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Asset Identification
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Abstract

Asset identification plays an important role in an organization's ability to quickly correlate different sets of information about assets. This document provides the necessary constructs to uniquely identify assets based on known identifiers and/or known information about the assets. This document describes the purpose of asset identification, a data model for identifying assets, methods for identifying assets, and guidance on how to use asset identification. It also identifies a number of known use cases for asset identification.

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1. Introduction

One of the primary requirements for performing asset management is the ability to identify assets based on some set of data known about them. Asset identification, the use of attributes and methods to uniquely identify an asset, allows for correlation of data across multiple sources, reporting of asset information across different organizations and databases, targeted actions against specific assets, and usage of asset data in other business processes.

Unfortunately, neither a unified method nor a published specification for performing asset identification exists at this time. Existing security automation specifications either do not consider asset identification or represent identification information differently than other specifications with which they interoperate. This means that correlation of data relies on a transformation process between each specification, which is expensive and unreliable. Creation of such a unified method and specification for performing asset identification would allow for greater interoperability, increased capabilities, and easier implementation of asset management processes.

This Asset Identification specification describes a framework for how asset management processes and other specifications may identify assets using some set of information known or generated about the asset. It describes the data model and representation of asset identification information and it provides requirements for consuming and producing identification information. Requirements for usage of asset information and requirements for how the information that identifies assets is collected or generated are out of scope for this specification.

For the purposes of this specification, an asset is considered to be anything that has value to an organization. For example, computing devices are one form of asset that many organizations track. This specification, however, does not limit asset identification to identifying computing devices; any type of asset may be identified. The specification itself provides constructs for identifying many types of assets, and users may extend the model to include other asset types if they wish to identify asset types that are not addressed in the specification.

It is expected that other standards, data formats, tools, processes, and organizations will reference this specification to describe how to represent asset identification information. This will ensure compatibility of asset identifications among these components and allow for improved asset management processes.

While this specification was developed to support the immediate needs of the security automation community, it is expected that it will be valuable in general asset management processes both inside and outside of the security automation space.

1.1. Purpose and Scope

The purpose of this document is to define the Asset Identification specification, a standardized model for representing and identifying assets.

The scope of this document is to give an introduction to Asset Identification, give guidelines on using Asset Identification, describe the Asset Identification data model, and document conformance requirements to comply with Asset Identification. Other versions of Asset Identification and the associated component specifications, including emerging specifications and future versions, are not addressed here.

Future versions of Asset Identification will be defined in distinct revisions of this document, each clearly labeled with a document revision number and the appropriate Asset Identification version number.

1.2. Audience

This specification is intended for authors of specifications that must support asset identifications, implementers of those specifications, system integrators composing architectures from tools that implement those specifications, and end users who wish to understand how these tools work.

1.3. Document Structure

The remainder of this document is organized into the following major sections:

- o Section 2 defines the terms used within this specification and provides a list of common abbreviations.
- o Section 3 describes how this specification fits with related standards and specifications.
- o Section 4 defines the conformance requirements for asset identification.
- o Section 5 gives an overview of asset identification.

- o Section 6 describes the asset identification data model constructs.
- o Section 7 presents the asset identification schema.
- o Appendix A recognizes the work of the original Asset Identification specification [IR7693].
- o Appendix B describes possible use cases for asset identification.
- o Appendix C explains how the specification can be extended.

1.4. Document Conventions

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].

Both inline and indented forms use qualified names to refer to specific XML elements. A qualified name associates a named element with a namespace. The namespace identifies the specific XML schema that defines (and consequently may be used to validate) the syntax of the element instance. A qualified name declares this schema to element association using the format prefix:element-name. The association of prefix to namespace is defined in the metadata of an XML document and generally will vary from document to document. In this specification, the conventional mappings listed in Table 1-1 are used.

Prefix	Namespace URI	Schema
ai	urn:ietf:params:xml:ns:asset-identification-1.0	Asset Identification 1.0
core	http://scap.nist.gov/schema/reporting-core/1.1	SCAP Reporting Core 1.1
cpe-name	http://cpe.mitre.org/naming/2.0	CPE 2.3 Naming Specification
xal	urn:oasis:names:tc:ciq:xsd:schema:xAL:2.0	OASIS extensible Address Language

xnl	urn:oasis:names:tc:ciq:xsdschema:xNL:2.0	OASIS	
		extensible	
		Name Language	
+-----+	+-----+	+-----+	+-----+

Conventional XML Mappings

2. Terms and Abbreviations

Asset: Anything that has value to an organization, including, but not limited to, another organization, person, computing device, information technology (IT) system, IT network, IT circuit, software (both an installed instance and a physical instance), virtual computing platform (common in cloud and virtualized computing), and related hardware (e.g., locks, cabinets, keyboards).

Asset Identification: The use of attributes and methods to uniquely identify an asset.

Asset Identification Element: A complete, bound expression of an asset identification using the constructs defined in this specification.

Circuit: A dedicated single connection between two endpoints on a network.

Computing Device: A machine (real or virtual) for performing calculations automatically (including, but not limited to, computer, servers, routers, switches, etc.)

Data: Any piece of information suitable for use in a computer.

Database: A repository of information or data, which may or may not be a traditional relational database system.

Extension Identifier: Any piece of identifying information provided in an asset identification element that is not explicitly defined in the Asset Identification schema.

Identifying Information: The set of an asset's attributes that may be useful for identifying that asset, including discoverable information about the asset and identifiers assigned to the asset.

Matching: The process of determining whether two or more asset identification expressions refer to the same asset.

Network: An information system(s) implemented with a collection of interconnected components. Such components may include routers, hubs, cabling, telecommunications controllers, key distribution centers, and technical control devices.

Organization: An entity of any size, complexity, or positioning within an organizational structure (e.g., a federal agency, or, as appropriate, any of its operational elements).

Person: Any person considered as an asset by the management domain.

Relationship Identifier: Identifying information where the value is a relationship to another asset.

Service: A set of related IT components provided in support of one or more business processes.

Software: Computer programs and associated data that may be dynamically written or modified during execution.

System: A discrete set of information resources organized for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information.

Synthetic Identifier: An identifier that is assigned to an asset in the context of some management domain.

Website: A set of related web pages that are prepared and maintained as a collection in support of a single purpose.

2.1. Acronyms

BIOS: Basic Input/Output System

CIDR: Classless Inter-Domain Routing

CPE: Common Platform Enumeration

FQDN: Fully-Qualified Domain Name

GUID: Globally Unique Identifier

HTTP: Hypertext Transfer Protocol

IETF: Internet Engineering Task Force

IP: Internet Protocol

IT: Information Technology

ITL: Information Technology Laboratory

MAC: Media Access Control

NIST: National Institute of Standards and Technology

OASIS: Organization for the Advancement of Structured Information
Standards

RFC: Request for Comment

URI: Uniform Resource Identifier

URL: Uniform Resource Locator

W3C: World Wide Web Consortium

WFN: Well-Formed Name

xAL: Extensible Address Language

XML: Extensible Markup Language

xNL: Extensible Naming Language

XSD: XML Schema

3. Relationship to Existing Standards and Specifications

This specification defines the constructs and methods for representing asset identification information and thus can be leveraged by any other specification where identifying assets is required or beneficial.

This specification uses several industry-standard mechanisms for representing identification information and providing conformance requirements.

Common Platform Enumeration (CPE)TM is a structured naming scheme for information technology systems, platforms, and packages. Based upon the generic syntax for Uniform Resource Identifiers (URI), CPE includes a formal name format. CPE version 2.3 Well-Formed Names (WFN) are used as software- identifying information by this specification [CPE23].

The extensible Address Language (xAL) by the Organization for the Advancement of Structured Information Standards (OASIS) is an XML standard format for representing international address information [XAL]. Asset Identification leverages xAL to represent address information for assets.

The extensible Name Language (xNL) by OASIS is an XML standard format for representing the names of people and organizations. [XNL] Asset Identification leverages xNL to represent the names of people and organizations.

4. Conformance

A product may want to claim conformance with this specification so that users and organizations can use the product with the assurance that the product can identify assets in a consistent and standard manner. The ability for a product to identify assets in a standard manner increases the likelihood of interoperability between conforming products. This section defines the criteria for products to claim conformance with this specification.

4.1. Product Conformance

Products are divided into two roles based on their use of asset identification information: consumers and producers.

- o Consuming products ("consumers") must be able to receive and understand information in compliance with this specification.
- o Producing products ("producers") must create asset identification information in a format compliant with this specification.

A product may be both a consumer and producer. The following subsections document the conformance requirements for the two types of products.

4.1.1. Consumers

Any consuming product claiming conformance to this specification MUST adhere to the following requirements.

- o The consumer SHALL be capable of processing the identification information represented in constructs consistent with the Asset Identification data model without error. See Section 6.
- o The consumer MAY attempt to consume constructs that are invalid per the Asset Identification data model. See Section 6.
- o The consumer MAY consume extension identifiers and use them as an input into a matching process. See Section 5.3.4.
- o The consumer MUST NOT abnormally end, crash, or otherwise be unable to fully process asset identification elements that include extension identifiers. It MAY ignore any information in extension identifiers.

4.1.2. Producers

Any producing product claiming conformance to this specification MUST adhere to the following requirements.

- o The producer SHALL accurately produce the asset identification element in XML consistent with the data model. Section 6.
- o When representing identification information, the producer SHOULD provide as much information as is sufficient to allow for a match. See Section 5.3.
- o When representing identification information, the producer MAY provide as much or as little identifying information as allowed in the data model per other recommendations or tool capabilities. See Section 5.3.
- o The producer MAY provide extension identifiers for any asset identification element. See Section 5.3.4.

5. Asset Identification Overview

This section gives an overview of the Asset Identification model and its key concepts.

5.1. Scope

In order to support the variety of use cases discussed in Appendix A, the scope of this specification is limited to a description of how asset management tools can represent asset identification information when communicating it to other tools. It is out of scope of this specification to recommend which identifiers to use or to require that identification information be collected in a certain way or from a certain place. Higher-level specifications, tools, and organizations that implement Asset Identification, however, are encouraged to make these recommendations or specify these requirements in order to support the particular needs of their use cases.

Additionally, the Asset Identification specification is not a mechanism for expressing information about an asset that is not related to asset identification. Only elements that are used for identification are included in the core specification. Asset Identification elements **MUST NOT** be used to represent information about an asset unless it is being used to identify that asset.

5.2. Core Specification and Extension Points

The core Asset Identification specification defines eleven asset types and definitions of how those asset types may be identified using a set of literal attributes and relationships to other assets. The core specification is intended to provide definitions for commonly used asset types and identification attributes; it is not intended to be an exhaustive list of all possible asset types and attributes that may be used for identification. Anything explicitly defined in the asset identification schema and the asset identification controlled vocabulary for relationship identifiers is considered part of the core specification.

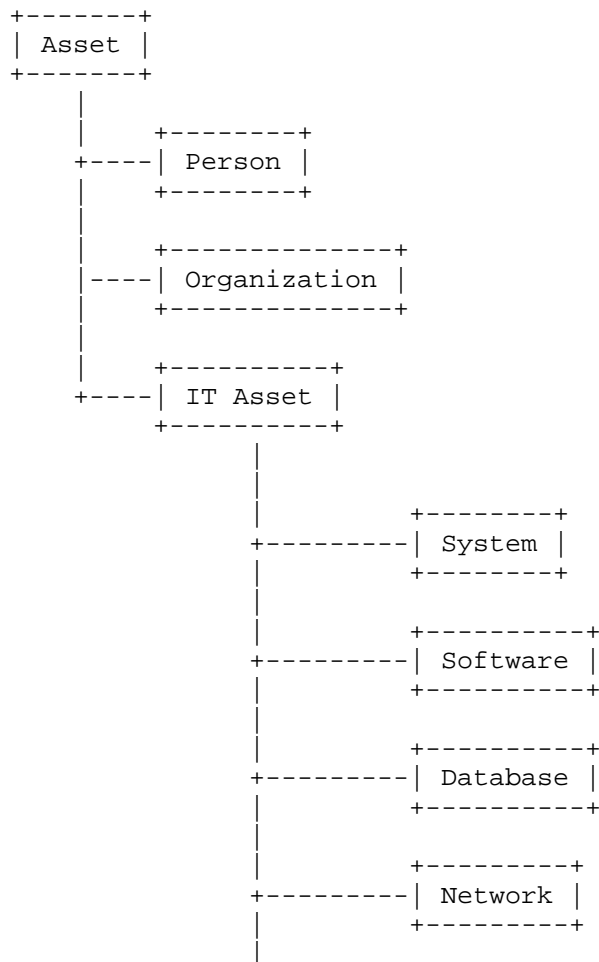
There are several extension points in the Asset Identification data model to allow for identification of asset types beyond what is included in the core specification and to allow attributes or relationships outside of the core specification to be used to identify asset types that are included. These extension points are:

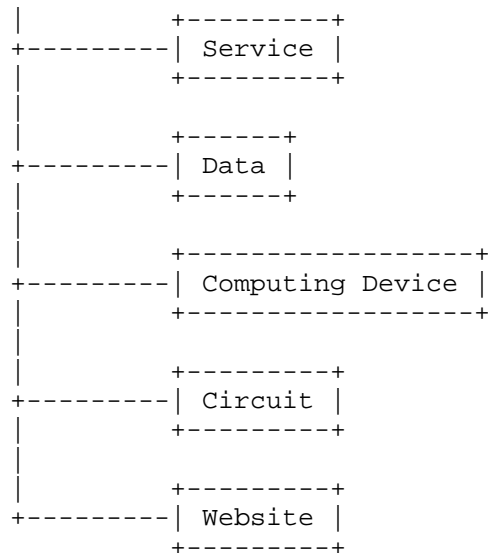
- o Additional asset types may be created by inheriting from any concrete or abstract "asset" data element in the core XML schema.

- o The core asset types may be enhanced by adding elements to the appropriate asset type as literal values in the "extended-information" element.
- o Additional relationships can be defined by creating a separate vocabulary for relationship identifiers.

5.3. Data Model Overview

The Asset Identification data model consists of a set of asset types and a set of information that can be provided about each asset type. The asset types currently supported in this specification are:





For the purposes of this specification the above asset types MUST be understood as defined in Section 2.

The specification MAY be extended by Asset Identification producers to allow for other asset types as needed; however, it is OPTIONAL for Asset Identification consumers to support asset types not present in the core specification.

For each asset type above, the specification has a core set of fields that may be provided in order to identify an asset of that type. For example, an asset of type "person" may be identified by an email address, full name, telephone number, or birth date. Any number of these fields may be populated in order to create an asset identification element. Specifications, management environments, organizations, and tool vendors implementing Asset Identification are encouraged to recommend, restrict, or require that certain fields be populated or not populated; however, the specification itself does not do so.

There are several different types of information that may be used to identify assets: literal identifiers, relationship identifiers, synthetic identifiers, and extension identifiers. These four identifier types are differentiated only because they are represented differently in the data model. No identifier type is intrinsically more or less valuable for performing asset identification than any other identifier type.

5.3.1. Literal Identifiers

Literal identifiers are the pre-defined fields containing literal values that may identify an asset. For example, Media Access Control (MAC) address is an example of a literal identifier for a computing device. Literal identifiers defined in Asset Identification MUST be properly processed without error by Asset Identification consumers.

5.3.2. Synthetic Identifiers

Synthetic identifiers are meant to be used when a database or process assigns an identifier. For example, an employee is often assigned an employee identifier which may be used to track him or her across the organization. These identifiers should be represented using the synthetic identifier construct: the namespace denotes the management domain for which the identifier is valid and the identifier contains the identifier itself. Each asset type allows for a list of zero to many synthetic identifiers. Synthetic identifiers MUST be properly processed without error by Asset Identification consumers.

5.3.3. Relationship Identifiers

Relationship identifiers are meant to be used when an asset may be identified based on a relationship to another asset. For example, a system may be identified based on the fact that it is named "System 1" and it is connected to network "INTERNAL". Relationship types are represented as a controlled vocabulary. Any relationships defined in the Asset Identification controlled vocabulary are core and MUST be processed without error by Asset Identification consumers. Relationships that are defined in other controlled vocabularies are considered extension identifiers and MAY be supported by Asset Identification consumers.

5.3.4. Extension Identifiers

Although this specification intends to support the most common types of information that are used to identify assets, certain users, organizations, or use cases may find that the core model does not support some fields that they need. Asset Identification supports a producer's ability to provide these identifiers in any asset identification element through extension identifiers; however, it is OPTIONAL for consumers to process or understand these identifiers unless some other specification requires it. Extension identifiers may include additional literal values as well as relationship identifiers that are outside of the Asset Identification controlled vocabulary. Extension identifiers MUST be processed without error by consumers; however, consumers are encouraged to ignore identifying information that they do not understand and is not defined in the

core schema, which ensures accurate correlation.

5.4. Providing Asset Identifications

In the absence of other guidance or requirements, Asset Identification providers SHOULD provide as much information as they have available in the core (non-extension) asset identification element. Bandwidth constraints, other specifications, and tool intelligence MAY help define how much or which information SHOULD be provided beyond this recommendation.

5.5. Consuming Asset Identifications

Asset Identification consumers MUST be able to process literal identifiers, synthetic identifiers, relationship identifiers, and extension identifiers without error. In this context, "process" simply means ingest without error and optionally use as an input in performing a matching. Asset Identification consumers SHOULD process literal identifiers, synthetic identifiers, and relationship identifiers and support incorporating them into a matching process. Asset Identification consumers SHOULD NOT incorporate unknown extended identifiers into a matching process as they may be misleading or misunderstood.

Extended identifiers that are defined in another specification or policy that the consumer implements MAY be supported as appropriate and as defined by that specification or policy.

5.6. Matching

Matching is the process of determining whether or not two or more asset identification elements are referring to the same asset. Matching is performed across an entire asset identification element, not across each individual property of an identifier.

Although matching identifiers is an important part of the asset identification process, due to a wide variety of current tool practices, organizational architectures, and the need to allow for innovation, this specification does not provide any normative requirements in regards to matching. Tools are free to perform matching based on their own logic, and specifications implementing asset identification are encouraged to provide their own recommendations or requirements around matching.

5.7. Sample Correlation Workflow

The diagram in Figure 1 shows a sample correlation workflow, including matching discoverable information and several synthetic

identifiers.

In this sample architecture, which is merely one example, several tools report on information about an asset. The information is correlated by an asset database, potentially processed or aggregated, and then reported to a higher-level database.

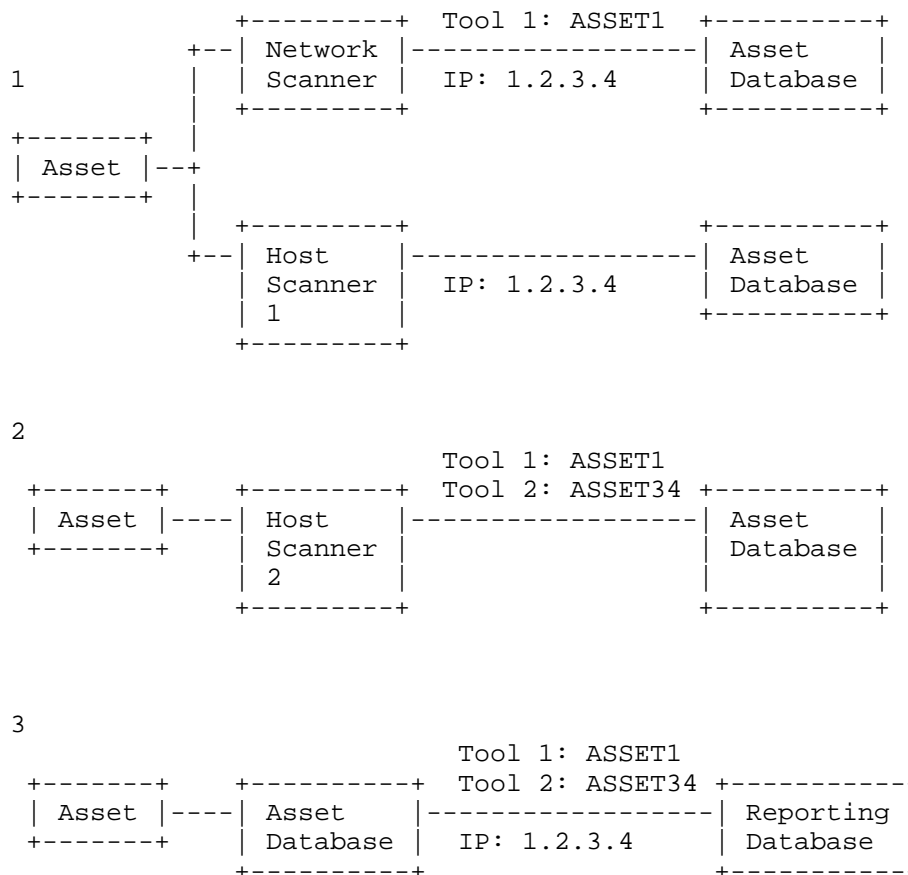


Figure 1: Sample Correlation Workflow

In step 1, a host-based scanner is reporting on asset information (e.g. vulnerability assessment results) using a synthetic identifier in its own namespace and an IP address as identifying information. Additionally, a network scanner is reporting on network events by IP address. This allows the asset database to correlate information coming from the network with information on the host, potentially matching vulnerabilities discovered by the host-based scanner with attacks against that vulnerability discovered by the network scanner.

In step 2, another host-based scanner (e.g., an asset inventory tool) reports data using both a synthetic identifier in its own namespace and a synthetic identifier in the first host-based tool's namespace. This other identifier may have been collected on the system or may have been discovered some other way; how that collection happens is out of scope of this specification. By passing both identifiers, however, the scanner provides enough data to the asset database to correlate the additional inventory data with the vulnerability and event data. Additionally, any other data reported using either the IP address or the two synthetic identifiers will be able to be correlated as well. Note that this specification does not require or recommend that tools process identifiers in certain ways: for example, an IP address may become stale after a period of time, but it is out of scope for this specification to recommend how to deal with that.

In step 3, the asset database provides a report to a higher-level database. Depending on the reporting architecture, organizational hierarchy, and reporting requirements, asset databases may want to report on data with different sets of synthetic identifiers for each asset. This specification does not restrict or recommend architectures or workflows.

In the reporting architecture shown above, all known asset identifiers for each asset are being used to report information to the higher level. In this architecture, data provided by other tools to the higher-level database may be correlated with the reported data. Other options would be to only report some information to the higher-level database or even to generate a new synthetic identifier to perform reporting, depending on the reporting requirements and network architectures.

6. Data Model

This section documents the data model for Asset Identification. The XML schema that implements this data model is provided separate from this specification.

The Asset Identification model is a fairly flat model that defines the constructs to hold identifying information about an asset. A limited number of asset types are defined for which model constructs exist. In order to use the Asset Identification model:

- o The user SHOULD produce an XML ai:assets or ai:asset-related element consistent with the data model described in Section 6.3.12.1.
- o The XML element produced MUST validate against the XML schema (XSD) for Asset Identification in Section 7. In situations where the XML schema does not match the documented model in this specification, the XSD takes precedence.

The following subsections formalize the logical data model. The data contained in the subsections include prose and tables, which MUST be interpreted as follows:

- o The subsection title indicates the name for the entity being described.
- o The "INHERITS" field indicates that the element takes on all of the properties of the inherited element in addition to the properties defined for the element.
- o The "DEFINITION" field indicates the prose description of the text. The field MAY contain requirement words as indicated in [RFC2119].
- o The "Properties" field is broken into a four column table:
 - * The "Name" column indicates the name of a property that MAY or MUST be included in the described element in accordance with the cardinality indicated in the "Count" field.
 - * The "Type" column indicates the type of data that MUST be the value for the property. There are two categories of types: literal and element. A literal type will indicate the type of literal. The element type will reference the name of another element that defines the content for that property.

- * The "Count" column indicates the cardinality of the property within the element. The property MUST be included in the element in accordance with the cardinality. If a range is given, and "n" is the upper-bound of the range, then the upper limit is unbounded.
- * The "Definition" column defines the property in the context of the element. The field MAY contain requirement words as indicated in [RFC2119].

Each literal data element MAY have a "source" attribute associated with it. The source attribute is intended to capture the source of the information for that data element. The field SHALL be a string type, but the value of the field is left to the content producer. The value MAY include, but is not restricted to, a synthetic ID of the asset that sourced the information, another ID of the source, or a description of the source. See the XSD for additional clarity on the "source" attribute.

Each literal data element MAY have a "timestamp" attribute associated with it. If populated, the timestamp attribute indicates when the data was last known to be correct for that element.

6.1. Abstract Elements

6.1.1. ai:asset

INHERITS: None.

DEFINITION: The root element from which all other asset elements derive. This element does not represent any specific type of asset, and therefore should only be used as a base class for other, concrete, asset elements. Any element that claims to be an asset element compliant with this specification SHALL directly or indirectly inherit all of the attributes in this element. The asset element SHALL NOT be used directly in an asset identification instance because it is abstract.

Name	Type	Cnt	Definition
synthetic-id	element-synthetic-id	0-n	Holds the synthetic ID information for the asset.
locations	element - locations	0-1	Holds the location information where the asset resides.
extended-information	element - locations	0-1	Holds extension identifiers for the asset. The content can be any well- formed XML defined in a namespace other than the Asset Identification namespace.
timestamp	literal - dateTime	0-1	The date and time when the information was last known to be correct.

Table 1: ai:asset Properties

6.1.2. ai:it-asset

INHERITS: ai:asset

DEFINITION: An abstract element that extends from the asset element. it-asset is a placeholder element to carry common attributes related to IT assets. For the current iteration of this specification no common attributes have been identified, but future iterations of the specification MAY contain common attributes for IT assets. All asset elements that are describing IT assets SHOULD extend from the it-asset element.

Name	Type	Cnt	Definition
N/A	N/A	N/A	N/A

Table 2: ai:it-asset Properties

6.2. Concrete Asset Elements

The following elements describe the data elements for the asset types defined in this specification.

6.2.1. ai:circuit

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a circuit.

Name	Type	Cnt	Definition
circuit-name	literal - token	0-1	The name of the circuit being identified.

Table 3: ai:circuit Properties

6.2.2. ai:computing-device

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a computing device.

Name	Type	Cnt	Definition
distinguished-name	literal - token	0-1	The X.500 distinguished name of the computing device being identified.
cpe	literal - ai:cpe	0-n	The Common Platform Enumeration name for the computing device being identified. This MUST be a hardware CPE. This MUST be a CPE 2.2 URI [CPE22] or CPE 2.3 formatted string [CPE23].
connections	elements - ai:connections	0-1	Information about a network interface on the computing device being identified.
fqdn	literal - token	0-1	The fully-qualified domain name for the computing device being identified.
hostname	literal - token	0-1	The hostname of the computing device.
motherboard-guid	literal - string	0-1	The motherboard globally unique identifier of the computing device.

Table 4: ai:computing-device Properties

6.2.3. ai:data

INHERITS: ai:asset

DEFINITION: A generic element to describe any type of data. Since this element is generic it does not define any of its own properties, but instead relies solely on the properties inherited from asset.

Name	Type	Cnt	Definition
synthetic-id	element-synthetic-id	0-n	Holds the synthetic ID information for the asset.
N/A	N/A	N/A	N/A

Table 5: ai:data Properties

6.2.4. ai:database

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a database.

Name	Type	Cnt	Definition
instance-name	literal - token	0-1	The name of the database instance.

Table 6: ai:database Properties

6.2.5. ai:network

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a network.

Name	Type	Cnt	Definition
network-name	literal - normalizedString	0-1	The name of the network being identified.
ip-net-range	element - ip-net-range	0-1 (if ip-net-range, then not cidr)	The starting and ending IP addresses for the range of IP addresses for the network being identified.

cidr	literal - token	0-1 (if cidr, then not ip-net-range)	The Classless Inter-Domain Routing information for the network being identified.
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Table 7: ai:network Properties

6.2.6. ai:organization

INHERITS: ai:asset

DEFINITION: Captures identifying information about an organization.

Name	Type	Cnt	Definition
xnl:OrganisationNameDetails	element - xnl:OrganisationNameDetails	0-n	The name of the organization being identified. See [xNL] for details on populating this element
email-address	literal - token	0-n	An email address associated with the organization being identified.

telephone-number	literal - token	0-n	A phone number associated with the organization being identified. For a North American number, the number MUST be valid and the format MUST be XXX- XXX-XXXX where X is a digit. For an international number, the number MUST begin with a '+' symbol, followed by 7 to 15 digits. A space MAY be used between digits, as appropriate. For example: +88 888 888 8 (this is following the ITU-T E.123 notation). Regex: ((([2-9][0-8]\d-[2-9]\d{2}-[0-9]{4}) (\+[0-9]?){6,14}[0-9]))
website-url	literal - URL	0-n	A website associated with the organization being identified.

Table 8: ai:organization Properties

6.2.7. ai:person

INHERITS: ai:asset

DEFINITION: Captures identifying information about a person.

Name	Type	Cnt	Definition
xnl:PersonName	element - xnl:PersonName	0-1	The name of the person being identified. The element type is defined in [xNL] and SHALL be used as documented in that specification.
email-address	literal - token	0-n	An email address associated with the person being identified.
telephone-number	literal - token	0-n	A phone number associated with the person being identified. For a North American number, the number MUST be valid and the format MUST be XXX-XXX-XXXX where X is a digit. For an international number, the number MUST begin with a '+' symbol, followed by 7 to 15 digits. A space MAY be used between digits, as appropriate. For example: +88 888 888 8 (this is following the ITU-T E.123 notation). Regex: <code>((([2-9][0-8]\d-[2-9]\d{2}-[0-9]{4}) (\+([0-9]?){6,14}[0-9]))</code>
birthdate	literal - date	0-1	The birth date of the person being identified.

Table 9: ai:person Properties

6.2.8. ai:service

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a service running on a computing-device.

Name	Type	Cnt	Definition
host	element - host	0-1	The IP address or fully qualified domain name of the host of the service.
port	literal - integer	0-n	The port number that the service is bound to. Restricted to $0 \leq x \leq 65535$
port-range	element - ai:port-range	0-n	The lower and upper bound (inclusive) of the range of ports the service is bound to.
protocol	literal - string	0-1	The protocol used to interact with the service (e.g., HTTP, JMS, SSH, FTP).

Table 10: ai:service Properties

6.2.9. ai:software

INHERITS: ai:it-asset

DEFINITION: Captures identifying information about a class of software or a software instance.

Name	Type	Cnt	Definition
installation-id	literal - token	0-1	Any identifier for a software instance (installation). Use when identifying an instance of software and not just the class of software.
cpe	literal - ai:cpe	0-1	The Common Platform Enumeration name for the class of software being identified. This MUST be a software CPE. This MUST be a CPE 2.2 URI [CPE22] or CPE 2.3 formatted string [CPE23].

license	literal - string	0-n	The license key associated with the software instance (installation). Use when identifying an instance of software and not just the class of software.
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Table 11: ELEMENT NAME PROPERTIES

6.2.10. ai:system

INHERITS: parent

DEFINITION: definition text.

Name	Type	Cnt	Definition
system-name	literal - token	0-n	The name of the system being identified. This property can be replicated as systems may have multiple, or abbreviated, names. All of the names (including acronyms) MAY be captured here.
version	literal - token	0-1	The version of the system being identified.

Table 12: ai:system Properties

6.2.11. ai:website

INHERITS: parent

DEFINITION: definition text.

Name	Type	Cnt	Definition
document-root	literal 1-token	0-1	The absolute path to the document root location of the website on the host.

locale	litera l- token	0-1	The locale of the website represented as an RFC 5646 language, and optionally, region code. Language and region codes SHOULD be in the Internet Assigned Numbers Authority (IANA) Language Subtag Registry [ILSR]. Regex: <code>[a-zA-Z]{2,3}(-([a-zA-Z]{2} [0-9]{3}))?</code>
--------	-----------------------	-----	--

Table 13: ai:website Properties

6.3. Helper Elements

6.3.1. ai:synthetic-id

INHERITS: N/A

DEFINITION: Holds the synthetic identifier information for an asset.

Name	Type	Cnt	Definition
resource	literal - URI	1	A URI for the namespace in which the identifier is governed and unique.
id	literal - token	1	The unique identifier for the asset within the resource namespace.

Table 14: ai:synthetic-id Properties

6.3.2. ai:connections

INHERITS: N/A

DEFINITION: Contains a list of ai:connection elements.

Name	Type	Cnt	Definition
connection	element - ai:connection	1-n	Information about a network interface on the computing device being identified.

Table 15: ai:connections Properties

6.3.3. ai:connection

INHERITS: N/A

DEFINITION: Contains information relevant to a single connection to a network. If multiple IP addresses map to the same MAC address, each ai:connection SHALL represent a single MAC address-IP address pair.

Name	Type	Cnt	Definition
ip-address	literal-token	0-1	The IP address for the connection. IPv4 Regex: ([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5])) IPv6 Regex: ([0-9a-fA-F]{1,4}:){7}[0-9a-fA-F]{1,4}
mac-address	literal - ai:mac-address-type	0-1	The Media Access Control address for the network interface. Regex: ([0-9a-fA-F]{2}:){5}[0-9a-fA-F]{2}
url	literal - URL	0-n	A Universal Resource Locator address for the network interface.
subnet-mask	literal - token	0-1	The subnet mask for the connection. IPv4 Regex: ([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5])) IPv6 Regex: ([0-9a-fA-F]{1,4}:){7}[0-9a-fA-F]{1,4}

default- route	literal - token	0-1	The IP address for the default gateway for the connection. IPv4 Regex: ([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5])) IPv6 Regex: ([0-9a-fA-F]{1,4}:){7}[0-9a-fA-F]{1,4}
-------------------	--------------------	-----	--

Table 16: ELEMENT NAME PROPERTIES

6.3.4. ai:locations

INHERITS: N/A

DEFINITION: Contains a geographic coordinate system point.

Name	Type	Cnt	Definition
location	element - one of: location-point, location-region, location-address (type xal:AddressDetails)	1-n	ai:location is an abstract element that is the root of the substitution group for the elements listed in the type field. Use one of those to describe the location of the asset. xal:AddressDetails is defined in [xAL].

Table 17: ai:locations Properties

6.3.5. ai:location-point

INHERITS: N/A

DEFINITION: Contains a geographic coordinate system point.

Name	Type	Cnt	Definition
latitude	literal - number	1	The latitude of the point represented as a number between -90 and 90. 90 = 90oN, -90 = 90oS. Value constraint: -90 <= x <= 90
longitude	literal - number	1	The longitude of the point represented as a number between -180 and 180. 180 = 180oE, -180 = 180oW. Value constraint: -180 < x <= 180
elevation	literal - number	0-1	The elevation of the point represented in meters above sea level. A negative number would indicate below sea level.
radius	literal - number	0-1	The radius of a horizontal circle centered on the point within which the asset resides. Value constraint: x >= 0

Table 18: ai:location-point Properties

6.3.6. ai:location-region

INHERITS: N/A

DEFINITION: Contains region information.

Name	Type	Cnt	Definition
region-name	literal - normalizedString	1	The name of the region.

Table 19: ai:location-region Properties

6.3.7. ai:ip-range

INHERITS: N/A

DEFINITION: Contains a start and end IP address to create a range.

Name	Type	Cnt	Definition
ip-net-range-start	element - ai:ip-address	1	The start IP address of the range
ip-net-range-end	element - ai:ip-address	1	The end IP address of the range.

Table 20: ELEMENT NAME PROPERTIES

6.3.8. ai:ip-address

INHERITS: N/A

DEFINITION: Contains an IP address.

Name	Type	Cnt	Definition
ip-v4	literal - token	0-1	An IP v4 address. Regex: ([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))\.([0-9] [1-9][0-9] 1([0-9][0-9]) 2([0-4][0-9] 5[0-5]))
ip-v6	literal - token	0-1	An IP v6 address. Regex: ([0-9a-fA-F]{1,4}:){7}[0-9a-fA-F]{1,4}

Table 21: ai:ip-address Properties

6.3.9. ai:port-range

INHERITS: N/A

DEFINITION: Contains a start and end port number to create a range..

Name	Type	Cnt	Definition
lower-bound	literal - token	1	The lower bound (inclusive) of the range of ports. Restricted to $0 \leq x \leq 65535$
upper-bound	literal - token	1	The lower bound (inclusive) of the range of ports. Restricted to $0 \leq x \leq 65535$. MUST be greater than lower-bound.

Table 22: ai:port-range Properties

6.3.10. ai:host

INHERITS: N/A

DEFINITION: Holds a fully-qualified domain name or an IP address.

Name	Type	Cnt	Definition
fqdn	literal - token	1 (if not ip-address)	The fully-qualified domain name of the host. One of fqdn or ip-address must be specified
ip-address	element - ai:ip-address	1 (if not fqdn)	The IP address of the host. One of fqdn or ip- address must be specified.

Table 23: ai:host Properties

6.3.11. ai:cpe

INHERITS: N/A

DEFINITION: A CPE 2.2 URI [CPE22] or CPE 2.3 formatted string [CPE23].

Name	Type	Cnt	Definition
N/A	N/A	N/A	N/A

Table 24: ai:cpe Properties

6.3.12. Relating Assets to Other Assets

While the assets modeled in Section 6.2, and their related elements, capture the literal values helpful for identifying the respective assets, it is often useful or necessary to define one or more relationships between assets. Those relationships can give additional context to the identifying algorithm in the implementing tool.

The Asset Identification data model allows for explicit relationships to be defined between an asset and one or more other assets. Each relationship is defined as {subject} {predicate} {object}, where {subject} is the asset from which the relationship begins, {predicate} is the relationship type being established, and {object} is one or more other assets. The predicate MUST be a qualified name that refers to a term in a controlled vocabulary. Section 6.4.1 documents the data model to represent assets along with relationships. Section 6.4.2 defines terms in a controlled vocabulary for Asset Identification.

6.3.12.1. Relationship Data Model

Asset Identification defines two elements that can be leveraged by specifications desiring to represent Asset Identification information. The first element, ai:asset-related, SHOULD be leveraged when the implementing specification desires to identify a single asset while demonstrating relationships between that asset and other assets. The second element, ai:assets, SHOULD be leveraged when the implementing specification desires to identify multiple assets while documenting the relationships between those assets and other assets. The two elements are documented in the following tables.

6.3.12.1.1. ai:asset-related

INHERITS: N/A

DEFINITION: Identifies a single asset while capturing the relationships between that asset and other assets.

Name	Type	Cnt	Definition
asset-ref	literal - NCName	1	Contains the ID value of an ai:asset found on this ai:asset-related element. The asset referenced from this property is the primary asset of this element and SHALL be understood to be the asset being identified by this ai:asset-related element.
relationships	element - core:relationships	0-1	Contains the relationships between assets identified in this element.
asset	element - ai:asset	1-n	The assets captured in this element. This includes at minimum the primary asset referenced in asset-ref, as well as any additional assets that the primary asset is related to through a relationship.

Table 25: ai:asset-related Properties

6.3.12.1.2. ai:assets

INHERITS: N/A

DEFINITION: Identifies multiple assets as well as the relationships between the assets.

Name	Type	Cnt	Definition
relationships	element - core:relationships	0-1	Contains the relationships between assets identified in this element
asset	element - ai:asset	1-n	The assets captured in this element.

Table 26: ai:assets Properties

6.3.12.1.3. core:relationships

INHERITS: N/A

DEFINITION: Contains a collection of relationships between the report content and assets, report requests, and other reports.

Name	Type	Cnt	Definition
relationship	element - core:relationship	1-n	Contains a relationship between the subject and object(s) assets.

Table 27: ELEMENT NAME PROPERTIES

6.3.12.1.4. core:relationship

INHERITS: N/A

DEFINITION: Contains a relationship between the subject and object(s) assets.

Name	Type	Cnt	Definition
ref	literal - NCName	1-n	This element MUST identify the object of this relationship by specifying the ID of the asset. Depending on the type of relationship being asserted, there may be additional restrictions on which types of objects may be referenced, but that will be documented with the vocabulary term.
type	literal - QName	1	This element contains the type of relationship that is being specified. The QName MUST refer to a term in a controlled vocabulary. The controlled vocabulary is identified by the namespace URI of the QName, and the term in that controlled vocabulary is specified by the local name of the QName. It is helpful, though not required, that when the namespace URI and local name are concatenated, the resulting URI is dereferenceable and points to a location that defines the term.
scope	literal - token	0-1	Determines how to interpret multiple ref elements in a relationship. If used, this element MUST contain the string "inclusive" or "exclusive". When this element is not provided, its default value is "inclusive". When "inclusive" is specified, this relationship should be understood to exist between the subject asset and the collection of objects identified by the ref elements on this relationship. When "exclusive" is specified, this relationship should be understood to exist between the subject asset and each object asset identified by the ref elements individually.

subject	literal - NCName	1	The property MUST identify the subject of the relationship by specifying the ID of the asset. Depending on the type of relationship being asserted, there may be additional restrictions on which type of asset may be referenced, but that will be documented with the vocabulary term.
---------	------------------------	---	--

Table 28: core:relationship Properties

6.3.12.2. Relationship Types

Defined below are terms in a controlled vocabulary for Asset Identification. It is OPTIONAL that content producers use the terms defined below, but all Asset Identification compliant implementations MUST understand the terms defined in this section. Content producers SHOULD use these terms when possible.

All terms listed in Table 29 exist in the controlled vocabulary identified by <http://scap.nist.gov/specifications/ai/vocabulary/relationships/1.0#>. The definition of each term can also be found at the URL created when concatenating the URL and the term together. The table MUST be interpreted as follows:

- o The "Term" column indicates the local-name of the term being identified.
- o The "Domain" column indicates the exhaustive set of subject types that may be referenced by a relationship of that type. A relationship of that type MUST reference a subject of the type indicated in "Domain" for that relationship.
- o The "Range" column indicates the exhaustive set of object types that may be referenced by a relationship of that type. A relationship of that type MUST reference an object of the type indicated in "Range" for that relationship.
- o The "Description" column contains a prose description of the relationship type. This column may contain requirement words as indicated in [RFC 2119]. Those requirement words MUST be interpreted as described in [RFC 2119] for the relationship.

Term	Domain	Range	Description
hasTerminationDevice	ai:circuit	ai:computing-device	The circuit is terminated by the device
hasServiceProvider	ai:circuit	ai:organization	The circuit is owner/operated by the organization.
hasNetworkTerminationPoint	ai:circuit	ai:network	The circuit ends at the network.
servedBy	ai:database, ai:website	ai:service	The database or website is served up by the service.
hasServiceProvider	ai:service	ai:software	The service is provided by the software.
installedOnDevice	ai:software	ai:computing-device	The software is installed on the computing device.

connectedToNetwork	ai:system	ai:network	The system is connected to the network.
isOwnerOf	ai:person, ai:organization	ai:it-asset	The person or organization owns the IT asset.
isAdministratorOf	ai:person	ai:computing-device, ai:system	The person is the system administrator of the computing device or system.
partOf	ai:person	ai:organization	The person is in some way a part of the organization.
connectedTo	ai:computing-device, ai:system	ai:system	The computing device or system is connected to the system.

Table 29: Controlled Vocabulary Defined for Asset Identification

Content producers that choose to use terms that are not listed in Table 6-29, or to use other terms in addition to those listed in Table 6-29, MAY do so while still remaining compliant to this specification. Content producers SHALL always use terms defined in a controlled vocabulary. The controlled vocabulary SHALL be identified using a URI. Concatenating the controlled vocabulary URI with a term in the vocabulary MAY create a dereferencable URI that points to a definition for that term. This is often accomplished by using an HTTP URL for the controlled vocabulary URI, and ending that URL in

"#" or "/". For instance, <http://scap.nist.gov/specifications/ai/vocabulary/relationships/1.0#installedOnDevice> is a deferenceable link to the definition of "installedOnDevice".

6.3.13. Guidance for Incorporating Asset Identification Elements into Other Data Models

The following guidance applies when incorporating the Asset Identification data model into other data models.

- o If the target data model needs to include a list of assets and the associated relationships between the assets, then the ai:assets element SHOULD be included in the target data model. This will be the case when the target data model will make explicit references to assets in the asset list.
- o If the target data model needs to include a single asset, but other assets are needed to help identify that asset, then the ai:asset-related element SHOULD be included in the target data model. The @asset-ref attribute on ai:asset-related SHALL refer to the specific asset that is being identified.
- o If the target data model needs to include only a single asset, and no relationships are needed to identify that asset, then the element defining the asset MAY be included in the target data model. While this is allowed, it is preferred that the ai:asset-related element be included instead.

7. Asset Identification Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:ai="http://scap.nist.gov/schema/asset-identification/1.1"
  xmlns:core="http://scap.nist.gov/schema/reporting-core/1.1"
  xmlns:xal="urn:oasis:names:tc:ciq:xsdschema:xAL:2.0"
  xmlns:xnl="urn:oasis:names:tc:ciq:xsdschema:xNL:2.0"
  targetNamespace="http://scap.nist.gov/schema/asset-identification/1.1"
  elementFormDefault="qualified" attributeFormDefault="unqualified"
  version="1.1.1" xmlns:cpe-name="http://cpe.mitre.org/naming/2.0">
  <xs:annotation>
    <xs:appinfo>
      <schema>Asset Identification</schema>
      <author>David Waltermire, Adam Halbardier, John Wunder</author>
      <version>1.1.1</version>
      <date>2012-02-13</date>
    </xs:appinfo>
  </xs:annotation>
  <xs:import namespace="urn:oasis:names:tc:ciq:xsdschema:xAL:2.0"
    schemaLocation="http://docs.oasis-open.org/election/external/xAL.xsd" />
  <xs:import namespace="urn:oasis:names:tc:ciq:xsdschema:xNL:2.0"
    schemaLocation="http://docs.oasis-open.org/election/external/xNL.xsd" />
  <xs:import namespace="http://scap.nist.gov/schema/reporting-core/1.1"
    schemaLocation="http://scap.nist.gov/schema/reporting-core/1.1/reporting-core
_1.1.0.xsd" />
  <xs:import namespace="http://cpe.mitre.org/naming/2.0"
    schemaLocation="http://scap.nist.gov/schema/cpe/2.3/cpe-naming_2.3.xsd" />
  <!--The following elements are first-order citizens of this model-->
  <xs:element name="asset-related" type="ai:asset-identification-type">
    <xs:key name="assetRelKey">
      <xs:selector xpath="ai:asset" />
      <xs:field xpath="@id" />
    </xs:key>
    <xs:keyref refer="ai:assetRelKey" name="assetRelKeyRef">
      <xs:selector xpath="." />
      <xs:field xpath="@asset-ref" />
    </xs:keyref>
    <xs:keyref refer="ai:assetRelKey" name="assetRelRefSubjKeyRef">
      <xs:selector xpath="core:relationships/core:relationship" />
      <xs:field xpath="@subject" />
    </xs:keyref>
    <xs:keyref refer="ai:assetRelKey" name="assetRelRefObjKeyRef">
      <xs:selector xpath="core:relationships/core:relationship/core:ref" />
      <xs:field xpath="." />
    </xs:keyref>
  </xs:element>

```

```
</xs:element>
<xs:complexType name="asset-identification-type">
  <xs:complexContent>
    <xs:extension base="ai:assets-type">
      <xs:attribute name="asset-ref" type="xs:NCName" use="required"
        />
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
<xs:element name="assets" type="ai:assets-type">
  <xs:key name="assetsRelKey">
    <xs:selector xpath="ai:asset" />
    <xs:field xpath="@id" />
  </xs:key>
  <xs:keyref refer="ai:assetsRelKey" name="assetsRelRefSubjKeyRef">
    <xs:selector xpath="core:relationships/core:relationship" />
    <xs:field xpath="@subject" />
  </xs:keyref>
  <xs:keyref refer="ai:assetsRelKey" name="assetsRelRefObjKeyRef">
    <xs:selector xpath="core:relationships/core:relationship/core:ref" />
    <xs:field xpath="." />
  </xs:keyref>
</xs:element>
<xs:complexType name="assets-type">
  <xs:complexContent>
    <xs:extension base="core:relationships-container-type">
      <xs:sequence>
        <xs:element name="asset" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="ai:asset" />
            </xs:sequence>
            <xs:attribute name="id" type="xs:NCName" use="required">
              <xs:annotation>
                <xs:documentation>An internal ID to identify this
                  asset.</xs:documentation>
              </xs:annotation>
            </xs:attribute>
            <xs:anyAttribute namespace="##other">
              <xs:annotation>
                <xs:documentation>A placeholder so that content
                  creators can add attributes as
                  desired.</xs:documentation>
              </xs:annotation>
            </xs:anyAttribute>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
```

```
        </xs:extension>
      </xs:complexContent>
    </xs:complexType>
    <xs:element name="asset" type="ai:asset-type" abstract="true">
      <xs:annotation>
        <xs:documentation>Holds identifying attributes that are common to
          all assets.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="it-asset" type="ai:it-asset-type" abstract="true"
      substitutionGroup="ai:asset">
      <xs:annotation>
        <xs:documentation>Holds identifying attributes that are common to
          all IT assets</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="circuit" type="ai:circuit-type"
      substitutionGroup="ai:it-asset">
      <xs:annotation>
        <xs:documentation>Holds identifying attributes for a
          circuit.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="computing-device" type="ai:computing-device-type"
      substitutionGroup="ai:it-asset">
      <xs:annotation>
        <xs:documentation>Holds identifying attributes for a computing
          device.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="data" type="ai:data-type"
      substitutionGroup="ai:asset">
      <xs:annotation>
        <xs:documentation>A stub element to represent the identification
          of data. This element can be extended in the future for specific
          types of data.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="database" substitutionGroup="ai:it-asset"
      type="ai:database-type">
      <xs:annotation>
        <xs:documentation>Holds identifying attributes for a
          database.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="network" type="ai:network-type"
      substitutionGroup="ai:it-asset">
      <xs:annotation>
```

```
<xs:documentation>Holds identifying attributes for a
  network.</xs:documentation>
</xs:annotation>
</xs:element>
<!-- This element leverages the OASIS xNL specification which spells it as "org
anisation" -->
<xs:element name="organization" type="ai:organization-type"
  substitutionGroup="ai:asset">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for an
      organization.</xs:documentation>
    </xs:annotation>
  </xs:element>
<xs:element name="person" type="ai:person-type"
  substitutionGroup="ai:asset">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for a
      person.</xs:documentation>
    </xs:annotation>
  </xs:element>
<xs:element name="service" substitutionGroup="ai:it-asset"
  type="ai:service-type">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for a
      service.</xs:documentation>
    </xs:annotation>
  </xs:element>
<xs:element name="software" type="ai:software-type"
  substitutionGroup="ai:it-asset">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for a software
      installation</xs:documentation>
    </xs:annotation>
  </xs:element>
<xs:element name="system" type="ai:system-type"
  substitutionGroup="ai:it-asset">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for a
      system.</xs:documentation>
    </xs:annotation>
  </xs:element>
<xs:element name="website" substitutionGroup="ai:it-asset"
  type="ai:website-type">
  <xs:annotation>
    <xs:documentation>Holds identifying attributes for a
      website.</xs:documentation>
    </xs:annotation>
  </xs:element>
<!--The following types correspond directly to the elements above-->
```



```
<xs:complexType name="asset-type" abstract="true">
  <xs:sequence>
    <xs:element ref="ai:synthetic-id" minOccurs="0"
      maxOccurs="unbounded" />
    <xs:element ref="ai:locations" minOccurs="0" />
    <xs:element name="extended-information" minOccurs="0">
      <xs:annotation>
        <xs:documentation>This is a container to hold any additional
          identifying information for an asset, as specified by the
          content creator.</xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:sequence>
          <xs:any namespace="##other" processContents="lax"
            maxOccurs="unbounded" />
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
  <xs:attribute ref="ai:timestamp" />
</xs:complexType>
<xs:complexType name="it-asset-type" abstract="true">
  <xs:complexContent>
    <xs:extension base="ai:asset-type" />
  </xs:complexContent>
</xs:complexType>
<xs:complexType name="circuit-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element name="circuit-name" minOccurs="0">
          <xs:annotation>
            <xs:documentation>The common name for the
              circuit.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:simpleContent>
              <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
              </xs:extension>
            </xs:simpleContent>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

```
</xs:complexType>
<xs:complexType name="computing-device-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element name="distinguished-name" minOccurs="0">
          <xs:annotation>
            <xs:documentation>The full X.500 distinguished name for
              the device.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:simpleContent>
              <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
              </xs:extension>
            </xs:simpleContent>
          </xs:complexType>
        </xs:element>
        <xs:element ref="ai:cpe" minOccurs="0" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>The hardware CPE name for the device
              (CPE 2.2 URI or CPE 2.3 Formatted
              String).</xs:documentation>
          </xs:annotation>
        </xs:element>
        <xs:element name="connections" minOccurs="0">
          <xs:annotation>
            <xs:documentation>The IP network interface connections
              that exist for the device (regardless of if the network
              interface is connected to a network or
              not).</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:sequence>
              <xs:element name="connection"
                type="ai:network-interface-type" maxOccurs="unbounded">
                <xs:annotation>
                  <xs:documentation>An IP network interface
                    connection.</xs:documentation>
                </xs:annotation>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element minOccurs="0" ref="ai:fqdn" />
        <xs:element name="hostname" minOccurs="0">
```

```
<xs:annotation>
  <xs:documentation>The hostname of the computing
    device.</xs:documentation>
</xs:annotation>
<xs:complexType>
  <xs:simpleContent>
    <xs:extension base="ai:hostname-type">
      <xs:attribute ref="ai:source" />
      <xs:attribute ref="ai:timestamp" />
      <xs:anyAttribute namespace="##other" />
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
</xs:element>
<xs:element minOccurs="0" name="motherboard-guid">
  <xs:annotation>
    <xs:documentation>The motherboard globally unique
      identifier of the computing device.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="data-type">
  <xs:complexContent>
    <xs:extension base="ai:asset-type" />
  </xs:complexContent>
</xs:complexType>
<xs:complexType name="database-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element minOccurs="0" name="instance-name">
          <xs:annotation>
            <xs:documentation>The name of the database instance being
              identified.</xs:documentation>
          </xs:annotation>
        </xs:element>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

```
<xs:simpleContent>
  <xs:extension base="xs:token">
    <xs:attribute ref="ai:source" />
    <xs:attribute ref="ai:timestamp" />
    <xs:anyAttribute namespace="##other" />
  </xs:extension>
</xs:simpleContent>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="network-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element name="network-name" minOccurs="0">
          <xs:annotation>
            <xs:documentation>The name of the network as commonly
              referred to.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:simpleContent>
              <xs:extension base="xs:normalizedString">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
              </xs:extension>
            </xs:simpleContent>
          </xs:complexType>
        </xs:element>
        <xs:choice minOccurs="0">
          <xs:element name="ip-net-range">
            <xs:annotation>
              <xs:documentation>The start and end IP addresses to
                indicate the range of IP addresses covered by this
                network.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
              <xs:sequence>
                <xs:element name="ip-net-range-start"
                  type="ai:ip-address-type">
                  <xs:annotation>
                    <xs:documentation>The starting IP address in the
                      network.</xs:documentation>
                  </xs:annotation>
                </xs:element>
```

```
<xs:element name="ip-net-range-end"
  type="ai:ip-address-type">
  <xs:annotation>
    <xs:documentation>The ending IP address in the
      network.</xs:documentation>
  </xs:annotation>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="cidr">
  <xs:annotation>
    <xs:documentation>The classless inter-domain routing
      notation for the network.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="ai:cidr-type">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
</xs:choice>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="organization-type">
  <xs:complexContent>
    <xs:extension base="ai:asset-type">
      <xs:sequence>
        <xs:element ref="xnl:OrganisationNameDetails" minOccurs="0"
          maxOccurs="unbounded" />
        <xs:element ref="ai:email-address" minOccurs="0"
          maxOccurs="unbounded" />
        <xs:element ref="ai:telephone-number" minOccurs="0"
          maxOccurs="unbounded" />
        <xs:element ref="ai:website-url" minOccurs="0"
          maxOccurs="unbounded" />
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
<xs:complexType name="person-type">
  <xs:complexContent>
```

```
<xs:extension base="ai:asset-type">
  <xs:sequence>
    <xs:element ref="xnl:PersonName" minOccurs="0" />
    <xs:element ref="ai:email-address" minOccurs="0"
      maxOccurs="unbounded" />
    <xs:element ref="ai:telephone-number" minOccurs="0"
      maxOccurs="unbounded" />
    <xs:element name="birthdate" minOccurs="0">
      <xs:annotation>
        <xs:documentation>The birthdate of the
          person.</xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:simpleContent>
          <xs:extension base="xs:date">
            <xs:attribute ref="ai:source" />
            <xs:attribute ref="ai:timestamp" />
            <xs:anyAttribute namespace="##other" />
          </xs:extension>
        </xs:simpleContent>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="service-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element minOccurs="0" name="host">
          <xs:annotation>
            <xs:documentation>The hostname or IP address where the
              service is hosted.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:choice>
              <xs:element ref="ai:fqdn" />
              <xs:element ref="ai:ip-address" />
            </xs:choice>
          </xs:complexType>
        </xs:element>
        <xs:element name="port" maxOccurs="unbounded" minOccurs="0">
          <xs:annotation>
            <xs:documentation>The port to which the service is
              bound.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
```

```
<xs:simpleContent>
  <xs:extension base="ai:port-type">
    <xs:attribute ref="ai:source" />
    <xs:attribute ref="ai:timestamp" />
    <xs:anyAttribute namespace="##other" />
  </xs:extension>
</xs:simpleContent>
</xs:complexType>
</xs:element>
<xs:element name="port-range" maxOccurs="unbounded"
  minOccurs="0">
  <xs:annotation>
    <xs:documentation>The inclusive port range to which the
      service is bound.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:attribute name="lower-bound" type="ai:port-type"
      use="required" />
    <xs:attribute name="upper-bound" type="ai:port-type"
      use="required" />
    <xs:attribute ref="ai:source" />
    <xs:attribute ref="ai:timestamp" />
    <xs:anyAttribute namespace="##other" />
  </xs:complexType>
</xs:element>
<xs:element name="protocol" minOccurs="0">
  <xs:annotation>
    <xs:documentation>The protocol used to interact with the
      service.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="software-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
```

```
<xs:element name="installation-id" minOccurs="0">
  <xs:annotation>
    <xs:documentation>Any identifier for the software instance
      (installation)</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="xs:token">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
<xs:element ref="ai:cpe" minOccurs="0">
  <xs:annotation>
    <xs:documentation>The CPE name for the software (CPE 2.2
      URI or CPE 2.3 Formatted String).</xs:documentation>
  </xs:annotation>
</xs:element>
<xs:element name="license" minOccurs="0" maxOccurs="unbounded">
  <xs:annotation>
    <xs:documentation>The license key for the
      software.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="system-type">
  <xs:complexContent>
    <xs:extension base="ai:it-asset-type">
      <xs:sequence>
        <xs:element name="system-name" minOccurs="0"
          maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>The name of the system. It is possible
```



```
        that a system have multiple names, or even abbreviated
        names. Each one of those names may be captured
        here.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element name="version" minOccurs="0">
    <xs:annotation>
        <xs:documentation>The version of the
            system.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="website-type">
    <xs:complexContent>
        <xs:extension base="ai:it-asset-type">
            <xs:sequence>
                <xs:element name="document-root" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The absolute path to the document root
                            location of the website on the host.</xs:documentation>
                    </xs:annotation>
                    <xs:complexType>
                        <xs:simpleContent>
                            <xs:extension base="xs:token">
                                <xs:attribute ref="ai:source" />
                                <xs:attribute ref="ai:timestamp" />
                                <xs:anyAttribute namespace="##other" />
                            </xs:extension>
                        </xs:simpleContent>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

```

        </xs:extension>
      </xs:simpleContent>
    </xs:complexType>
  </xs:element>
  <xs:element name="locale" minOccurs="0">
    <xs:annotation>
      <xs:documentation>The locale of the website represented as
        an RFC 5646 language, and optionally, region
        code.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:simpleContent>
        <xs:extension base="ai:locale-type">
          <xs:attribute ref="ai:source" />
          <xs:attribute ref="ai:timestamp" />
          <xs:anyAttribute namespace="##other" />
        </xs:extension>
      </xs:simpleContent>
    </xs:complexType>
  </xs:element>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<!--The follow elements support the first-order citizen elements defined above-->
<xs:element name="cpe">
  <xs:annotation>
    <xs:documentation>A Common Platform Enumeration (CPE) name (CPE
      2.2 URI or CPE 2.3 Formatted String).</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="ai:cpe-type">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
<xs:element name="synthetic-id">
  <xs:annotation>
    <xs:documentation>Holds the synthetic ID for the
      asset</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:attribute name="resource" type="xs:anyURI" use="required">
      <xs:annotation>

```

```

    <xs:documentation>The namespace governing this synthetic
        ID.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="id" type="xs:token" use="required">
    <xs:annotation>
        <xs:documentation>The ID of the asset within the resource
            namespace.</xs:documentation>
    </xs:annotation>
</xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="email-address">
    <xs:annotation>
        <xs:documentation>An email address</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element name="fqdn">
    <xs:annotation>
        <xs:documentation>The fully qualified domain name for the
            object.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:token">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element name="ip-address" type="ai:ip-address-type">
    <xs:annotation>
        <xs:documentation>An IP address</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="location" abstract="true" />
<xs:element name="location-address" type="xal:AddressDetails"
```

```
substitutionGroup="ai:location">
  <xs:annotation>
    <xs:documentation>The address where an asset is
      located.</xs:documentation>
  </xs:annotation>
</xs:element>
<xs:element name="location-point" substitutionGroup="ai:location">
  <xs:annotation>
    <xs:documentation>The geographic point where an asset is
      located.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:attribute name="latitude" use="required">
      <xs:annotation>
        <xs:documentation>The latitude of the asset, defined between
          -90 (90 degrees South, inclusive) and 90 (90 degrees North,
            inclusive).</xs:documentation>
      </xs:annotation>
      <xs:simpleType>
        <xs:restriction base="xs:double">
          <xs:minInclusive value="-90" />
          <xs:maxInclusive value="90" />
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="longitude" use="required">
      <xs:annotation>
        <xs:documentation>The longitude of the asset, defined between
          -180 (180 degrees West, exclusive) and 180 (180 degrees
            East, inclusive).</xs:documentation>
      </xs:annotation>
      <xs:simpleType>
        <xs:restriction base="xs:double">
          <xs:minExclusive value="-180" />
          <xs:maxInclusive value="180" />
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="elevation" type="xs:double">
      <xs:annotation>
        <xs:documentation>The elevation of the asset, specified in
          meters from sea level.</xs:documentation>
      </xs:annotation>
    </xs:attribute>
    <xs:attribute name="radius">
      <xs:annotation>
        <xs:documentation>The radius of a horizontal circle centered
          on the point within which the asset
```

```
        resides.</xs:documentation>
      </xs:annotation>
      <xs:simpleType>
        <xs:restriction base="xs:double">
          <xs:minInclusive value="0" />
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute ref="ai:source" />
    <xs:attribute ref="ai:timestamp" />
    <xs:anyAttribute namespace="##other" />
  </xs:complexType>
</xs:element>
<xs:element name="location-region" substitutionGroup="ai:location">
  <xs:annotation>
    <xs:documentation>The region where an asset is
      located.</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:simpleContent>
      <xs:extension base="xs:normalizedString">
        <xs:attribute ref="ai:source" />
        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:element>
<xs:element name="locations">
  <xs:annotation>
    <xs:documentation>One or more locations where this asset
      resides</xs:documentation>
  </xs:annotation>
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="ai:location" maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>The base for a substitution group for
            elements that contain location
            information.</xs:documentation>
        </xs:annotation>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="served-by" type="ai:service-type">
  <xs:annotation>
    <xs:documentation>The service that is serving up the
```

```
        asset.</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="telephone-number">
    <xs:annotation>
        <xs:documentation>The telephone number. For a North American
            number, the number must be valid and the format must be
            XXX-XXX-XXXX where X is a digit. For an international number,
            the number must begin with a '+' symbol, followed by 7 to 15
            digits. A space may be used between digits, as appropriate. For
            example: +88 888 888 8 (this is following the ITU-T E.123
            notation).</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="ai:telephone-number-type">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element name="website-url">
    <xs:annotation>
        <xs:documentation>The URL to the website.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:anyURI">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<!--The following types support the supporting elements above-->
<xs:attribute name="source" type="xs:string">
    <xs:annotation>
        <xs:documentation>Contains the source of the information. The
            value of this field is left open to the content producer, but
            MAY include a synthetic ID of the asset which sourced the
            information, another ID of the source, or a description of the
            source.</xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="timestamp" type="xs:dateTime">
```

```
<xs:annotation>
  <xs:documentation>Indicates when the data was last known to be
    correct.</xs:documentation>
</xs:annotation>
</xs:attribute>
<xs:complexType name="ip-address-type">
  <xs:sequence>
    <xs:element name="ip-v4" minOccurs="0">
      <xs:complexType>
        <xs:simpleContent>
          <xs:extension base="ai:ipv4-type">
            <xs:attribute ref="ai:source" />
            <xs:attribute ref="ai:timestamp" />
            <xs:anyAttribute namespace="##other" />
          </xs:extension>
        </xs:simpleContent>
      </xs:complexType>
    </xs:element>
    <xs:element name="ip-v6" minOccurs="0">
      <xs:complexType>
        <xs:simpleContent>
          <xs:extension base="ai:ipv6-type">
            <xs:attribute ref="ai:source" />
            <xs:attribute ref="ai:timestamp" />
            <xs:anyAttribute namespace="##other" />
          </xs:extension>
        </xs:simpleContent>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:complexType>
<xs:complexType name="network-interface-type">
  <xs:sequence>
    <xs:element ref="ai:ip-address" minOccurs="0">
      <xs:annotation>
        <xs:documentation>The IP address for this network
          interface.</xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:element name="mac-address" minOccurs="0">
      <xs:annotation>
        <xs:documentation>The MAC address associated with this network
          interface.</xs:documentation>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
  <xs:simpleContent>
    <xs:extension base="ai:mac-address-type">
      <xs:attribute ref="ai:source" />
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>
```

```

        <xs:attribute ref="ai:timestamp" />
        <xs:anyAttribute namespace="##other" />
    </xs:extension>
</xs:simpleContent>
</xs:complexType>
</xs:element>
<xs:element name="url" minOccurs="0" maxOccurs="unbounded">
    <xs:annotation>
        <xs:documentation>A URL in a relevant DNS server for this IP
            address.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
        <xs:simpleContent>
            <xs:extension base="xs:anyURI">
                <xs:attribute ref="ai:source" />
                <xs:attribute ref="ai:timestamp" />
                <xs:anyAttribute namespace="##other" />
            </xs:extension>
        </xs:simpleContent>
    </xs:complexType>
</xs:element>
<xs:element name="subnet-mask" type="ai:ip-address-type"
    minOccurs="0">
    <xs:annotation>
        <xs:documentation>The subnet mask address for this network
            interface.</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="default-route" type="ai:ip-address-type"
    minOccurs="0">
    <xs:annotation>
        <xs:documentation>The IP address for the default gateway of
            this connection.</xs:documentation>
    </xs:annotation>
</xs:element>
</xs:sequence>
</xs:complexType>
<xs:simpleType name="cidr-type">
    <xs:restriction base="xs:token">
        <xs:pattern
            value="([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))\.([0-9]|[1-9]
            |[0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))\.([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-
            4][0-9]|5[0-5]))\.([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))/([0-9]|[1
            -2][0-9]|3[0-2])"
            />
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="cpe-type">
    <xs:union memberTypes="cpe-name:cpe22Type cpe-name:cpe23Type" />
</xs:simpleType>
<xs:simpleType name="hostname-type">

```



```

    <xs:restriction base="xs:token">
      <xs:pattern value="[\w\-\-]+(\.[\w\-\-]+){0,}" />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="ipv4-type">
    <xs:restriction base="xs:token">
      <xs:pattern
        value="([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))\.([0-9]|[1-9]
        |[0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))\.([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-
        4][0-9]|5[0-5]))\.([0-9]|[1-9][0-9]|1([0-9][0-9])|2([0-4][0-9]|5[0-5]))"
        />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="ipv6-type">
    <xs:restriction base="xs:token">
      <xs:pattern value="([0-9a-fA-F]{1,4}:){7}[0-9a-fA-F]{1,4}" />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="locale-type">
    <xs:restriction base="xs:token">
      <xs:pattern value="[a-zA-Z]{2,3}(-([a-zA-Z]{2}|[0-9]{3}))?" />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="mac-address-type">
    <xs:restriction base="xs:token">
      <xs:pattern value="([0-9a-fA-F]{2}:){5}[0-9a-fA-F]{2}" />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="port-type">
    <xs:restriction base="xs:integer">
      <xs:minInclusive value="0" />
      <xs:maxInclusive value="65535" />
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="telephone-number-type">
    <xs:restriction base="xs:token">
      <xs:pattern
        value="((([2-9][0-8]\d-[2-9]\d{2}-[0-9]{4})|(\+([0-9] ?){6,14}[0-9]))"
        />
    </xs:restriction>
  </xs:simpleType>
</xs:schema>

```

8. IANA Considerations

This document uses URNs to describe an XML namespace and schema conforming to a registry mechanism described in [RFC3688].

Registration for the IODEF namespace:

- o URI: urn:ietf:params:xml:ns:asset-identification-1.0
- o Registrant Contact: See the first author of the "Author's Address" section of this document.
- o XML: None. Namespace URIs do not represent an XML specification.
- o URI: urn:ietf:params:xml:schema:asset-identification-1.0
- o Registrant Contact: see the first author of the "Author's Address" section of this document.
- o XML: See the "Asset Identification Schema" in ietf-montville-sacm-asset-identification-00.

9. Security Considerations

As a data format, Asset Identification does not intrinsically have any real security concerns - at least none are known at this time. However, as a data format designed to be stored and transmitted between entities within an enterprise, the fact of the matter is that it SHOULD be used within a properly secured environment. Over time, a significant amount of information valuable to attackers can be gleaned from Asset Identification information (i.e. derived topology, asset purpose and criticality, to name just two). Therefore, it is recommended that use of Asset Identification expressions be performed in environments providing communication security mechanisms supplying the properties of confidentiality, data integrity, and non-repudiation. For example, transmission over a properly configured TLS connection would be better than being sent in the clear with no protection.

10. References

10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2396] Berners-Lee, T., Fielding, R., and L. Masinter, "Uniform Resource Identifiers (URI): Generic Syntax", RFC 2396, August 1998.
- [RFC5646] Phillips, A. and M. Davis, "Tags for Identifying Languages", BCP 47, RFC 5646, September 2009.
- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, January 2004.
- [CPE23] "NIST Interagency Report 7695, Common Platform Enumeration: Naming Specification Version 2.3", April 2011.
- [ILSR] "IANA Language Subtag Registry".
- [XAL] "Organization for the Advancement of Structured Information Standards (OASIS) Extensible Address Language (xAL) Version 2.0", July 2002.
- [XNL] "Organization for the Advancement of Structured Information Standards (OASIS) Extensible Naming Language (xNL) Version 2.0", May 2002.
- [IR7693] Wunder, J., Halbardier, A., and D. Waltermire, "Specification for Asset Identification 1.1", June 2011.

10.2. Informative References

- [CPE22] "Common Platform Enumeration (CPE) Specification Version 2.2", March 2009.

Appendix A. Acknowledgements

Special thanks go to John Wunder, Adam Halbardier, and David Waltermire, and those others who participated in the definition of the Asset Identification Specification version 1.1 [IR7693]

Appendix B. Use Cases

The following use cases describe some common asset management processes that rely on the ability to uniquely identify assets. The asset identification specification was developed primarily in order to support these use cases, although the specification may be useful for other processes or uses.

B.1. Correlation of Sensed Data

Sensor data is not limited to an automated process: user surveys, manually entered information, and other data may also be correlated using this Asset Identification specification. The data must be correlated both with other manually collected data and with data collected by automated sensors, in order to build a complete representation of all known data about an asset.

Consistent asset identification allows data to be correlated regardless of:

- o Collection timeframe
- o Data type (vulnerability scan vs. user survey)
- o Manual or automated process
- o Data format

In this case, the goal of asset identification is to provide as much identifying information as possible about an asset in order to ensure the greatest probability of matching asset data from several different sources. Constraining which data is provided merely reduces the possibility of a match.

B.2. Federation of Asset Databases

While many smaller organizations may only have a single asset database, larger organizations with many asset databases may wish to share information about assets among them. This includes:

- o Peer to peer relationships, where asset data is replicated and fused between several asset databases
- o Hierarchical relationships, where an asset database is aggregated from several lower-level databases into fewer higher-level databases

In both use cases, asset identification facilitates detection of

duplicate asset representations, correlation of asset data across the databases, and direct queries for asset data among tools.

In this use case, asset databases may wish to use a smaller set of data, or even a single identifier, in order to properly federate the asset data. For example, use of the motherboard GUID or single synthetic ID, such as an asset tag, may be sufficient to allow asset databases to exchange information about assets.

B.3. Directly Targeted Remediation Actions

While assessment and sensor data may be collected from all assets in a particular organization environment without specifically identifying a particular asset identifier, remediation actions require a more granular identification process that directly targets the asset using identification data. This ensures that unintended side effects are avoided and the intended remediation action is able to be completed successfully.

A single agent identifier or motherboard GUID allows those triggering remediation actions to specify exactly which assets should have the remediation applied and allows the tools to unambiguously identify those assets in the remediation control language.

B.4. Management of Asset Data

Outside of the collection of sensor data and federation of asset databases, asset data may be used in a variety of management processes. This includes both further processing of asset data, such as aggregation for the purposes of metrics collection, and display to an end user. Both of these uses require asset identification be present to ensure all systems are able to accurately represent the correct assets. For purposes of aggregation, for example, asset identification may be used to request detailed data about outliers from the sensors that collected the data.

Appendix C. Extending the Asset Identification Specification

Although the core Asset Identification specification should satisfy most users, some organizations may find that there are weaknesses or missing elements in the specification. In these cases, the organization may extend the Asset Identification specification by extending the XML schema that defines the data model. These extensions should be published as an XML schema to ensure that both schema extensions and instance documents are valid.

C.1. Additional Asset Types

Some organizations may wish to identify assets that are not contained in the valid asset list as defined in Section 5.3. To do this, additional XML elements can be defined that extend (using the XSD extension mechanism) an appropriate asset type (best practices entail using the most specific asset type that captures the necessary elements). Additional identification fields can be defined in the schema and additional relationships can be defined by creating new relationship types in a non-core controlled vocabulary.

C.2. Additional Literal Identifiers for Existing Asset Types

Additional literal identifiers for existing asset types may be added by creating schema elements in the extended-information element. Although there is no technical restriction of these fields to literal identifiers (i.e. information that is used to identify the asset), placing information in an asset element that does not help identify the asset is counter to the purpose of this specification.

C.3. Additional Relationships

Organizations may also wish to identify existing or new asset types using relationships that are not defined in the core specification. This may be accomplished by defining and publishing a relationship vocabulary in a separate namespace than the core Asset Identification relationship vocabulary.

C.4. Additional Properties on Existing Data Elements

The XML schema also provides extension points on most XML elements to allow for tracking metadata about Asset Identification information, such as classification level, sensitivity, or other organization-specific data. As long as Asset Identification elements are able to validate against the core schema and conform to the requirements of this specification, these extensions and the Asset Identification elements are valid.

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