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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 System Object data model, which is one of the Object data models for CybOX content.

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Table of Contents

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 System 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 System Object data model. We present the System 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 key 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 System data model is `SystemObj`. Note that in this specification document, we do not explicitly specify the package prefix for any classes that originate from the System 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 System 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
captures	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.
	Examples: The `Observable_Source` property characterizes the source of the Observable information. Examples of details captured include identifying characteristics, time-related attributes, and a list of the tools used to collect the information. The `Description` property captures a textual description of the Action.
characterizes	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.
	Examples: The `Action` property characterizes a cyber observable Action. The `Obfuscation_Technique` property characterizes a technique an attacker could potentially leverage to obfuscate the Observable.
specifies	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.
	Example: The `cybox_major_version` property specifies the major version of the CybOX language used for the set of Observables.

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 System 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 SystemObjectType Class

The `SystemObjectType` class is intended to characterize computer systems (as a combination of both software and hardware). The UML diagram corresponding to the `SystemObjectType` class is shown in **Figure 3-1**.

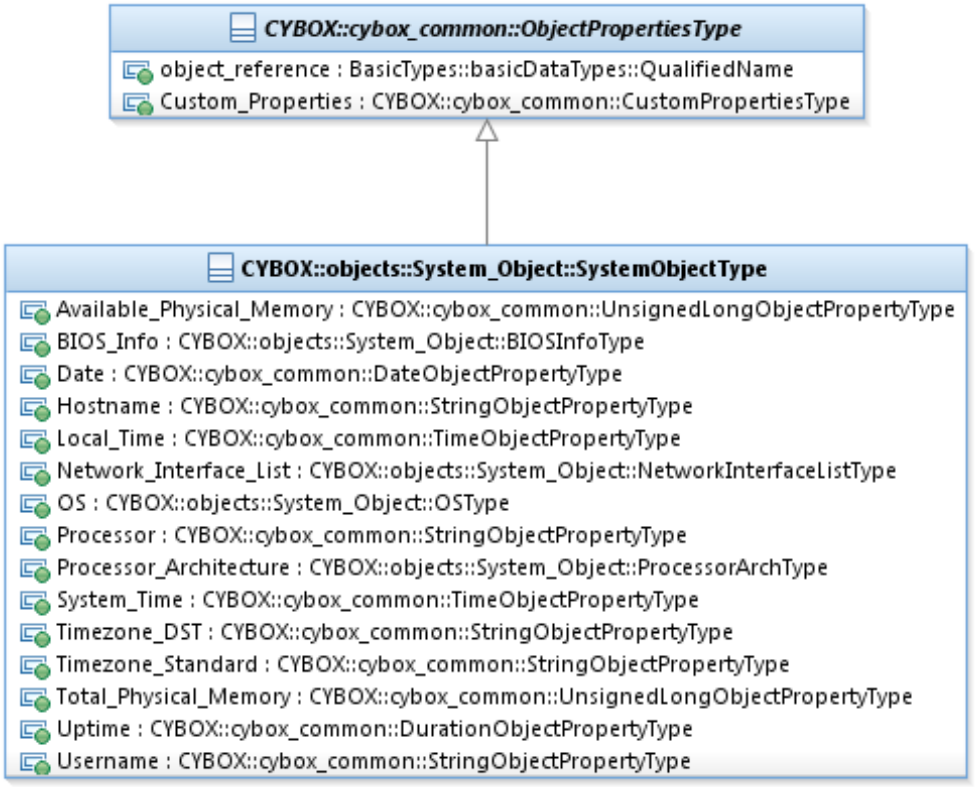

Figure 3-1. UML diagram of the `SystemObjectType` class

The property table of the `SystemObjectType` class is given in **Table 3-1**.

Table 3-1. Properties of the SystemObjectType class

Name	Type	Multiplicity	Description
Available_Physical_Memory	cyboxCommon: UnsignedLongObjectPropertyType	0..1	The Available_Physical_Memory property specifies the amount of physical memory available on the system, in bytes.
BIOS_Info	BIOSInfoType	0..1	The BIOS_Info property specifies information about the BIOS on the system.
Date	cyboxCommon: DateObjectPropertyType	0..1	The Date property specifies the current date on the system.
Hostname	cyboxCommon: StringObjectPropertyType	0..1	The Hostname property specifies the hostname of the system.
Local_Time	cyboxCommon: TimeObjectPropertyType	0..1	The Local_Time property specifies the local time on the system.
Network_Interface_List	NetworkInterfaceListType	0..1	The Network_Interface_List property specifies the list of network interfaces present on the system.
OS	OSType	0..1	The OS property specifies information about the operating system installed on the system.
Processor	cyboxCommon: StringObjectPropertyType	0..1	The Processor property specifies the name of the CPU used by the system.
Processor_Architecture	ProcessorArchType	0..1	The Processor_Architecture property specifies the specific architecture (e.g. x86) used by the CPU of the system.

System_Time	cyboxCommon: TimeObjectPropertyType	0..1	The System_Time property specifies the system, or hardware, time on the system.
Timezone_DST	cyboxCommon: StringObjectPropertyType	0..1	The Timezone_DST property specifies the time zone used by the system, taking daylight savings time (DST) into account.
Timezone_Standard	cyboxCommon: StringObjectPropertyType	0..1	The Timezone_Standard property specifies the time zone used by the system, without taking daylight savings time (DST) into account.
Total_Physical_Memory	cyboxCommon: UnsignedLongObjectPropertyType	0..1	The Total_Physical_Memory property specifies the total amount of physical memory present on the system, in bytes.
Uptime	cyboxCommon: DurationObjectPropertyType	0..1	The Uptime property specifies the duration that represents the current amount of time that the system has been up.
Username	cyboxCommon: StringObjectPropertyType	0..1	The Username property specifies the name of the user currently logged into the system.

3.2 BIOSInfoType Class

The BIOSInfoType class specifies information about a system's BIOS.

The property table of the BIOSInfoType class is given in **Table 3-2**.

Table 3-2. Properties of the BIOSInfoType class

Name	Type	Multiplicity	Description
BIOS_Date	cyboxCommon:	0..1	The BIOS_Date property specifies the date of the BIOS (e.g. the

	DateObjectPropertyType		datestamp of the BIOS revision).
BIOS_Version	cyboxCommon: StringObjectPropertyType	0..1	The BIOS_Version property specifies the version of the BIOS.
BIOS_Manufacturer	cyboxCommon: StringObjectPropertyType	0..1	The BIOS_Manufacturer property specifies the manufacturer of the BIOS.
BIOS_Release_Date	cyboxCommon: DateObjectPropertyType	0..1	The BIOS_Release_Date property specifies the date the BIOS was released.
BIOS_Serial_Number	cyboxCommon: StringObjectPropertyType	0..1	The BIOS_Serial_Number property specifies the serial number of the BIOS.

3.3 NetworkInterfaceListType Class

The NetworkInterfaceListType class specifies information about the network interfaces present on the system.

The property table of the NetworkInterfaceListType class is given in **Table 3-3**.

Table 3-3. Properties of the NetworkInterfaceListType class

Name	Type	Multiplicity	Description
Network_Interface	SystemObj:NetworkInterfaceType	1..*	The Network_Interface property specifies information about a network interface, such as its MAC address.

3.4 IPGatewayListType Class

The `IPGatewayListType` class specifies the IP Addresses of the gateways used by the system.

The property table of the `IPGatewayListType` class is given in **Table 3-4**.

Table 3-4. Properties of the `IPGatewayListType` class

Name	Type	Multiplicity	Description
IP_Gateway_Address	`AddressObj: AddressObjectType`	1..*	The `IP_Gateway_Address` property specifies the IP Address of a gateway used by the system.

3.5 NetworkInterfaceType Class

The `NetworkInterfaceType` class specifies information about a network interface, such as its MAC address.

The property table of the `NetworkInterfaceType` class is given in **Table 3-5**.

Table 3-5. Properties of the `NetworkInterfaceType` class

Name	Type	Multiplicity	Description
Adapter	`cyboxCommon: StringObjectPropertyType`	0..1	The `Adapter` property specifies the name of the network adapter used by the network interface.
Description	`cyboxCommon: StringObjectPropertyType`	0..1	The `Description` property captures a technical description of the Network Interface. Any length is permitted. Optional formatting is supported via the `structuring_format` property of the `StructuredTextType` class.
DHCP_Lease_Expires	`cyboxCommon:`	0..1	The `DHCP_Lease_Expires` property specifies the date/time that the DHCP lease obtained on the network interface

	DateTimeObjectPropertyType		expires.
DHCP_Lease_Obtained	cyboxCommon: DateTimeObjectPropertyType	0..1	The DHCP_Lease_Obtained property specifies the date/time that the DHCP lease was obtained on the network interface.
DHCP_Server_List	DHCPServerListType	0..1	The DHCP_Server_List property specifies the list of DHCP servers used by the network interface.
IP_Gateway_List	IPGatewayListType	0..1	The IP_Gateway_List property specifies the list of IP Gateways used by the network interface.
IP_List	IPInfoListType	0..1	The IP_List property specifies the list of IP addresses used by the network interface.
MAC	cyboxCommon: StringObjectPropertyType	0..1	The MAC property specifies the MAC or hardware address of the physical network card. Either a colon (':') or a dash ('-') may be used as a separator between the octets.

3.6 IPInfoListType Class

The IPInfoListType class specifies a list of IP address/subnet mask pairs associated with a network interface.

The property table of the IPInfoListType class is given in **Table 3-6**.

Table 3-6. Properties of the IPInfoListType class

Name	Type	Multiplicity	Description
IP_Info	IPInfoType	1..*	The IP_Info property specifies an IP Address/Subnet mask entry in the list.

3.7 IPInfoType Class

The `IPInfoType` class specifies information about the IP address and its associated subnet mask used by a network interface.

The property table of the `IPInfoType` class is given in **Table 3-7**.

Table 3-7. Properties of the `IPInfoType` class

Name	Type	Multiplicity	Description
IP_Address	`AddressObj:AddressObjectType`	0..1	The `IP_Address` property specifies an IP address.
Subnet_Mask	`AddressObj:AddressObjectType`	0..1	The `Subnet_Mask` property specifies a subnet mask.

3.8 DHCPServerListType Class

The `DHCPServerListType` class specifies a list of DHCP Servers, via their IP addresses.

The property table of the `DHCPServerListType` class is given in **Table 3-8**.

Table 3-8. Properties of the `DHCPServerListType` class

Name	Type	Multiplicity	Description
DHCP_Server_Address	`AddressObj:AddressObjectType`	1..*	The `DHCP_Server_Address` property specifies the IP address of a DHCP server.

3.9 OSType Class

The `OSType` class specifies information about an operating system. It imports and extends the `PlatformSpecificationType` class from the CybOX Common Types.

The property table of the `OSType` class is given in **Table 3-9**.

Table 3-9. Properties of the `OSType` class

Name	Type	Multiplicity	Description
Bitness	`BitnessType`	0..1	The `Bitness` property specifies the bitness of the operating system (i.e. 32 or 64). Note that this is potentially different from the word size of the underlying hardware or CPU. A 32-bit operating system can be installed on a machine running a 64-bit processor.
Build_Number	`cyboxCommon: StringObjectPropertyType`	0..1	The `Build_Number` property specifies the build number of the operating system.
Environment_Variable_List	`cyboxCommon: EnvironmentVariableListType`	0..1	The `Environment_Variable_List` property specifies a list of environment variables present on the operating system.
Install_Date	`cyboxCommon: DateObjectPropertyType`	0..1	The `Install_Date` property specifies the date the operating system was installed.
Patch_Level	`cyboxCommon: StringObjectPropertyType`	0..1	The `Patch_Level` property specifies the patch level of the operating system.
Platform	`cyboxCommon: PlatformSpecificationType`	0..1	The `Platform` property contains general identifiers for this OS instance.

3.10 ProcessorArchType Data Type

The `ProcessorArchType` data type characterizes the CPU architecture type. Its core value SHOULD be a literal from the `ProcessorArchEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.11 BitnessType Data Type

The `BitnessType` data type characterizes the operating system bitness. Its core value SHOULD be a literal from the `BitnessEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.12 ProcessorArchEnum Enumeration

The literals of the `ProcessorArchEnum` enumeration are given in **Table 3-10**.

Table 3-10. Literals of the `ProcessorArchEnum` enumeration

Enumeration Literal	Description
x86-32	Specifies the 32-bit x86 architecture.
x86-64	Specifies the 64-bit x86 architecture.
IA-64	Specifies the 64-bit IA (Itanium) architecture.
PowerPC	Specifies the PowerPC IA (Itanium) architecture.
ARM	Specifies the ARM architecture.
Alpha	Specifies the Alpha architecture.
SPARC	Specifies the SPARC architecture.

z/Architecture	Specifies the z/architecture, used on IBM mainframes.
eSi-RISC	Specifies the eSi-RISC architecture.
MIPS	Specifies the MIPS architecture.
Motorola 68k	Specifies the Motorola 68k architecture.
Other	Specifies a processor architecture other than those defined in this enumeration.

3.13 BitnessEnum Enumeration

The literals of the `BitnessEnum` enumeration are given in **Table 3-11**.

Table 3-11. Literals of the `BitnessEnum` enumeration

Enumeration Literal	Description
32	Specifies a 32-bit operating system.
64	Specifies a 64-bit operating system.

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

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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