

IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Test Results and Session Information via the eXtensible Markup Language (XML)

IEEE Standards Coordinating Committee 20

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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 Test Results and Session Information via the eXtensible Markup Language (XML)

Sponsor

**IEEE Standards Coordinating Committee on
Test and Diagnosis for Electronic Systems (SCC20)**

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Abstract: This standard is intended to promote and facilitate interoperability between components of an automatic test system (e.g., between test executive and diagnostic reasoner) where test results need to be shared. The standard thus facilitates the capture of test results data in storage devices and databases, facilitating online and offline analysis. The test results schema becomes a class of information that can be used within the SIMICA family of standards.

Keywords: Automatic Test Markup Language (ATML), automatic test systems, eXtensible Markup Language (XML), IEEE 1636.1, Software Interface for Maintenance Information Collection and Analysis (SIMICA), test results, XML schema

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Introduction

This introduction is not part of IEEE Std 1636.1-2007, IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Test Results and Session Information via the eXtensible Markup Language (XML).

This standard provides a detailed specification for the Test Results and Session Information XML schema developed for use within the automatic test equipment industry.

This standard is intended to satisfy the following objectives:

- Define the structure for XML instance documents that exchange or store data related to test session events and the results generated in the execution of tests or equipment calibration
- Provide a standard syntax for the exchange of automatic test information

Test results data may be generated by automatic test equipment, test executive software, or any other means.

This schema is part of the SIMICA standard set, IEEE Std 1636™, “IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA),” and the ATML standard set, IEEE Std 1671™, “IEEE Trial-Use Standard for Automatic Test Markup Language (ATML) for exchanging Automatic Test Equipment and Test Information via XML.”

The schema provided in this standard follows the World Wide Web Consortium (W3C) XML Schema, 2nd edition, July 2004. It is anticipated that the IEEE 1671 and IEEE 1636.1 schemas 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. To accommodate use cases beyond the released design, the schemas provide the means for user extensibility.

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IEEE Standard for Software Interface for Maintenance Information Collection and Analysis (SIMICA): Exchanging Test Results and Session Information via the eXtensible Markup Language (XML)

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1. Overview

The schema described in this document is intended for the recording of the history of the execution and observations from a test or test session. This information includes results data directly generated by test equipment or by the test equipment operating software. The combination of this information will aid in the improvement of the test process. The XML schema associated with this standard is based on World Wide Web Consortium (W3C) XML Schema [B9].¹

1.1 Scope

The scope of this standard is the definition of an exchange format, utilizing XML, for exchanging data resulting from executing tests of a Unit Under Test (UUT) via a test program in an automatic test environment.

1.2 Purpose

The purpose of this standard is to promote and facilitate interoperability between components of an automatic test system (e.g., between test executive and diagnostic reasoner) where test results need to be shared. The standard thus facilitates the capture of test results data in storage devices and databases, facilitating online and offline analysis. The test results schema becomes a class of information that can be used within the SIMICA family of standards.

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

1.3 Application

This standard provides an overview, which is applicable to both the SIMICA and the ATML family of standards, for the development of shared maintenance data and the results of testing.

1.4 Users

Anticipated users of this standard are as follows:

- a) UUT developers;
- b) UUT 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 ATML-based tools and systems
- i) Developers of prime mission equipment that use the supported UUT as a component

1.5 Conventions used in this standard

In accordance with the *IEEE Standards Style Manual* [B5], any schema text will be treated as computer code and will be shown in `Courier` font. In cases where instance document examples are necessary to depict clearly the use of a schema type or element, such examples will also be shown in `Courier` font. When the characters “...” appear in an example, it indicates that the schema component is incomplete.

All XML simple and complex types, attribute groups, and elements will be listed; explanatory information will be provided. XML examples will also be provided if additional clarification is needed. This explanatory information will include information on the intended use of the elements and/or attributes. For elements derived from another source type (e.g., an abstract type), only extensions to the source type will be listed.

When an attribute name is referred to, the attribute name will be enclosed in single quotes. Element and type names will always be italicized when appearing in text.

When an element or attribute in the TestResults schema is inherited from the Common schema defined in IEEE Std 1671,² the name of the inherited entity will be prefixed with the alias “c:” to indicate this origin.

² Information on references can be found in Clause 2.

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 P1636™, IEEE Standard Interface for Maintenance Information Collection and Analysis.^{3, 4, 5}

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

ISO 10303-11:1994, Industrial Automation Systems and Integration—Product Data Representation and Exchange—Part 11: Description Methods: The EXPRESS Language Reference Manual.⁶

eXtensible Markup Language (XML) Schema Part 1: Structures, Second Edition. W3C Recommendation 28 October 2004.⁷

XML Schema Part 2: Datatypes, Second Edition. W3C Recommendation, 28 October 2004.⁸

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards Terms* [B1] should be referenced for terms not defined in this clause. In the event a term is explicitly redefined, or further defined, in this standard, that definition shall be normative for this standard.

3.1.1 branch: In an eXtensible Markup Language (XML) document or schema, a specified element and all elements subordinate to that specified element.

3.1.2 choice (in eXtensible Markup Language (XML) schema): A compositor for model group schema components that specifies whether a subordinate element in an instance document must correspond to one of the specified particles in the XML schema.

3.1.3 component (in eXtensible Markup Language (XML) schema): The generic term for the building blocks that comprise the abstract data model of the schema.

³ This IEEE standards project was not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining a draft, contact the IEEE.

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⁷ XML Schema Part 1 is available on the World Wide Web at <http://www.w3.org/TR/xmlschema-1/>.

⁸ XML Schema Part 2 is available on the World Wide Web at <http://www.w3.org/TR/xmlschema-2/>.

3.1.4 eXtensible Markup Language (XML) attribute: Name-value pair associated with an XML element.

3.1.5 eXtensible Markup Language (XML) document: A (text) data object that conforms to the XML requirements for being well-formed (as defined by W3C).

3.1.6 eXtensible Markup Language (XML) namespace: A method for distinguishing XML elements and attributes that may have the same name but different meanings. A URL is used as a prefix to a “local name.” This combination ensures the uniqueness of the element or attribute name. The URL is used only as a way to create a unique prefix and does not have to resolve to a real page on the Internet.

NOTE—See Namespaces in XML 1.0 [B6] and Schenk and Wilson [B7].⁹

3.1.7 eXtensible Markup Language (XML) schema: The structure or framework used to define a data record. This includes each field’s name, type, shape, dimension, and mapping.

3.1.8 instance document (specific to eXtensible Markup Language (XML)): An information set, grouped for some purpose, that is specified by one or more XML schemas.

3.1.9 particle (in eXtensible Markup Language (XML) schema): A kind of component.

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

3.1.11 qualified name (in eXtensible Markup Language (XML)): The complete name of an XML element, attribute, or data type, including the local name and a prefix that identifies the namespace in which the local name is defined/declared.

3.2 Acronyms and abbreviations

ATE	automatic test equipment
ATML	Automatic Test Markup Language
ATS	automatic test system
CR/LF	carriage return/line feed
FFT	fast Fourier transform
GUID	globally unique identifier
ISO	International Organization for Standardization
SIMICA	Software Interface for Maintenance Information Collection and Analysis
UUID	universally unique identifier
UUT	unit under test
URL	universal resource locator
URN	uniform resource name
W3C	World Wide Web Consortium
XML	eXtensible Markup Language

⁹ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

4. Test results and session information

4.1 Background

Current automatic test system architectures are implemented with tight coupling between components. This tight coupling inhibits interoperability by requiring components of the automatic test system to be developed specific to that particular architecture. In many cases, this coupling can be reduced by developing the components that operate relative to standard interfaces.

This standard will facilitate accomplishing several objectives. First, the standard will serve as a single source for specifying essential test data with data elements related to the UUT, the Test Station, and the Test Program. Second, the standard will assist the ATE industry to design and create compatible, interoperable tool sets such as data parsers and writers. Third, the standard will assist ATE users of such data (e.g., automotive, semiconductor, aerospace, and military) to process and display test results across a variety of systems.

This standard is being developed as a “component standard” under IEEE P1636. SIMICA’s purpose is to specify software interfaces for access, exchange, and analysis of product diagnostic and maintenance information. Test results provide a subset of the data needed to satisfy SIMICA’s requirements.

This standard also represents the Test Results component of IEEE Std 1671. In defining its overall architecture, IEEE 1671 references include both IEEE P1636 (SIMICA) and IEEE Std 1636.1 (this standard).

4.2 Purpose

The TestResults schema provides a standard format for the transport of both quantitative (measured values) and qualitative (pass/fail determination) test results. The schema design is such that it is possible to store ancillary information such as environmental conditions and system/operator messages in an instance document. This information, although not specifically “results,” is intended to permit use of an instance document for a variety of purposes, including statistical analysis and diagnostics. Some examples of this ancillary information include identifying information for the UUT, the test station, and the test program; ambient environmental conditions at the time of the test; test equipment calibration data; as well as test program input data and ancillary textual comments. The schema establishes a hierarchical structure for results data to permit the grouping of a series of related test results in a single instance document.

4.3 Applicability

This standard will permit test results data to be shared for a variety of purposes, including statistical analysis, diagnostics, and improvement of the unit under test (UUT) repair process.

4.4 Usage

This standard presumes some knowledge of XML and the use of XML schemas. A variety of XML software tools are available in a number of computer programming languages. This standard makes no presumption regarding the tool(s) being used or the specific test system(s) generating the test result information being captured in an XML instance document. This standard describes the TestResults XML schema and specifies the document model and information model that conformant instance documents must follow. In general, this standard serves as an enhancement to the annotations provided within the XML schema document. It is anticipated that changes to the schema shall be implemented more frequently than revisions to this standard are made.

4.4.1 XML schema representations

Within the body of this standard, unless otherwise indicated, all syntax references relate to XML. Refer to XML Schema Part 0 [B9] for a detailed description of the XML data formats used.

4.4.2 EXPRESS/EXPRESS-G representations

This standard also uses the EXPRESS information modeling language to represent the information contained in the XML schema in a way that supports alternative exchange mechanisms and better defines the semantics of the elements of the schema. The information models are presented in a lexical form (EXPRESS) as well as in graphical form (EXPRESS-G) to facilitate understanding. The EXPRESS language is defined by ISO 10303-11:1994, and tutorial information can be found in Schenk and Wilson [B7].

5. Conformance

The minimal expectation for IEEE 1636.1 conformant instance documents shall be that the instance document is considered valid if the document complies with the constraints expressed in the XML schema and with the EXPRESS information model associated with this standard when the instance document is completely populated.

6. Extensibility

6.1 XML instance documents

Extensions are permitted to XML instance documents conforming to this standard via standard XML extension mechanisms. Extensions shall only occur through the facility of the Extension mechanism described in IEEE Std 1671. In short, extensions shall only appear in the specific *Extension* elements provided in the XML schema for this standard. As defined in the W3C XML standard, an extended schema shall conform to the W3C XML schema specification and shall not contain any entities defined in the schema associated with this standard or with the schemas associated with IEEE Std 1671. If a user makes an extension to this schema to overcome perceived shortcomings with this schema, the user shall notify SCC20 DMC of this change. This notification will permit possible incorporation of this extension in future releases of this standard and associated schema.

6.2 EXPRESS information models

Extensions are not included in the IEEE 1636.1 EXPRESS information model; extensions are addressed only at the level of XML instance documents as described above.

7. Precedence

In the event that a conflict occurs between the XML schema element representation and the EXPRESS definition proved within this standard, the XML schema element representation shall take precedence. Users should also refer to the Notice to Users information regarding interpretations of this standard, which is available from the IEEE.

8. TestResults schema

The elements and types declared within the TestResults schema are specified in 8.1 through 8.5. The *TestResults* element, as root, is presented first. The immediate child elements of *TestResults* are then presented in alphabetical order, with the exception of *Extension*, which is presented last. In some cases, the second-level children of these elements are presented as subclauses to their respective parent element clause.¹⁰

8.1 Schema header and namespace

As of the release of this standard, the schema described incorporates the following “header” information:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:c="urn:IEEE-1671:2008.01:Common"
  xmlns="urn:IEEE-1636.1:2008.01:TestResults"
  targetNamespace="urn:IEEE-1636.1:2008.01:TestResults"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified"
  version="2.01">
  <xs:import namespace="urn:IEEE-1671:2008.01:Common"
    schemaLocation="Common.xsd"/>
```

All namespace declarations that include “urn:IEEE-1671:2008.01” are used only for enforcement of schema uniqueness within a domain (i.e., the namespace); they do not necessarily reflect a linkable URN. Note that actual schema details may be different than described in this standard. The schema document itself may be updated more frequently and shall always be considered definitive.

In actual usage, the “schemaLocation” declaration for Common.xsd shall be modified by the user as necessary. The user’s schemaLocation declaration shall reflect the physical or virtual location of the Common schema file being used in a format appropriate to the validation tool used. For example, the user system may store the Common.xsd file in the “schemas” subdirectory on network mapped drive “S:”; in which case, the schemaLocation string shall be “S:\schemas\Common.xsd”.

Many elements of the schema described in this standard are derived from IEEE Std 1671. As shown in the example above, the Common schema is available within the TestResults schema via the XML “import” mechanism.

8.2 Schema structure

The TestResults schema provides a hierarchical structure for grouping tests. The top-level “collector” for test-related result and session data is a *ResultSet*. This collector requires an “ID” attribute; it is left to the user/creator of the instance document to determine the format of this “ID.” In addition, there is a “name” attribute to identify further the *ResultSet* and a “securityClassification” attribute that optionally may be used to specify a security classification level for the data within the *ResultSet*. A *ResultSet* collector contains one or more *Test*, *TestGroup* or *SessionAction* child elements, as defined in type *TestGroup* below. The recursive definition of *TestGroup* enables subsequent nesting of an unbounded hierarchy of *Test*, *TestGroup*, or *SessionAction* elements. The *Test* and *SessionAction* elements inherit and extend the *Action*

¹⁰ For the convenience of users, a copy of the XML schema associated with this standard shall be available at <http://standards.ieee.org/downloads/1636/1636.1-2007/>. The imported IEEE 1671 Annex B Common schema shall also be available at this location. During the trial-use period of this standard, updates to the subject schema shall also be available at this download location.

type (see 8.5.1); *TestGroup* then inherits *Test*. This inheritance provides the required “ID” and optional “name” and “securityClassification” attributes as detailed in 8.5.

The *Test* element is the main container for specific test data, such as *Event* data (e.g., system messages during a test); test *Parameter* data; *Calibration* data; *TestLimits* against which data collected during the test is to be compared; the actual *TestResult* data; an *Outcome*, and an optional *Extension* to be used as required by the use case. The *Test* element shall always have, at least, an *Outcome* child element. The structure of the *Test* element is defined in complex type *Test*, which is fully described in 8.5.7.

In general, XML schemas consist of Elements that may or may not have associated Attributes (metadata). Elements may be based on (i.e., derived from) defined Types that may be either standard XML types (e.g., xs:string) or types defined within the schema itself. Likewise, Attributes may be “grouped” and referenced as an “attribute group” in an Element definition.

An example XML schema string defining an element is as follows:

```
<xs:element name="Description" type="xs:string" minOccurs="0" />
```

This string defines an XML element with a name of “Description”. The element is optional (i.e., is not required to appear in the XML instance document); any data contained in this element shall be of standard XML type “string”. In an XML instance document, an element of this type might appear as follows:

```
<Description>This is the description text</Description>
```

8.3 Schema elements

8.3.1 TestResults

This root element for the TestResults schema shall be the root-level parent for all other elements of the schema. All TestResults instance documents shall begin with this element as follows:

```
...
<TestResults xmlns="urn:IEEE-1636.1:2008.01:TestResults"
  xmlns:c="urn:IEEE-1671:2008.01:Common"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:IEEE-1636.1:2008.01:TestResults
  TestResults.xsd">
```

As previously explained, the attributes shown are required for the purpose of document validation. The values depicted are illustrative, and they may not reflect actual values in the eventual release schema. The “xmlns:c=...” attribute declares an XML qualified name with an alias of “c” for the included Common schema. The “xsi:schemaLocation” statement contains a data pair (namespace/schema name and location) that is used by validation software to determine the physical location of the schema file.

8.3.1.1 Attributes

The “uuid” and “securityClassification” attributes are inherited as part of the DocumentRootAttributes attribute group from the Common schema of IEEE Std 1671. A complete description of the attributes associated with the *TestResults* element is as follows:

Name	Type	Description	Use
uuid	c:Uuid	A universally unique identifier for the instance document. This attribute shall contain a 32-byte globally unique ID (GUID). Examples of permitted strings include “033DFF36-1F95-4E58-974C-8F713AB2D027” or “033DFF361F954E58974C8F713AB2D027”. Enclosing parentheses or braces are optional. (A complete explanation of GUIDs is included in IEEE Std 1671.)	Required
securityClassification	c:NonBlankString	A string that permits the overall classification level of the instance document to be indicated.	Optional
name	c:NonBlankString	A use case defined common name for the instance document.	Optional

8.3.1.2 Children

As previously stated, the TestResults element is the root element for the entire schema. The immediate child elements of TestResults are as follows:

Name	Type	Description	Use
EnvironmentalData	c:EnvironmentalElements	See 8.3.2	Optional
Indictments	None; a collector element	See 8.3.3	Optional
Personnel	None; a collector element	See 8.3.4	Required
PreTestRepairs	None; a collector element	See 8.3.5	Optional
References	None; a collector element	See 8.3.6	Optional
ResultSet	TestGroup	See 8.3.7	Required
TestDescription	c:ItemDescriptionReference	See 8.3.8	Optional
TestProgram	c:SoftwareInstance	See 8.3.9	Optional
TestStation	c:HardwareInstance	See 8.3.10	Optional
UUT	c:HardwareInstance	See 8.3.11	Required
WorkOrder	None; a collector element	See 8.3.12	Optional
Extension	c:Extension	See 8.3.13	Optional

8.3.2 Environmental

The *EnvironmentalData* element is a collector element for an unbounded set of child *Environmental* elements, which are derived from base type *c:EnvironmentalElements*. In an XML instance document, this branch shall be used to capture a variety of environmental condition data related to the subject test results. These data may be useful in diagnostics or in a detailed analysis and reconstruction of a test.

8.3.3 Indictments

The *Indictments* element is a collector for the unbounded *Indictment* child element and for the optional, unbounded *OtherData* child element. As a collector, it has no associated attributes. The *OtherData* child element provides a set of name/value pairs and shall be used to capture additional information that applies to all indictments in the instance document.

8.3.3.1 Indictment child element

The *Indictment* child element of *Indictments* shall be used to identify in a unique way a UUT or component identified by the test system as being the probable cause of a test failure. Multiple *Indictment* elements are permitted. The *c:ItemInstance* base type provides for an optional choice between a *DescriptionDocumentReference* element and a *Definition*. *DescriptionDocumentReference* shall contain a GUID, which is a reference to an IEEE Std 1671.3™-2007 [B4] UUTDescription or other ATML-derived instance document. The *Definition* structure shall be used for non-ATML references. An optional *SerialNumber* element is provided and shall be used when this information is known or significant. An example *Indictment* for part number “38A792” with reference designator “A5” is shown:

```
...
<Indictments>
  <Indictment>
    <Definition>
      <Identification designator="A5">
        <ModelName>Digitizer</ModelName>
        <IdentificationNumbers>
          <IdentificationNumber number="38A792" type="Part"
qualifier="none"/>
        </IdentificationNumbers>
      </Identification>
    </Definition>
  </Indictment>
</Indictments>
...
```

8.3.4 Personnel

The *Personnel* element is a collector for *CustomerRepresentative*, *QualityAssurance*, and *SystemOperator* child elements. These child elements shall be used, as necessary, to identify such individuals in the *TestResults* instance document. At a minimum, a *SystemOperator* element shall appear in a conformant XML instance document.

Name	Type	Description	Use
CustomerRepresentative	Person (see 8.5.5)	Shall contain, as necessary, identification information for the customer representative witnessing or signing off the <i>TestResults</i> instance document.	Optional
QualityAssurance	Person	Shall contain, as necessary, identification information for the Quality Assurance representative signing off the <i>TestResults</i> instance document.	Optional
SystemOperator	Person	Shall identify the human operator of the test system or test station during execution of the subject test.	Required

8.3.5 PreTestRepairs

PreTestRepairs is a collector element for the unbounded *Repair* child element. The *PreTestRepairs* element shall be used when it is necessary to capture details regarding repairs made to a UUT or UUT component prior to the start of testing. Such information can be useful in a diagnostic process.