

CybOX™ Version 2.1.1. Part 49: Semaphore Object

Committee Specification Draft 01 / Public Review Draft 01

20 June 2016

Specification URIs

This version:

<http://docs.oasis-open.org/cti/cybox/v2.1.1/csprd01/part49-semaphore/cybox-v2.1.1-csprd01-part49-semaphore.docx> (Authoritative)
<http://docs.oasis-open.org/cti/cybox/v2.1.1/csprd01/part49-semaphore/cybox-v2.1.1-csprd01-part49-semaphore.html>
<http://docs.oasis-open.org/cti/cybox/v2.1.1/csprd01/part49-semaphore/cybox-v2.1.1-csprd01-part49-semaphore.pdf>

Previous version:

N/A

Latest version:

<http://docs.oasis-open.org/cti/cybox/v2.1.1/part49-semaphore/cybox-v2.1.1-part49-semaphore.docx> (Authoritative)
<http://docs.oasis-open.org/cti/cybox/v2.1.1/part49-semaphore/cybox-v2.1.1-part49-semaphore.html>
<http://docs.oasis-open.org/cti/cybox/v2.1.1/part49-semaphore/cybox-v2.1.1-part49-semaphore.pdf>

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Additional artifacts:

This prose specification is one component of a Work Product whose components are listed in <http://docs.oasis-open.org/cti/cybox/v2.1.1/csprd01/cybox-v2.1.1-csprd01-additional-artifacts.html>.

Related work:

This specification is related to:

- *STIX™ Version 1.2.1*. Edited by Sean Barnum, Desiree Beck, Aharon Chernin, and Rich Piazza. 05 May 2016. OASIS Committee Specification 01. <http://docs.oasis-open.org/cti/stix/v1.2.1/cs01/part1-overview/stix-v1.2.1-cs01-part1-overview.html>.

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 specification document defines the Semaphore Object data model, which is one of the Object data models for CybOX content.

Status:

This document was last revised or approved by the OASIS Cyber Threat Intelligence (CTI) TC on the above date. The level of approval is also listed above. Check the “Latest version” location noted above for possible later revisions of this document. Any other numbered Versions and other technical work produced by the Technical Committee (TC) are listed at https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=cti#technical.

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Citation format:

When referencing this specification the following citation format should be used:

[CybOX-v2.1.1- Semaphore]

CybOX™ Version 2.1.1. Part 49: Semaphore Object. Edited by Desiree Beck, Trey Darley, Ivan Kirillov, and Rich Piazza. 20 June 2016. OASIS Committee Specification Draft 01 / Public Review Draft 01. <http://docs.oasis-open.org/cti/cybox/v2.1.1/csprd01/part49- Semaphore/cybox-v2.1.1-csprd01-part49- Semaphore.html>. Latest version: <http://docs.oasis-open.org/cti/cybox/v2.1.1/part49- Semaphore/cybox-v2.1.1-part49- Semaphore.html>.

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1 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 document serves as the specification for the CybOX Semaphore Object Version 2.1.1 data model, which is one of eighty-eight CybOX Object data models.

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 Section 1.4. In Section 2, we give background information necessary to fully understand the Semaphore Object data model. We present the Semaphore Object data model specification details in Section 3 and conformance information in Section 4.

1.1 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).

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 is not necessary.

The [CybOX Version 2.1.1 Part 1: Overview](#) document provides a comprehensive overview of the full set of CybOX data models, which in addition to the Core, Common, and numerous Object data models, includes various extension data models and a vocabularies data model, which contains a set of default controlled vocabularies. [CybOX Version 2.1.1 Part 1: Overview](#) also summarizes the relationship of CybOX to other languages, and outlines general CybOX data model conventions.

1.2 Document Conventions

The following conventions are used in this document.

1.2.1 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](#).

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 (with single 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*

1.2.2 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. 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.

The `package_prefix` for the Semaphore data model is `SemaphoreObj`. Note that in this specification document, we do not explicitly specify the package prefix for any classes that originate from the Semaphore Object data model.

1.2.3 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. The fully described class can usually be found in a related diagram. 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.

1.2.3.1 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.

1.2.3.2 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 1-1. UML diagram icons

Icon	Description
	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.

1.2.4 Property Table Notation

Throughout Section 3, tables are used to describe the properties of each data model class. Each property table consists of a column of names to identify the property, a type column to reflect the datatype of the property, a multiplicity column to reflect the allowed number of occurrences of the property, and a description column that describes the property. Package prefixes are provided for classes outside of the Semaphore Object data model (see Section 1.2.2).

Note that if a class is a specialization of a superclass, only the properties that constitute the specialization are shown in the property table (i.e., properties of the superclass will not be shown). However, details of the superclass may be shown in the UML diagram.

1.2.5 Property and Class Descriptions

Each class and property defined in CybOX is described using the format, “The X property verb Y.” For example, in the specification for the CybOX Core data model, we write, “The `id` property specifies a globally unique identifier for the Action.” In fact, the verb “specifies” could have been replaced by any number of alternatives: “defines,” “describes,” “contains,” “references,” etc.

However, we thought that using a wide variety of verb phrases might confuse a reader of a specification document because the meaning of each verb could be interpreted slightly differently. On the other hand, we didn’t want to use a single, generic verb, such as “describes,” because although the different verb choices may or may not be meaningful from an implementation standpoint, a distinction could be useful to those interested in the modeling aspect of CybOX.

Consequently, we have preferred to use the three verbs, defined as follows, in class and property descriptions:

Verb	CybOX Definition
<u>captures</u>	Used to record and preserve information without implying anything about the structure of a class or property. Often used for properties that encompass general content. This is the least precise of the three verbs.
	<p><i>Examples:</i></p> <p>The <code>Observable_Source</code> property characterizes the source of the Observable information. Examples of details <u>captured</u> include identifying characteristics, time-related attributes, and a list of the tools used to collect the information.</p> <p>The <code>Description</code> property <u>captures</u> a textual description of the Action.</p>
<u>characterizes</u>	Describes the distinctive nature or features of a class or property. Often used to describe classes and properties that themselves comprise one or more other properties.
	<p><i>Examples:</i></p> <p>The <code>Action</code> property <u>characterizes</u> a cyber observable Action.</p> <p>The <code>Obfuscation_Technique</code> property <u>characterizes</u> a technique an attacker could potentially leverage to obfuscate the Observable.</p>
<u>specifies</u>	Used to clearly and precisely identify particular instances or values associated with a property. Often used for properties that are defined by a controlled vocabulary or enumeration; typically used for properties that take on only a single value.
	<p><i>Example:</i></p> <p>The <code>cybox_major_version</code> property <u>specifies</u> the major version of the CybOX language used for the set of Observables.</p>

1.3 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].

1.4 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>.

2 Background Information

In this section, we provide high level information about the Semaphore Object data model that is necessary to fully understand the specification details given in Section 3.

2.1 Cyber Observables

A cyber observable is a dynamic event or a stateful property that occurs, or may occur, in the operational cyber domain. Examples of stateful properties include the value of a registry key, the MD5 hash of a file, and an IP address. Examples of events include the deletion of a file, the receipt of an HTTP GET request, and the creation of a remote thread.

A cyber observable is different than a cyber indicator. A cyber observable is a statement of fact, capturing what was observed or could be observed in the cyber operational domain. Cyber indicators are cyber observable patterns, such as a registry key value associated with a known bad actor or a spoofed email address used on a particular date.

2.2 Objects

Cyber observable objects (Files, IP Addresses, etc) in CybOX are characterized with a combination of two levels of data models.

The first level is the Object data model which specifies a base set of properties universal to all types of Objects and enables them to integrate with the overall cyber observable framework specified in the CybOX Core data model.

The second level are the object property models which specify the properties of a particular type of Object via individual data models each focused on a particular cyber entity, such as a Windows registry key, or an Email Message. Accordingly, each release of the CybOX language includes a particular set of Objects that are part of the release. The data model for each of these Objects is defined by its own specification that describes the context-specific classes and properties that compose the Object.

Any specific instance of an Object is represented utilizing the particular object properties data model within the general Object data model.

3 Data Model

3.1 SemaphoreObjectType Class

The `SemaphoreObjectType` class is intended to characterize generic semaphore objects. The UML diagram corresponding to the `SemaphoreObjectType` class is shown in [Figure 3-1](#).

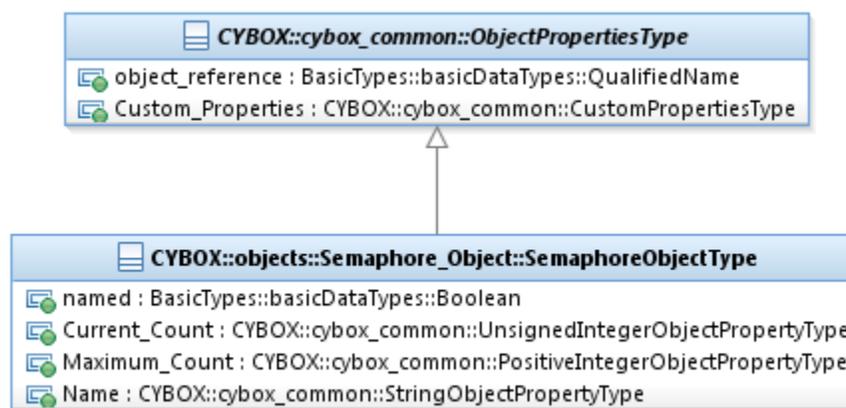


Figure 3-1. UML diagram of the `SemaphoreObjectType` class

The property table of the `SemaphoreObjectType` class is given in [Table 3-1](#).

Table 3-1. Properties of the `SemaphoreObjectType` class

Name	Type	Multiplicity	Description
named	<code>basicDataTypes:Boolean</code>	0..1	The <code>named</code> property specifies whether the Semaphore is named.
Current_Count	<code>cyboxCommon:</code>	0..1	The <code>Current_Count</code> property specifies the current count

	UnsignedIntegerObjectPropertyType		value for the semaphore.
Maximum_Count	cyboxCommon: PositiveIntegerObjectPropertyType	0..1	The Maximum_Count property specifies the maximum count value for the semaphore.
Name	cyboxCommon: StringObjectPropertyType	0..1	The Name property specifies the name of the semaphore, if applicable.

4 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.

Appendix A. 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

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

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

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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

Rutger Prins

Andrei Sirghi

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.

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

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Daniel Dye
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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.

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Symantec Corp.

Curtis Kostrosky

The Boeing Company

Crystal Hayes

ThreatQuotient, Inc.

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U.S. Bank

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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.

Appendix B. Revision History

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