

IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Maintenance Action Information via the Extensible Markup Language (XML)

IEEE Standards Coordinating Committee 20

Sponsored by the
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Test and Diagnosis for Electronic Systems

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IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Maintenance Action Information via the Extensible Markup Language (XML)

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**IEEE Standards Coordinating Committee 20 on
Test and Diagnosis for Electronic Systems**

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Abstract: Interoperability between components of automatic test systems (ATS) is promoted and facilitated. The standard facilitates the capture of maintenance action information (MAI) associated with the removal, repair, and replacement of a particular system component (e.g., unit(s) under test) in order to maintain/support that particular operational system. The MAI schema becomes a class of information that can be used within the SIMICA family of standards. The exchange format utilizes the XML formats.

Keywords: automated test system (ATS), eXtensible markup language (XML), IEEE 1636.2, maintenance action information (MAI), Software Interface for Maintenance Information Collection and Analysis (SIMICA), XML schema

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Introduction

This introduction is not part of IEEE Std 1636.2-2010, IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Maintenance Action Information via the Extensible Markup Language (XML).

Maintainers of complex systems require the ability to capture and share the maintenance action information (MAI) in a way that supports such activities as performance analysis, post production product improvement, maintenance process improvement, and diagnostic maturation. Principal stakeholders of this project include but are not limited to maintenance organizations within various departments/ministries of defense, the commercial airlines, the automotive industry, and the telecommunications industry. This standard is being developed as a component of the IEEE 1636™ SIMICA project. SIMICA's purpose is to specify a software interface for access, exchange, and analysis of product diagnostic and maintenance information. MAI provides a subset of the data needed to satisfy SIMICIA requirements.

The use of formal information models will facilitate exchanging historical maintenance information between information systems and analysis tools. The models will facilitate creating open system software architectures for maturing system diagnostics.

The XML schema described in this standard where appropriate utilizes and references components of the IEEE 1671™ schema set.

It is anticipated that these schemas will be used throughout industries that utilize diagnostic and maintenance data as an exchange format that can be understood by humans or machines. In order to ensure wide acceptance throughout the user community, the schemas have been designed to encompass a broad range of use cases. To accommodate use cases beyond the released design, the schemas provide means for user extensibility.

It is anticipated that the IEEE 1636.2 schema will be used throughout the automatic test equipment (ATE) industry as an exchange format that can be understood by humans or machines. In order to ensure wide acceptance throughout the user community, the schemas have been designed to encompass a broad range of use cases.

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Contents

1. Overview	1
1.1 Scope	1
1.2 Purpose	1
1.3 General	2
1.4 Application	2
1.5 Conventions used in this standard	2
2. Normative references	3
3. Definitions, acronyms, and abbreviations	4
3.1 Definitions	4
3.2 Acronyms and abbreviations	4
4. Maintenance action information schema	5
4.1 General	5
4.2 Elements	5
4.3 Complex types	11
5. Conformance	16
6. Extensibility	16
Annex A (normative) Maintenance action information model	17
A.1 AssociatedTestEvent	17
A.2 Code	18
A.3 FailureCode	18
A.4 Observation	18
A.5 ParameterValue	18
A.6 Qualifier	18
A.7 RelativeSkill	19
A.8 SequenceCode	19
A.9 Category	19
A.10 MaintenanceActionValue	20
A.11 MaintenanceType	20
A.12 EquipmentDescription	20
A.13 Equipment	20
A.14 InstallAction	21
A.15 Maintainer	21
A.16 MaintenanceAction	22
A.17 MaintenanceActionInformation	23
A.18 MaintenanceActionStatus	24
A.19 MaintenanceDelay	24
A.20 MaintenanceEvent	25
A.21 NoAction	26
A.22 Parameter	26
A.23 Reason	27
A.24 RemoveAction	28
A.25 RepairAction	28
A.26 Resource	28
A.27 TestResult	29
A.28 MAI model EXPRESS-G diagrams	30

Annex B (normative) SimicaCommon XML schema	34
B.1 Schema—SimicaCommon.xsd	34
Annex C (normative) SIMICA common information model	43
C.1 Abbreviation	43
C.2 AddressComponent.....	43
C.3 Date.....	43
C.4 DateTime	44
C.5 DescriptionType.....	44
C.6 Duration	44
C.7 EmailAddress.....	44
C.8 Exclusion	45
C.9 Identifier.....	45
C.10 IdentifierType	45
C.11 NameType.....	45
C.12 SequenceCode.....	45
C.13 PhoneNumber	46
C.14 URL	46
C.15 Uuid	46
C.16 Version.....	46
C.17 DescriptionOrReference.....	46
C.18 Contact.....	47
C.19 DiagnosticContextModel	47
C.20 Document.....	48
C.21 HardwareInstance	48
C.22 IdentificationNumber	49
C.23 ItemDescription.....	49
C.24 MailingAddress.....	49
C.25 MaintenanceLevel.....	50
C.26 ManufacturerIdNumber	51
C.27 Organization.....	51
C.28 Person.....	52
C.29 PowerOn	52
C.30 QualifiedIdNumber	52
C.31 SoftwareInstance.....	53
C.32 SystemInstance	53
C.33 TestResultsAndSessionInformation.....	55
C.34 Warranty	55
C.35 WorkOrder.....	56
C.36 SIMICA COMMON Model EXPRESS-G diagrams	57
Annex D (informative) Maintenance Action Information instance documents (.XML files) and user examples.....	61
D.1 Maintenance Action Information instance documents (.XML files)	61
D.2 User examples.....	62
Annex E (informative) Bibliography.....	66

IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Maintenance Action Information via the Extensible Markup Language (XML)

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1. Overview

1.1 Scope

The scope of this standard is the definition of an exchange format, utilizing XML, for exchanging maintenance action information (MAI) associated with the removal, repair, and replacement of system components to maintain/support an operational system.

1.2 Purpose

The purpose of this standard is to promote and facilitate interoperability between components of a test system and applications in a maintenance environment where MAI needs to be shared. The standard will facilitate the capture and exchange of unit under test (UUT) specific maintenance information, facilitating online and offline analysis of the maintenance process. The maintenance action schema defines a class of information to be used within the SIMICA family of standards.

1.3 General

This standard, which is a component of the Software Interface for Maintenance Information Collection and Analysis (SIMICA) standard, was developed by the Diagnostic and Maintenance Control Subcommittee of the IEEE Standards Coordinating Committee 20 (SCC20) on Test and Diagnosis for Electronic Systems to provide standard, unambiguous definitions of maintenance information semantics and interrelationships.

This standard specifically describes a set of formal specifications consisting of the logical representation of the information that is used and generated during related diagnostic and maintenance processes. The information model contained in this document provides a normative formal specification of the information concepts and precise semantics that support the unambiguous exchange of information between producers and consumers of historical diagnosis and maintenance information in a platform independent manner.

The schemas described in this standard are intended to document the maintenance actions and events associated with the removal, repair, and replacement of system components required to maintain and support an operational system. This information can be used to support policies, procedures, and designs resulting from the analysis of associated maintenance actions and diagnostics. The *express* schema in this standard is based on ISO 10303-11:1994 [B2].¹ The XML schema associated with this standard is based on the W3C Extensible Markup Language (XML) 1.0 [B1].

1.4 Application

This standard provides a specification for information required in the development of shared maintenance data and the results of testing. Anticipated users of this standard include the following:

- a) System developers
- b) System maintainers
- c) Test program set (TPS) developers
- d) TPS maintainers
- e) Automatic test equipment (ATE) system developers
- f) ATE system maintainers
- g) Test instrument developers
- h) Developers of automatic test markup language (ATML)-based tools and systems
- i) Developers of prime mission equipment that use the supported UUT as a component
- j) Reliability, maintainability, and diagnostic analytical applications

1.5 Conventions used in this standard

1.5.1 General

All simple and complex types, attribute groups, and elements will be listed; explanatory information will be provided, along with examples if additional clarification is needed. The explanatory information shall include information on the intended use of the elements and/or attributes where the name of the entity does not clearly indicate its intended use. For elements derived from another source type (e.g., an abstract type),

¹ The numbers in brackets correspond to those of the bibliography in Annex E.

only attributes that extend the source type shall be listed; details regarding the base type shall be listed along with the base type.

The namespace prefix “c:” identifies that the type or attribute group is contained in Annex B of IEEE Std 1671-2006 (Schema-Common.xsd).²

When referring to an attribute of an XML element, the convention of *[element]@[attribute]* shall be used. In cases where an attribute name is referred to with no associated element, the attribute name shall be enclosed in single quotes. Element and type names shall always be italicized when appearing in text.

In tables that describe XML elements, the column “Use” indicates the occurrence constraints for each element. Other terms are as follows:

- a) “Required” indicates that the element shall appear exactly once
- b) “Optional” indicates that the attribute may appear once or not at all
- c) “1..∞” indicates that the element shall appear at least once and may appear multiple times
- d) “0..∞” indicates that the element may appear multiple times, once, or not at all

All specifications for the EXPRESS language are given in the `Courier` type font, which includes references to entity and attribute names in the supporting text.

1.5.2 Word usage

In this document, the word *shall* is used to indicate a mandatory requirement. The word *should* is used to indicate a recommendation. The word *may* is used to indicate a permissible action. The word *can* is used for statements of possibility and capability.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 1232TM-2002, IEEE Standard for Artificial Intelligence Exchange and Service Tie to All Test Environments (AI-ESTATE).^{3, 4}

IEEE Std 1636TM-2009, IEEE Trial-Use Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA).

IEEE Std 1636.1TM-2007, IEEE Trial-Use Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Test Results and Session Information via the Extensible Markup Language (XML).

IEEE Std 1671TM-2006, IEEE Trial-Use Standard for Automatic Test Markup Language (ATML) for Exchanging Automatic Test Equipment and Test Information via XML.

² Information on references can be found in Clause 2.

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IEEE Std 1671.3™-2007, IEEE Trial-Use Standard for Automatic Test Markup Language (ATML) for exchanging Automatic Test Information via Extensible Markup Language (XML): Exchanging Unit Under Test (UUT) Description Information.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.⁵

framework: A framework is a real or conceptual structure expressed as a set of abstract classes. The framework provides a context for the components to be used.

instance document: A textual information set grouped for some purpose that is governed by a single XML schema.

maintenance: Activity intended to keep equipment (hardware) or programs (software) in satisfactory working condition, including replacements, adjustments, repairs, software/firmware updates, and program improvements. Maintenance can be preventative or corrective.

NOTE—Adapted from MIL-STD-1309D [B3].

sequence: sequence (in XML schema): A compositor for model group schema components that specifies that subordinate elements in an instance document must correspond, in order, to the specified particles.

3.2 Acronyms and abbreviations

AI-ESTATE	Artificial Intelligence Exchange and Service Tie to All Test Environments
ATE	automatic test equipment
ATML	automatic test markup language
ATS	automatic test system
MAI	maintenance action information
SIMICA	Software Interface for Maintenance Information Collection and Analysis
URL	uniform resource locator
UUID	universally unique identifier
UUT	unit under test
XML	eXtensible Markup Language

⁵ *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

4. Maintenance action information schema

4.1 General

The MAI schema formally defines the structure (model) and constraints for expressing MAI XML documents. This schema defines rules that can be used for document generation and data validation, and is an essential requirement to ensure the effective use of data in an open system environment and aids in the reuse and interoperability of maintenance data elements derived from this schema.

This schema is arranged in a hierarchical (element) approach, which consists of simple and complex data types. The structure was created to help illustrate the intended semantic interpretation of the data based on the conceptual relationships of maintenance action elements.

All elements in this document with a base type from SimicaCommon. “sc:” identifies that type or attribute group that can be found in Annex B.

All elements in this document with a base type from Common “c:” identifies that type or attribute group that can be found in IEEE Std 1671-2006, Annex B. These entities are not listed within this document.

Elements are defined through the description of their attributes and child elements. Where an element has hierarchy, the element and its associated child elements are shown in a figure in Clause 4. The Clause 4 figures show a hierarchal layout of the schema structure and illustrate the XML types (both simple and complex) that comprise the element. Within the Clause 4 figures, the “solid lined boxes” indicate that the XML type shall be required, while “dotted lined boxes” indicate that the XML type may be used (optional). Where the child element has hierarchy, details of the child elements will follow in the appropriate clauses.

4.2 Elements

4.2.1 MaintenanceActionInformation root (or document)

There is exactly one element, called the *root* or *document element*, of which no part appears in the content of any other element. This root element serves as the parent for all other elements of the MaintenanceActionInformation schema.

The MaintenanceActionInformation schema root element is defined as follows:

Name	Set to
Attribute form Default	unqualified (see Note 1)
Element form Default	qualified (see Note 2)
Encoding	UTF-8 (Unicode Transformation Format)
Included schema	None
Imported schema	urn:IEEE-1636-2009:SimicaCommon
Imported schema	urn:IEEE-1671:2006:Common
Target Namespace	urn: IEEE-1636.2:2010:MaintenanceActionInformation
Version	1.00
XML Schema Namespace Reference	^a
NOTE 1—Specifies that attributes in XML instance documents are unqualified with the namespace of the XML schema in which they are defined.	
NOTE 2—Specifies that elements in XML instance documents are qualified with the namespace of the XML schema in which they are defined.	

^a Set to: <http://www.w3.org/2001/XMLSchema>.

4.2.2 MaintenanceActionInformation

Properties: isRef 0, content complex

The *MaintenanceActionInformation* element defines the information associated with actions required for the maintenance of a product at a specific level of maintenance or at a repair facility.

Figure 1 shows a hierarchal layout of the element structure and illustrates the XML complex types that comprise the *MaintenanceActionInformation* element.

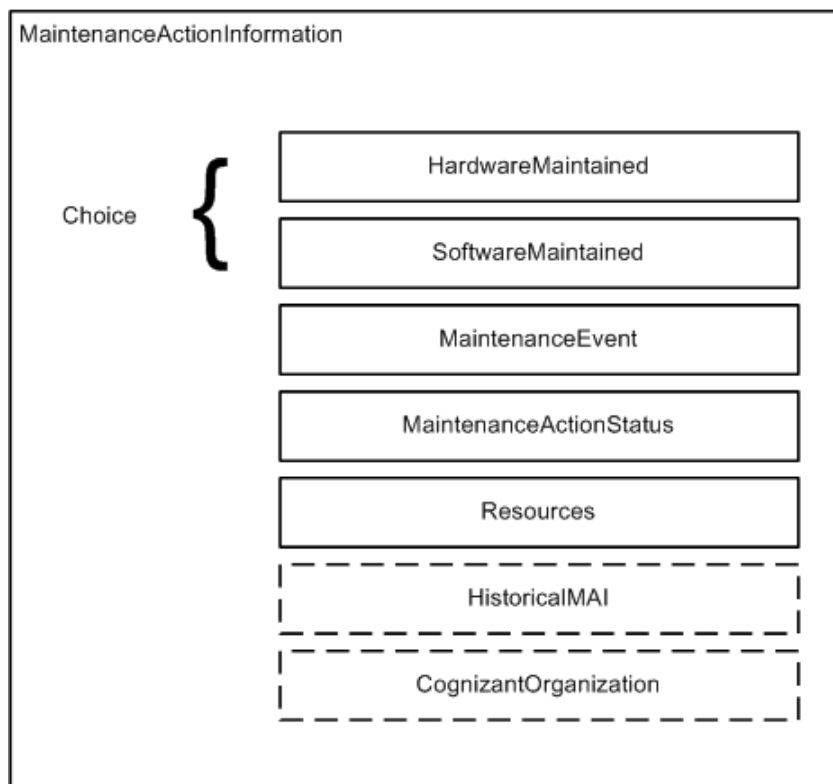


Figure 1—MaintenanceActionInformation element

4.2.2.1 Attributes

The *MaintenanceActionInformation* element contains the following attributes:

Name	Type	Description	Use
maintenanceDuration	xs:duration	Indicates the actual duration of the entire process associated with the maintenance action.	Required
maintenanceStartTime	xs:dateTime	Provides the date and time when maintenance was initiated.	Required
parentUuid	c:Uuid	Reference to the parent MaintenanceActionInformation.	Optional
uuid	c:Uuid	Uniquely identifies the MAI instance document.	Required

4.2.2.2 Child elements

The *MaintenanceActionInformation* element contains the following child elements:

	Name	Type	Description	Use
	CognizantOrganization	c:Organization	Organization that is responsible for the system.	Optional
	WorkOrder	sc:WorkOrder	See B.1.2.18	Required
Choice	HardwareMaintained	sc:HardwareInstance	See 4.2.3	Required
	SoftwareMaintained	sc:SoftwareInstance	See 4.2.8	
	HistoricalMAI	c:DocumentReference	Reference to the instance of the MAI document from the prior maintenance action for this UUT.	0..∞
	MaintenanceActionStatus	—	See 4.2.4	Required
	MaintenanceEvent	—	See 4.2.5	Required
	ResourcesUtilized	—	See 4.2.7	Required

Choice indicates that one of these elements shall be included.

4.2.2.3 Key and key references

The *MaintenanceActionInformation* element contains the following key and key references:

Name	Type	Refers	Selector	Fields
personKey	key	—	../mai:ResourcesUtilized/mai:Personnel	@name
personRef	keyref	mai:personKey	../mai:PersonAssigned	@name

4.2.3 MaintenanceActionInformation/ HardwareMaintained

Base type: *sc:HardwareInstance*

Properties: isRef 0, content complex

The *MaintenanceActionInformation/HardwareMaintained* element supports the case where the object of maintenance is a hardware component.

4.2.3.1 Attributes

The *MaintenanceActionInformation/HardwareMaintained* element contains no attributes.

4.2.3.2 Child elements

The *MaintenanceActionInformation/HardwareMaintained* element contains the following element in addition to those inherited from *sc:HardwareInstance*.

Name	Type	Description	Use
ItemMaintained	mai:ItemMaintained	Refers to the actual repair item as described in an associated IEEE 1232 XML document.	Optional
Warranty	sc:Warranty	Defines a manufacturer's legal responsibility for the support of a given system or item	0..∞

4.2.4 MaintenanceActionInformation/MaintenanceActionStatus

Properties: isRef 0, content complex

The *MaintenanceActionInformation/MaintenanceActionStatus* element describes the state of the UUT resulting from maintenance tasks performed on it.

4.2.4.1 Attributes

The *MaintenanceActionInformation/MaintenanceActionStatus* element contains the following attributes:

Name	Type	Description	Use
resultQualifier	c:NonBlankString	Defines an application-specific string to provide additional details about an associated attribute of the parent entity.	Optional
resultStatus	c:NonBlankString	Indicates the result or outcome of a maintenance action that has been performed and shall contain one of the following enumerations: AwaitingMaintenance, Completed, InWork, or UserDefined.	Required

4.2.4.2 Child elements

The *MaintenanceActionInformation/MaintenanceActionStatus* element contains no child elements.

4.2.5 MaintenanceActionInformation/MaintenanceEvent

Properties: isRef 0, content complex

The *MaintenanceActionInformation/MaintenanceEvent* element defines an occurrence in a maintenance environment that can be decomposed into a series of compound actions.

Figure 2 show a hierarchal layout of the element structure and illustrates the XML complex types that comprise the *MaintenanceActionInformation/MaintenanceEvent* element.

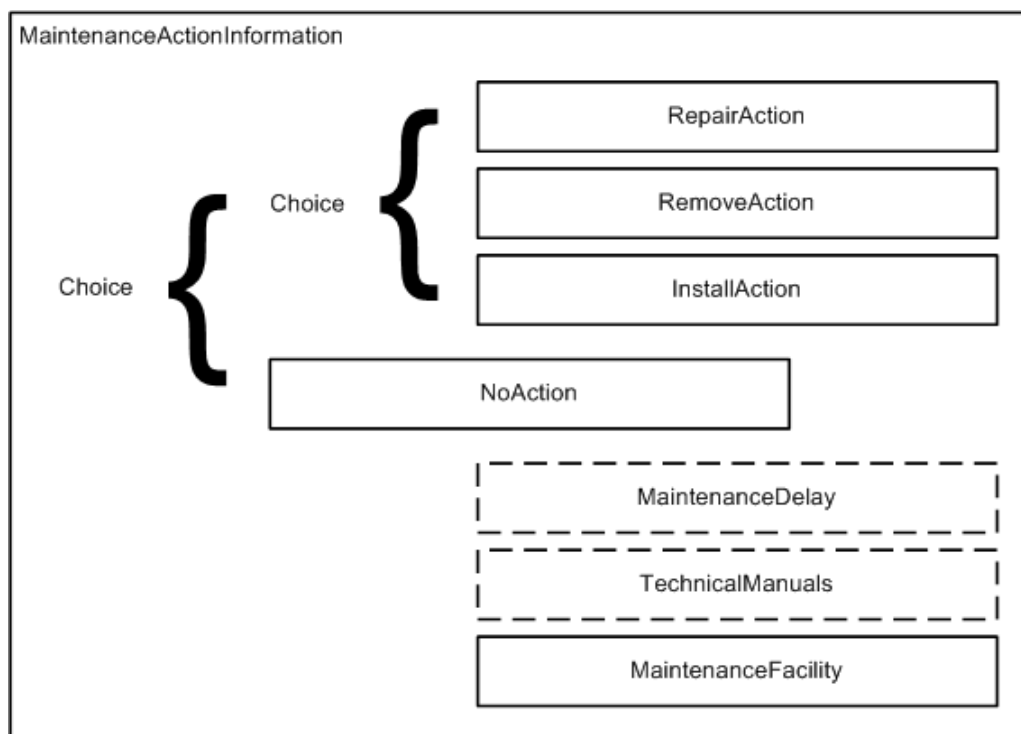


Figure 2—MaintenanceActionInformation/MaintenanceEvent element

4.2.5.1 Attributes

The *MaintenanceActionInformation/MaintenanceEvent* element contains the following attribute:

Name	Type	Description	Use
maintenanceType	c:NonBlankString	Enumerated type defining the type of maintenance being performed on the maintenance item. Valid enumerated values include “Scheduled” and “Unscheduled.”	Required

4.2.5.2 Child elements

The *MaintenanceActionInformation/MaintenanceEvent* element contains the following child elements:

		Name	Type	Description	Use
Choice	Choice	InstallAction	mai:MaintenanceAction	Installation of a component required to complete the maintenance action.	1..∞
		RemoveAction	mai:MaintenanceAction	Removal of a component required to complete the maintenance action.	
		RepairAction	mai:MaintenanceAction	Work required to restore the unit to an operational state. When something is repaired, this element lists details on the part repaired.	
		NoAction	c:ItemDescription	Reason for not being able to perform maintenance on the unit.	Required
		MaintenanceDelay	—	See 4.2.6	0..∞
		MaintenanceFacility	c:Organization	Facility where maintenance has been performed.	Required
		TechnicalManuals	c:DocumentList	Lists relevant technical manuals that support maintenance of the UUT.	Optional
<i>Choice</i> indicates that either “NoAction” or a selection among “InstallAction,” “RemoveAction,” or “RepairAction” shall be included.					

4.2.6 MaintenanceActionInformation/MaintenanceEvent/MaintenanceDelay

Properties: isRef 0, content complex

The *MaintenanceActionInformation/MaintenanceEvent/MaintenanceDelay* element is for record-keeping only and is used after the maintenance is performed to document reason(s) for the awaiting maintenance time.

4.2.6.1 Attributes

The *MaintenanceActionInformation/MaintenanceEvent/MaintenanceDelay* element contains the following attributes:

Name	Type	Description	Use
awaitingMaintenanceCode	c:NonBlankString	Provides a code that explains the reason for awaiting maintenance on the unit. Maintenance organizations typically have a list of organization-unique codes that best describe the reasons for awaiting maintenance on the unit. This attribute provides a place to record that code. The meaning and interpretation of the code is implementation-specific.	Optional
awaitingMaintenanceTimeStamp	xs:dateTime	Date/time when the unit was put on the awaiting maintenance condition.	Required
delayTime	xs:duration	Intended to capture the actual duration of the entire awaiting maintenance event.	Required

4.2.6.2 Child elements

The *MaintenanceActionInformation/MaintenanceEvent/MaintenanceDelay* element contains the following child element:

Name	Type	Description	Use
Description	c:NonBlankString	Description of reason(s) for the unit to be in the awaiting maintenance condition.	Required

4.2.7 MaintenanceActionInformation/ResourcesUtilized

Properties: isRef 0, content complex

The *MaintenanceActionInformation/ResourcesUtilized* element defines all of the necessary information (equipment, data, personnel, training needs, etc.) used during the maintenance action.

4.2.7.1 Attributes

The *MaintenanceActionInformation/ResourcesUtilized* element contains no attributes.

4.2.7.2 Child elements

The *MaintenanceActionInformation/ResourcesUtilized* element contains the following child elements:

Name	Type	Description	Use
Equipment	c:ItemDescriptionReference	Description of any equipment required to complete the maintenance action.	0..∞
Personnel	mai:Maintainer	Used to capture information about the person(s) performing the maintenance action on the item.	1..∞

4.2.8 MaintenanceActionInformation/SoftwareMaintained

Base type: *sc:SoftwareInstance*

Properties: isRef 0, content complex

The *MaintenanceActionInformation/Document/SoftwareMaintained* element supports the case where the object of maintenance is a software component.

4.2.8.1 Attributes

The *MaintenanceActionInformation/SoftwareMaintained* element contains no attributes.

4.2.8.2 Child elements

The *MaintenanceActionInformation/Document/SoftwareMaintained* element contains the following attribute in addition to those inherited from *sc:SoftwareInstance*:

Name	Type	Description	Use
ItemMaintained	mai:ItemMaintained	Refers to the actual repair item as described in an associated IEEE 1232 XML document.	Optional
Warranty	sc:Warranty	Defines a manufacturer's legal responsibility for the support of a given system or item.	0..∞

4.3 Complex types

4.3.1 ItemMaintained

Base type: *c:DocumentReference*

The *ItemMaintained* complex type refers to the actual repair item as described in an associated IEEE 1232 XML document. This extension shall have a specific ID and *uuid* associated with it. Details on the *DocumentReference* complex type are contained in IEEE Std 1671-2006, Annex B.

4.3.1.1 Attributes

The *ItemMaintained* complex type contains no additional attributes beyond those inherited from *c:DocumentReference*.

4.3.1.2 Child elements

The *ItemMaintained* complex type contains the following elements:

Name	Type	Description	Use
RepairItem	c:NonBlankString	Defines an XPath to the AI-ESTATE actual repair item maintained.	Optional

4.3.2 Maintainer

Base type: *c:Person*

The *Maintainer* complex type identifies the specific person performing the maintenance action on the system or item.

4.3.2.1 Attributes

The *Maintainer* element contains the following attributes in addition to those inherited from *c:Person*:

Name	Type	Description	Use
category	xs:string	Identifies the category to which a person belongs with respect to the current maintenance action. Enumerated type defining the type defines a string type for identifying the category or class of some entity or item. The legal values include “authorizer,” “inspector,” “performer,” or “supervisor.”	Required
skillLevel	xs:int	Provides the relative skill of the person as assigned by the responsible maintenance organization.	Required

4.3.2.2 Child elements

The *Maintainer* element inherits the child elements of *c:Person*.

4.3.3 MaintenanceAction

Base type: *sc:SystemInstance*

The *MaintenanceAction* complex type identifies a specific action taken in the maintenance of some item or entity.

4.3.3.1 Attributes

The *MaintenanceAction* complex type contains the following attributes:

Name	Type	Description	Use
ID	xs:ID	Descriptive or common name for the MaintenanceAction. The value of “ID” shall be unique within the context of the containing XML instance document.	
name	sc:NonBlankString	User-friendly textual name for the Maintenance Action.	Optional
endTime	xs:dateTime	Provides the date and time for the termination of a maintenance event.	Optional
startTime	xs:dateTime	Provides the date and time for the initiation of a maintenance event.	Required
totalTime	xs:duration	Provides the aggregate personnel time for the actual work duration of a maintenance event.	Required
preventive	xs:boolean	Indicates whether or not the maintenance action was performed as part of preventative maintenance.	Required
relatedEvent	sc:NonBlankString	References the related action of the maintenance task associated with the test result or a code that best describes the reason for not being able to take corrective action in the case where NoAction was used.	Optional

4.3.3.2 Child elements

The *MaintenanceAction* complex type contains the following elements in addition to those inherited from *sc:SystemInstance*: