CybOX™ Version 2.1.1. Part 94: X509 Certificate Object

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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 X509 Certificate 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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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 X509 Certificate 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 X509 Certificate Object data model. We present the X509 Certificate 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 X509 Certificate data model is `X509CertificateObj`. Note that in this specification document, we do not explicitly specify the package prefix for any classes that originate from the X509 Certificate 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 X509 Certificate 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 X509 Certificate 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 X509CertificateObjectType Class

The `X509CertificateObjectType` class is intended to characterize X.509 certificates. The UML diagram corresponding to the `X509CertificateObjectType` class is shown in **Figure 3-1**.
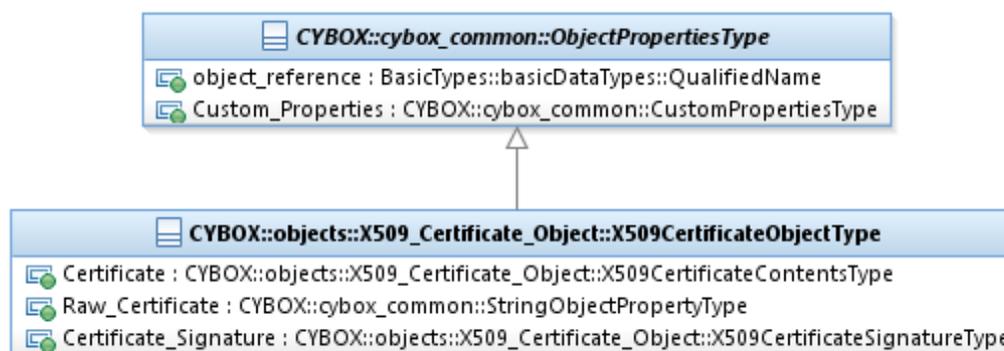
Figure 3-1. UML diagram of the `X509CertificateObjectType` class

The property table of the `X509CertificateObjectType` class is given in **Table 3-1**.

Table 3-1. Properties of the `X509CertificateObjectType` class

Name	Type	Multiplicity	Description
Certificate	`X509CertificateContentsType`	0..1	The `Certificate` property specifies the contents of an X.509 certificate, including items such as issuer, subject, and others.
Raw_Certificate	`cyboxCommon: StringObjectPropertyType`	0..1	The `Raw_Certificate` property captures the raw content of an X.509 certificate including the -----BEGIN CERTIFICATE----- and -----END CERTIFICATE----- lines.

Certificate_Signature	X509CertificateSignatureType	0..1	The Certificate_Signature property contains the signature and signature algorithm of this X.509 certificate.

3.2 X509CertificateContentsType Class

The X509CertificateContentsType class represents the contents of an X.509 certificate, including items such as issuer, subject, and others.

The property table of the X509CertificateContentsType class is given in **Table 3-2**.

Table 3-2. Properties of the X509CertificateContentsType class

Name	Type	Multiplicity	Description
Version	cyboxCommon: IntegerObjectPropertyType	0..1	The Version property describes the version of the encoded certificate.
Serial_Number	cyboxCommon: StringObjectPropertyType	0..1	The Serial_Number property is a unique identifier for each X.509 certificate issued by a specific Certificate Authority.
Signature_Algorithm	cyboxCommon: StringObjectPropertyType	0..1	The Signature_Algorithm property is the algorithm used to sign the X.509 certificate.
Issuer	cyboxCommon: StringObjectPropertyType	0..1	The Issuer property is the Certificate Authority who issued the X.509 certificate.
Validity	ValidityType	0..1	The Validity property is the time interval during which the issuer warrants that it will maintain information about the status of the certificate.
Subject	cyboxCommon:	0..1	The Subject identifies the entity associated with the

Name	Type	Multiplicity	Description
	`StringObjectPropertyType`		public key stored in the subject public key property of the X.509 certificate.
Subject_Public_Key	`SubjectPublicKeyType`	0..1	The `Subject_Public_Key` property is used to carry the public key and identify the algorithm with which the key is used.
Standard_Extensions	`X509V3ExtensionsType`	0..1	The `Standard_Extensions` property captures standard X509 V3 extensions that may be specified in the certificate.
Non_Standard_Extensions	`X509NonStandardExtensionsType`	0..1	The `Non_Standard_Extensions` property captures non-standard X509 extensions that may be specified in the certificate.

3.3 X509CertificateSignatureType Class

The `X509CertificateSignatureType` class contains the signature and signature algorithm of this X.509 certificate.

The property table of the `X509CertificateSignatureType` class is given in **Table 3-3**.

Table 3-3. Properties of the `X509CertificateSignatureType` class

Name	Type	Multiplicity	Description
Signature_Algorithm	`cyboxCommon: StringObjectPropertyType`	0..1	The `Signature_Algorithm` property contains the algorithm identifier for the algorithm used by the Certificate Authority to compute the signature.
Signature	`cyboxCommon: StringObjectPropertyType`	0..1	The `Signature` property contains a digital signature computed upon this X.509 certificate.

3.4 SubjectPublicKeyType Class

The `SubjectPublicKeyType` class is used to carry the public key and identify the algorithm with which the key is used.

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

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

Name	Type	Multiplicity	Description
Public_Key_Algorithm	cyboxCommon: StringObjectPropertyType	0..1	The `Public_Key_Algorithm` property is the algorithm with which to encrypt data being sent to the subject.
RSA_Public_Key	RSAPublicKeyType	0..1	The `RSA_Public_Key` property is the public key contained in this X.509 certificate.

3.5 ValidityType Class

The `ValidityType` class is the time interval during which the issuer warrants that it will maintain information about the status of the certificate.

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

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

Name	Type	Multiplicity	Description
Not_Before	cyboxCommon: DateTimeObjectPropertyType	0..1	The `Not_Before` property is the date on which the certificate validity period begins.
Not_After	cyboxCommon: DateTimeObjectPropertyType	0..1	The `Not_After` property is the date on which the certificate validity period ends.

3.6 RSAPublicKeyType Class

The `RSAPublicKeyType` class captures details of RSA public keys.

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

Table 3-6. Properties of the `RSAPublicKeyType` class

Name	Type	Multiplicity	Description
Modulus	cyboxCommon: StringObjectPropertyType	0..1	The `Modulus` property is the modulus portion of a public key.
Exponent	cyboxCommon: IntegerObjectPropertyType	0..1	The `Exponent` property is the exponent portion of a public key.

3.7 X509V3ExtensionsType Class

The `X509V3ExtensionsType` class captures the standard X509 V3 Extensions that may be used in X509 certificates. Based on RFC 3280, "Standard Extensions": http://www.ietf.org/rfc/rfc3280.txt.

The property table of the `X509V3ExtensionsType` class is given in **Table 3-7**.

Table 3-7. Properties of the `X509V3ExtensionsType` class

Name	Type	Multiplicity	Description
Basic_Constraints	cyboxCommon: StringObjectPropertyType	0..1	The `Basic_Constraints` property captures a multi-valued extension which indicates whether a certificate is a CA certificate. The first (mandatory) name is CA followed by TRUE or FALSE. If CA is TRUE then an optional pathlen name followed by a non-negative value can be included. Also

			equivalent to the object ID (OID) value of 2.5.29.19.
Name_Constraints	`cyboxCommon: StringObjectPropertyType`	0..1	The `Name_Constraints` property captures a name space within which all subject names in subsequent certificates in a certification path MUST be located. Also equivalent to the object ID (OID) value of 2.5.29.30.
Policy_Constraints	`cyboxCommon: StringObjectPropertyType`	0..1	The `Policy_Constraints` property captures any constraints on path validation for certificates issued to CAs. Also equivalent to the object ID (OID) value of 2.5.29.36.
Key_Usage	`cyboxCommon: StringObjectPropertyType`	0..1	The `Key_Usage` element property captures a multi-valued extension consisting of a list of names of the permitted key usages. Also equivalent to the object ID (OID) value of 2.5.29.15.
Extended_Key_Usage	`cyboxCommon: StringObjectPropertyType`	0..1	The `Extended_Key_Usage` property captures a list of usages indicating purposes for which the certificate public key can be used for. Also equivalent to the object ID (OID) value of 2.5.29.37.
Subject_Key_Identifier	`cyboxCommon: StringObjectPropertyType`	0..1	The `Subject_Key_Identifier` property captures the identifier that provides a means of identifying certificates that contain a particular public key. Also equivalent to the object ID (OID) value of 2.5.29.14.
Authority_Key_Identifier	`cyboxCommon:`	0..1	The `Authority_Key_Identifier`

	`StringObjectPropertyType`		property captures the identifier that provides a means of identifying the public key corresponding to the private key used to sign a certificate. Also equivalent to the object ID (OID) value of 2.5.29.35.
Subject_Alternative_Name	`cyboxCommon: StringObjectPropertyType`	0..1	The `Subject_Alternative_Name` property captures the additional identities to be bound to the subject of the certificate. Also equivalent to the object ID (OID) value of 2.5.29.17.
Issuer_Alternative_Name	`cyboxCommon: StringObjectPropertyType`	0..1	The `Issuer_Alternative_Name` property captures the additional identities to be bound to the issuer of the certificate. Also equivalent to the object ID (OID) value of 2.5.29.18.
Subject_Directory_Attributes	`cyboxCommon: StringObjectPropertyType`	0..1	The `Subject_Directory_Attributes` property captures the identification attributes (e.g., nationality) of the subject. Also equivalent to the object ID (OID) value of 2.5.29.9.
CRL_Distribution_Points	`cyboxCommon: StringObjectPropertyType`	0..1	The `CRL_Distribution_Points` property captures how CRL information is obtained. Also equivalent to the object ID (OID) value of 2.5.29.31.
Inhibit_Any_Policy	`cyboxCommon: NonNegativeIntegerObjectPropertyType`	0..1	The `Inhibit_Any_Policy` property specifies the number of additional certificates that may appear in the path before anyPolicy is no longer permitted. Also equivalent to the object ID (OID) value of 2.5.29.54.

Name	Type	Multiplicity	Description
Private_Key_Usage_Period	`X509CertificateObj:ValidityType`	0..1	The `Private_Key_Usage_Period` property captures the validity period for the private key, if it is different from the validity period of the certificate. Also equivalent to the object ID (OID) value of 2.5.29.16.
Certificate_Policies	`cyboxCommon:` `StringObjectPropertyType`	0..1	The `Certificate_Policies` property captures a sequence of one or more policy information terms, each of which consists of an object identifier (OID) and optional qualifiers. Also equivalent to the object ID (OID) value of 2.5.29.32.
Policy_Mappings	`cyboxCommon:` `StringObjectPropertyType`	0..1	The `Policy_Mappings` property captures one or more pairs of OIDs; each pair includes an issuerDomainPolicy and a subjectDomainPolicy. The pairing indicates whether the issuing CA considers its issuerDomainPolicy equivalent to the subject CA's subjectDomainPolicy. Also equivalent to the object ID (OID) value of 2.5.29.33.

3.8 X509NonStandardExtensionsType Class

The `X509NonStandardExtensionsType` class captures some non-standard or deprecated X509 extensions that may be useful. Based on the OpenSSL "Deprecated Extensions" documentation: https://www.openssl.org/docs/apps/x509v3_config.html#Deprecated_Extensions. Also based on the Alvestrand certificate extension reference: http://www.alvestrand.no/objectid/2.5.29.html.

The property table of the `X509NonStandardExtensionsType` class is given in **Table 3-8**.

Table 3-8. Properties of the `X509NonStandardExtensionsType` class

Name	Type	Multiplicity	Description

Netscape_Comment	cyboxCommon: StringObjectPropertyType	0..1	The Netscape_Comment property captures a comment which may be displayed when the certificate is viewed in some browsers.
Netscape_Certificate_Type	cyboxCommon: StringObjectPropertyType	0..1	The Netscape_Certificate_Type property captures a list of flags which indicate the purposes for which a certificate could be used.
Old_Authority_Key_Identifier	cyboxCommon: StringObjectPropertyType	0..1	The Old_Authority_Key_Identifier property captures the old version of the authority key identifier, equivalent to the object ID (OID) value of 2.5.29.1.
Old_Primary_Key_Attributes	cyboxCommon: StringObjectPropertyType	0..1	The Old_Primary_Key_Attributes property captures the old version of the primary key attributes, equivalent to the object ID (OID) value of 2.5.29.2.

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