data Models

CybOX™ Version 2.1.1 leverages several other externally-defined data models that are relevant to the cyber threat domain. A listing of these other data models is given below.

Please see [*CybOX™ Version 2.2.1 Part 4: Default Extensions*](#AdditionalArtifacts) for further information on all of the externally-defined data models CybOX leverages by default (with the exception of CybOX, for which a different reference is given in Section **4.4**).

## Customer Information Quality (CIQ)

The OASIS Customer Information Quality (CIQ) Version 3.0 is a set of XML specifications for representing characteristic information about individuals and organizations [**[CIQ]**](#ciq). By extending the CybOX Common AddressAbstractType and IdentityType classes, CybOX™ Version 2.2.1 leverages CIQ Version 3.0 to capture geographic address information and identity information associated with Threat Actors, victims, and sources of information.

## Common Platform Enumeration (CPE)

CPE is a structured naming scheme for information technology systems, software, and packages. Based upon the generic syntax for Uniform Resource Identifiers (URI), CPE includes a formal name format, a method for checking names against a system, and a description format for binding text and tests to a name. An XSD schema for CPE version 2.3 can be found at [[**[CPE]**](#cpe)**.**](#_Normative_References)

# Conformance

Implementations have discretion over which parts (components, properties, extensions, controlled vocabularies, etc.) of CybOX they implement (e.g., Observable/Object).

[1] Conformant implementations must conform to all normative structural specifications of the UML model or additional normative statements within this document that apply to the portions of CybOX they implement (e.g., Implementers of the entire Observable class must conform to all normative structural specifications of the UML model regarding the Observable class or additional normative statements contained in the document that describes the Observable class).

[2] Conformant implementations are free to ignore normative structural specifications of the UML model or additional normative statements within this document that do not apply to the portions of CybOX they implement (e.g., Non-implementers of any particular properties of the Observable class are free to ignore all normative structural specifications of the UML model regarding those properties of the Observable class or additional normative statements contained in the document that describes the Observable class).

The conformance section of this document is intentionally broad and attempts to reiterate what already exists in this document.

1. Acknowledgments

The following individuals have participated in the creation of this specification and are gratefully acknowledged:

|  |  |
| --- | --- |
| **Aetna**  David Crawford  **AIT Austrian Institute of Technology**  Roman Fiedler  Florian Skopik  **Australia and New Zealand Banking Group (ANZ Bank)**  Dean Thompson  **Blue Coat Systems, Inc.**  Owen Johnson  Bret Jordan  **Century Link**  Cory Kennedy  **CIRCL**  Alexandre Dulaunoy  Andras Iklody  Raphaël Vinot  **Citrix Systems**  Joey Peloquin  **Dell**  Will Urbanski  Jeff Williams  **DTCC**  Dan Brown  Gordon Hundley  Chris Koutras  **EMC**  Robert Griffin  Jeff Odom  Ravi Sharda  **Financial Services Information Sharing and Analysis Center (FS-ISAC)**  David Eilken  Chris Ricard  **Fortinet Inc.**  Gavin Chow  Kenichi Terashita  **Fujitsu Limited**  Neil Edwards  Frederick Hirsch  Ryusuke Masuoka  Daisuke Murabayashi  **Google Inc.**  Mark Risher  **Hitachi, Ltd.**  Kazuo Noguchi  Akihito Sawada  Masato Terada  **iboss, Inc**.  Paul Martini  **Individual**  Jerome Athias  Peter Brown  Elysa Jones  Sanjiv Kalkar  Bar Lockwood  Terry MacDonald  Alex Pinto  **Intel Corporation**  Tim Casey  Kent Landfield  **JPMorgan Chase Bank, N.A.**  Terrence Driscoll  David Laurance  **LookingGlass**  Allan Thomson  Lee Vorthman  **Mitre Corporation**  Greg Back  Jonathan Baker  Sean Barnum  Desiree Beck  Nicole Gong  Jasen Jacobsen  Ivan Kirillov  Richard Piazza  Jon Salwen  Charles Schmidt  Emmanuelle Vargas-Gonzalez  John Wunder  **National Council of ISACs (NCI)**  Scott Algeier  Denise Anderson  Josh Poster  **NEC Corporation**  Takahiro Kakumaru  **North American Energy Standards Board**  David Darnell  **Object Management Group**  Cory Casanave  **Palo Alto Networks**  Vishaal Hariprasad  **Queralt, Inc**.  John Tolbert  **Resilient Systems, Inc.**  Ted Julian  **Securonix**  Igor Baikalov  **Siemens AG**  Bernd Grobauer  **Soltra**  John Anderson  Aishwarya Asok Kumar  Peter Ayasse  Jeff Beekman  Michael Butt  Cynthia Camacho  Aharon Chernin  Mark Clancy  Brady Cotton  Trey Darley  Mark Davidson  Paul Dion  Daniel Dye  Robert Hutto  Raymond Keckler  Ali Khan  Chris Kiehl  Clayton Long  Michael Pepin  Natalie Suarez  David Waters  Benjamin Yates  **Symantec Corp.**  Curtis Kostrosky  **The Boeing Company**  Crystal Hayes  **ThreatQuotient, Inc.**  Ryan Trost  **U.S. Bank**  Mark Angel  Brad Butts  Brian Fay  Mona Magathan  Yevgen Sautin  **US Department of Defense (DoD)**  James Bohling  Eoghan Casey  Gary Katz  Jeffrey Mates  **VeriSign**  Robert Coderre  Kyle Maxwell  Eric Osterweil | **Airbus Group SAS**  Joerg Eschweiler  Marcos Orallo  **Anomali**  Ryan Clough  Wei Huang  Hugh Njemanze  Katie Pelusi  Aaron Shelmire  Jason Trost  **Bank of America**  Alexander Foley  **Center for Internet Security (CIS)**  Sarah Kelley  **Check Point Software Technologies**  Ron Davidson  **Cisco Systems**  Syam Appala  Ted Bedwell  David McGrew  Pavan Reddy  Omar Santos  Jyoti Verma  **Cyber Threat Intelligence Network, Inc. (CTIN)**  Doug DePeppe  Jane Ginn  Ben Othman  **DHS Office of Cybersecurity and Communications (CS&C)**  Richard Struse  Marlon Taylor  **EclecticIQ**  Marko Dragoljevic  Joep Gommers  Sergey Polzunov  Rutger Prins  Andrei Sîrghi  Raymon van der Velde  **eSentire, Inc.**  Jacob Gajek  **FireEye, Inc.**  Phillip Boles  Pavan Gorakav  Anuj Kumar  Shyamal Pandya  Paul Patrick  Scott Shreve  **Fox-IT**  Sarah Brown  **Georgetown University**  Eric Burger  **Hewlett Packard Enterprise (HPE)**  Tomas Sander  **IBM**  Peter Allor  Eldan Ben-Haim  Sandra Hernandez  Jason Keirstead  John Morris  Laura Rusu  Ron Williams  **IID**  Chris Richardson  **Integrated Networking Technologies, Inc.**  Patrick Maroney  **Johns Hopkins University Applied Physics Laboratory**  Karin Marr  Julie Modlin  Mark Moss  Pamela Smith  **Kaiser Permanente**  Russell Culpepper  Beth Pumo  **Lumeta Corporation**  Brandon Hoffman  **MTG Management Consultants, LLC.**  James Cabral  **National Security Agency**  Mike Boyle  Jessica Fitzgerald-McKay  **New Context Services, Inc.**  John-Mark Gurney  Christian Hunt  James Moler  Daniel Riedel  Andrew Storms  **OASIS**  James Bryce Clark  Robin Cover  Chet Ensign  **Open Identity Exchange**  Don Thibeau  **PhishMe Inc.**  Josh Larkins  **Raytheon Company-SAS**  Daniel Wyschogrod  **Retail Cyber Intelligence Sharing Center (R-CISC)**  Brian Engle  **Semper Fortis Solutions**  Joseph Brand  **Splunk Inc.**  Cedric LeRoux  Brian Luger  Kathy Wang  **TELUS**  Greg Reaume  Alan Steer  **Threat Intelligence Pty Ltd**  Tyron Miller  Andrew van der Stock  **ThreatConnect, Inc.**  Wade Baker  Cole Iliff  Andrew Pendergast  Ben Schmoker  Jason Spies  **TruSTAR Technology**  Chris Roblee  **United Kingdom Cabinet Office**  Iain Brown  Adam Cooper  Mike McLellan  Chris O’Brien  James Penman  Howard Staple  Chris Taylor  Laurie Thomson  Alastair Treharne  Julian White  Bethany Yates  **US Department of Homeland Security**  Evette Maynard-Noel  Justin Stekervetz  **ViaSat, Inc.**  Lee Chieffalo  Wilson Figueroa  Andrew May  **Yaana Technologies, LLC**  Anthony Rutkowski |

The authors would also like to thank the larger CybOX Community for its input and help in reviewing this document.

1. Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision** | **Date** | **Editor** | **Changes Made** |
| wd01 | 15 December 2015 | Desiree Beck Trey Darley Ivan Kirillov Rich Piazza | Initial transfer to OASIS template |