CybOX™ Version 2.1.1. Part 41: Network Socket Object

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Additional artifacts:

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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 Network Socket 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 Network Socket 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 Network Socket Object data model. We present the Network Socket 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 Network Socket data model is `NetworkSocketObj`. Note that in this specification document, we do not explicitly specify the package prefix for any classes that originate from the Network Socket 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 Network Socket 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 Network Socket 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 NetworkSocketObjectType Class

The `NetworkSocketObjectType` class is intended to characterize network sockets. The UML diagram corresponding to the `NetworkSocketObjectType` class is shown in **Figure 3-1**.

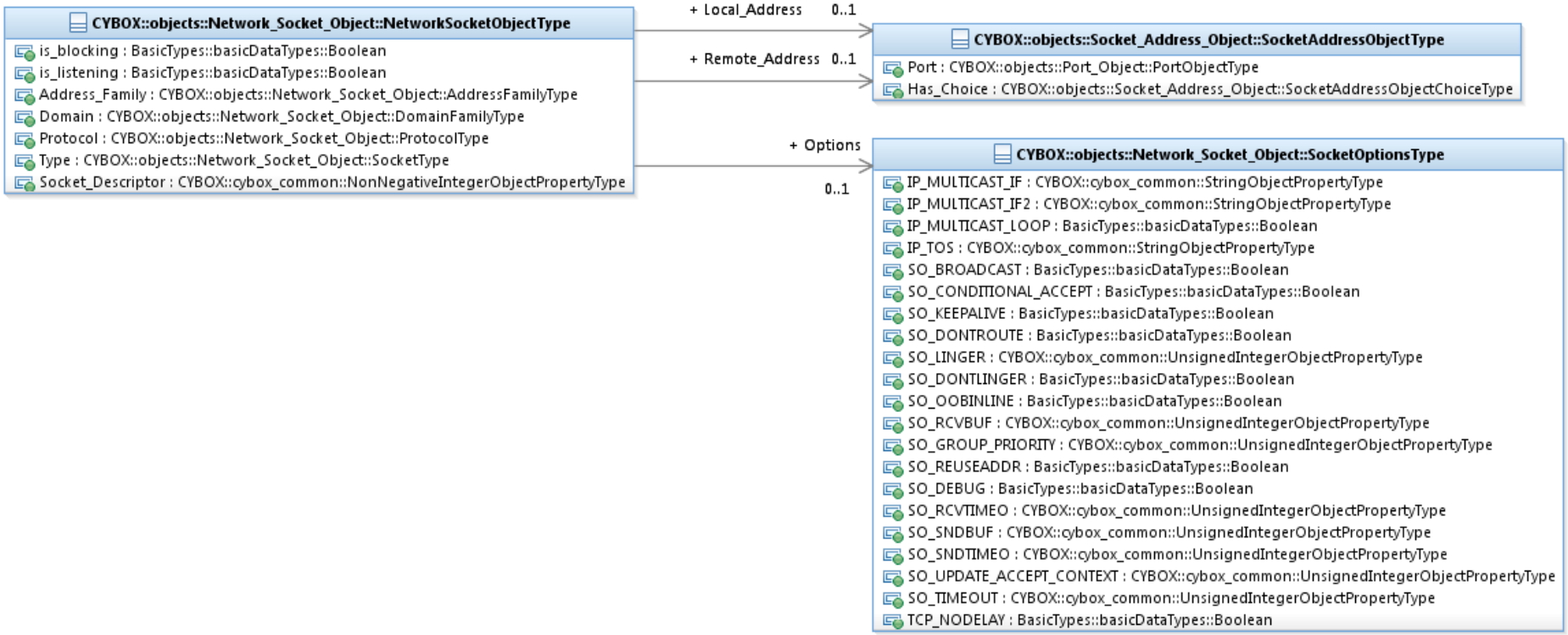

Figure 3-1. UML diagram of the `NetworkSocketObjectType` class

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

Table 3-1. Properties of the NetworkSocketObjectType class

Name	Type	Multiplicity	Description
is_blocking	basicDataTypes:Boolean	0..1	The is_blocking property specifies whether or not the socket is in blocking mode.
is_listening	basicDataTypes:Boolean	0..1	The is_listening property specifies whether or not the socket is in listening mode.
Address_Family	NetworkSocketObj:AddressFamilyType	0..1	The Address_Family property specifies the address family (AF_*) that the socket is configured for.
Domain	NetworkSocketObj:DomainFamilyType	0..1	The Domain property specifies the communication domain (PF_*) of the socket.
Local_Address	SocketAddressObj: SocketAddressObjectType	0..1	The Local_Address property specifies the IP address and port for the socket on the local machine.
Options	NetworkSocketObj:SocketOptionsType	0..1	The Options property specifies any particular options used by the socket.
Protocol	NetworkSocketObj:ProtocolType	0..1	The Protocol property specifies the type of IP layer protocol used by the socket.
Remote_Address	SocketAddressObj: SocketAddressObjectType	0..1	The Remote_Address property specifies the IP address and port for the socket on the remote machine.
Type	NetworkSocketObj:SocketType	0..1	The Type property specifies the type of socket being characterized.
Socket_Descriptor	cyboxCommon:	0..1	The Socket_Descriptor property specifies the

	NonNegativeIntegerObjectPropertyType		socket file descriptor value associated with the socket. Negative values are not allowed.

3.2 SocketOptionsType Class

The SocketOptionsType class specifies any particular options used by the socket. If an option is supported only by specific address families or socket class, that's indicated in parentheses.

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

Table 3-2. Properties of the SocketOptionsType class

Name	Type	Multiplicity	Description
IP_MULTICAST_IF	cyboxCommon: StringObjectPropertyType	0..1	The IP_MULTICAST_IF property is used to set the interface over which outgoing multicast datagrams should be sent (AF_INET / SOCK_DGRAM or SOCK_RAW).
IP_MULTICAST_IF2	cyboxCommon: StringObjectPropertyType	0..1	The IP_MULTICAST_IF2 property is used to set the interface over which outgoing multicast datagrams should be sent (AF_INET6 / SOCK_DGRAM or SOCK_RAW).
IP_MULTICAST_LOOP	basicDataTypes:Boolean	0..1	The IP_MULTICAST_LOOP property specifies that the sending host should receive a copy of an outgoing multicast datagram (AF_INET / SOCK_DGRAM or SOCK_RAW).
IP_TOS	cyboxCommon: StringObjectPropertyType	0..1	The IP_TOS property is used to set the Type of Service (TOS) and Precedence in the IP header (AF_INET).

SO_BROADCAST	basicDataTypes:Boolean	0..1	The SO_BROADCAST property indicates if the socket is issuing messages to a broadcast address (AF_INET / SOCK_DGRAM or SOCK_RAW). (.
SO_CONDITIONAL_ACCEPT	basicDataTypes:Boolean	0..1	The SO_CONDITIONAL_ACCEPT property allows an application to decide whether or not to accept an incoming connection on a listening socket (Windows only).
SO_KEEPALIVE	basicDataTypes:Boolean	0..1	The SO_KEEPALIVE property indicates if the connection should be kept up by sending periodic transmissions (AF_INET or AF_INET6 / SOCK_STREAM).
SO_DONTROUTE	basicDataTypes:Boolean	0..1	The SO_DONTROUTE property indicates if the normal routing mechanisms will be bypassed (AF_INET or AF_INET6).
SO_LINGER	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_LINGER property specifies if the system attempts delivery of or discards any buffered data when a close() is issued.
SO_DONTLINGER	basicDataTypes:Boolean	0..1	The SO_DONTLINGER property is the complement of SO_LINGER.
SO_OOBINLINE	basicDataTypes:Boolean	0..1	The SO_OOBINLINE property indicates whether out-of-band data is received inline with normal data (AF_INET or AF_INET6).
SO_RCVBUF	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_RCVBUF property specifies the size of the receive buffer.

SO_GROUP_PRIORITY	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_GROUP_PRIORITY property is used to set the relative priority for the socket in its group (Windows only).
SO_REUSEADDR	basicDataTypes:Boolean	0..1	The SO_REUSEADDR property indicates if the local socket address can be reused (AF_INET or AF_INET6 / SOCK_DGRAM or SOCK_RAW).
SO_DEBUG	basicDataTypes:Boolean	0..1	The SO_DEBUG property indicates if low-level debugging is active.
SO_RCVTIMEO	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_RCVTIMEO property specifies the receive timeout value.
SO_SNDBUF	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_SNDBUF property specifies the size of the send buffer.
SO_SNDTIMEO	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_SNDTIMEO property specifies the send timeout value.
SO_UPDATE_ ACCEPT_CONTEXT	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_UPDATE_ACCEPT_CONTEXT property is used to update the properties of the socket which are inherited from the listening socket (Windows only).
SO_TIMEOUT	cyboxCommon: UnsignedIntegerObjectPropertyType	0..1	The SO_TIMEOUT property is used to set the socket timeout.
TCP_NODELAY	basicDataTypes:Boolean	0..1	The TCP_NODELAY property indicates whether the TCP will send data immediately instead of using the Nagle delay algorithm (AF_INET or

			AF_INET6 / SOCK_STREAM). (.

3.3 AddressFamilyType Data Type

The `AddressFamilyType` data type specifies the address family type. Its core value SHOULD be a literal found in the `AddressFamilyTypeEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.4 DomainFamilyType Data Type

The `DomainFamilyType` data type specifies the domain family type. Its core value SHOULD be a literal found in the `DomainTypeEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.5 SocketType Data Type

The `SocketType` data type specifies the socket type. Its core value SHOULD be a literal found in the `SocketTypeEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.6 ProtocolType Data Type

The `ProtocolType` data type specifies the protocol type. Its core value SHOULD be a literal found in the `ProtocolTypeEnum` enumeration. It extends the `BaseObjectPropertyType` data type, in order to permit complex (i.e. regular-expression based) specifications.

3.7 AddressFamilyTypeEnum Enumeration

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

Table 3-3. Literals of the `AddressFamilyTypeEnum` enumeration

Enumeration Literal	Description
AF_UNSPEC	Specifies an unspecified address family.
AF_INET	Specifies sockets using for the Internet when using Berkeley sockets.

AF_IPX	Specifies the IPX (Novell Internet Protocol) address family.
AF_APPLETALK	Specifies the APPLETALK DDP address family.
AF_NETBIOS	Specifies the NETBIOS address family.
AF_INET6	Specifies the IP version 6 address family.
AF_IRDA	Specifies IRDA sockets.
AF_BTH	Specifies BTH sockets.

3.8 DomainTypeEnum Enumeration

The literals of the `DomainTypeEnum` enumeration are given in **Table 3-4**.

Table 3-4. Literals of the `DomainTypeEnum` enumeration

Enumeration Literal	Description
PF_LOCAL	Specifies the communication domain from local to host.
PF_UNIX	Specifies the communication domain from UNIX to host.
PF_FILE	Specifies the communication domain from file to host.
PF_INET	Specifies the IP protocol family.
PF_AX25	Specifies the Amateur Radio AX.25 family.

PF_IPX	Specifies the Novell Internet Protocol family.
PF_INET6	Specifies the IP version 6 protocol family.
PF_APPLETALK	Specifies the Appletalk DDP protocol family.
PF_NETROM	Specifies the Amateur radio NetROM protocol family.
PF_BRIDGE	Specifies the Multiprotocol bridge protocol family.
PF_ATMPVC	Specifies the ATM PVCs protocol family.
PF_X25	Specifies the protocol family reserved for the X.25 project.
PF_ROSE	Specifies the PF_KEY key management API family.
PF_DECnet	Specifies the protocol family reserved for the DECnet project.
PF_NETBEUI	Specifies the protocol family reserved for the 802.2LLC project.
PF_SECURITY	Specifies the Security callback pseudo AF protocol family.
PF_KEY	Specifies the PF_KEY key management API protocol family.
PF_NETLINK	Specifies the netlink routing API family.
PF_ROUTE	Specifies the PF_ROUTE routing API family.
PF_PACKET	Specifies the packet family.

PF_ASH	Specifies the Ash family.
PF_ECONET	Specifies the Acorn Econet family.
PF_ATMSVC	Specifies the ATM SVCs protocol family.
PF_SNA	Specifies the Linux SNA Project protocol family.
PF_IRDA	Specifies IRDA sockets.
PF_PPPOX	Specifies PPPoX sockets.
PF_WANPIPE	Specifies Wanpipe API sockets.
PF_BLUETOOTH	Specifies Bluetooth sockets.

3.9 SocketTypeEnum Enumeration

The literals of the `SocketTypeEnum` enumeration are given in **Table 3-5**.

Table 3-5. Literals of the `SocketTypeEnum` enumeration

Enumeration Literal	Description
SOCK_STREAM	Specifies a pipe-like socket which operates over a connection with a particular remote socket, and transmits data reliably as a stream of bytes.
SOCK_DGRAM	Specifies a socket in which individually-addressed packets are sent (datagram).

SOCK_RAW	Specifies raw sockets which allow new IP protocols to be implemented in user space. A raw socket receives or sends the raw datagram not including link level headers.
SOCK_RDM	Specifies a socket indicating a reliably-delivered message.
SOCK_SEQPACKET	Specifies a datagram congestion control Protocol socket.

3.10 ProtocolTypeEnum Enumeration

The literals of the `ProtocolTypeEnum` enumeration are given in **Table 3-6**.

Table 3-6. Literals of the `ProtocolTypeEnum` enumeration

Enumeration Literal	Description
IPPROTO_ICMP	Indicates the ICMP protocol.
IPPROTO_IGMP	Indicates the IGMP protocol.
BTHPROTO_RFCOMM	Indicates the Bluetooth protocol.
IPPROTO_TCP	Indicates the TCP protocol.
IPPROTO_UDP	Indicates the UDP protocol.
IPPROTO_ICMPV6	Indicates the ICMP v6 protocol.
IPPROTO_RM	Indicates the Reliable Multicasting protocol.

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.

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