IEC 61970-552

Edition 2.0 2016-09

INTERNATIONAL STANDARD

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Energy management system application program interface (EMS-API) – Part 552: CIMXML Model exchange format

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 552: Format d'échange de modèle CIMXML

IEC 61970-552:2016-09(en-fr)

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61970-552 has been prepared by IEC technical committee 57, Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) New Clause 4 that defines the versioning of CIMXML format described in this document.
b) Subclause 5.1, the statement on work flow support is removed.
c) Subclause 5.2, Statement about mandatory header added. Rules how to use the header added. The discussion on management of multiple CIMXML documents and archives is removed.

d) Subclause 5.3, FullModelDocumentElement removed, minor version added to profile URI and the meaning of the header is elaborated in Table 2.

e) Subclause 6.2 the description of rdf:ID and rdf:about has been updated.

f) Subclause 6.3 introduce the new urn:uuid form and discuss the backwards compatibility.

g) New Subclause 6.4 added on support of older UUID formats.

h) New Subclause 6.5 discussing object types added.

i) Subclause 7.2.3.3, Position of header described and duplicate rows removed.

j) Document identification and references between documents updated in Table 2 and Subclauses 7.2.3.4 and 7.2.4.6.

k) Subclause 7.2.3.7, A compound element can never be a root element.

l) Subclause 7.2.3.9, description of compound containment added.

m) Subclauses 7.2.3.4 and 7.2.4.7.3, More clarification of cascading delete.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/1752/FDIS	57/1773/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61970 series, published under the general title *Energy management system application program interface (EMS-API)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 61970 is part of the series of standards that define an Application Program Interface (API) for an Energy Management System (EMS).

IEC 61970-301 specifies a Common Information Model (CIM): a logical view of the physical aspects of an electric utility operations. The CIM is described using the Unified Modelling Language (UML), a language used to specify, visualize, and document systems in an object-oriented manner. UML is an analysis and design language; it is not a programming language. In order for software programs to use the CIM, it must be transformed into a schema form that supports a programmable interface.

IEC 61970-501 describes the translation of the CIM in UML form into a machine readable format as expressed in the Extensible Markup Language (XML) representation of that schema using the Resource Description Framework (RDF) Schema specification language.

This part of IEC 61970 specifies how the CIM RDF schema specified in IEC 61970-501 is used to exchange power system models using XML (referred to as CIMXML) defined in the 61970-45x series of profile standards, such as the CIM Transmission Network Model Exchange Profile described in IEC 61970-452.

ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 552: CIMXML Model exchange format

1 Scope

This part of IEC 61970 specifies the format and rules for exchanging modelling information based upon the CIM. It uses the CIM RDF Schema presented in IEC 61970-501 as the meta-model framework for constructing XML documents of power system modelling information. The style of these documents is called CIMXML format.

Model exchange by file transfer serves many useful purposes. Profile documents such as IEC 61970-452 and other profiles in the 61970-45x series of standards explain the requirements and use cases that set the context for this work. Though the format can be used for general CIM-based information exchange, specific profiles (or subsets) of the CIM are identified in order to address particular exchange requirements. The initial requirement driving the solidification of this specification is the exchange of transmission network modelling information for power system security coordination.

This part of IEC 61970 supports a mechanism for software from independent suppliers to produce and consume CIM described modelling information based on a common format. The proposed solution:

- is both machine readable and human readable, although primarily intended for programmatic access,
- can be accessed using any tool that supports the Document Object Model (DOM) and other standard XML application program interfaces,
- is self-describing,
- takes advantage of current World Wide Web Consortium (W3C) recommendations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050, *International Electrotechnical Vocabulary* (all parts)

IEC TS 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary*

IEC 61970-501:2006, *Energy management system application program interface (EMS-API) – Part 501: Common Information Model Resource Description Framework (CIM RDF) schema*

W3C, *RDF/XML Syntax Specification*

W3C, *XSL Transformations (XSLT)*

W3C, *Document Object Model (DOM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050 (for general glossary) and IEC TS 61970-2 (for EMS-API glossary definitions), as well as the following apply.

3.1
Application Program Interface
API
set of public functions provided by an executable application component for use by other executable application components

3.2
Common Information Model
CIM
abstract model that represents all the major objects in an electric utility enterprise typically contained in an EMS information model

Note 1 to entry: By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration of EMS applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management.

3.3
CIMXML
serialisation format for exchange of XML data as defined in this document

3.4
Document Object Model
DOM
platform- and language-neutral interface defined by the World Wide Web Consortium (W3C) that allows programs and scripts to dynamically access and exchange the content, structure and style of documents

3.5
Document Type Definition
DTD
standard for describing the vocabulary and syntax associated with an XML document

Note 1 to entry: XML Schema and RDF are other forms that can be used.

3.6
Energy Management System
EMS
computer system comprising a software platform providing basic support services and a set of applications providing the functionality needed for the effective operation of electrical generation and transmission facilities so as to assure adequate security of energy supply at minimum cost

3.7
Hypertext Markup Language
HTML
mark-up language used to format and present information on the Web

3.8
Model
collection of data describing instances, objects or entities, real or computed. In the context of CIM the semantics of the data is defined by profiles, see: 4.9. Hence a model can contain equipment data, power flow initial values, power flow results etc.

Note 1 to entry: In power system analysis, a model is a set of static data describing the power system. Examples of Models include the Static Network Model, the Topology Solution, and the Network Solution produced by a power flow or state estimator application.

3.9
Profile
schema that defines the structure and semantics of a model that may be exchanged

Note 1 to entry: A Profile is a restricted subset of the more general CIM.

3.10
Profile Document
collection of profiles intended to be used together for a particular business purpose

3.11
Resource Description Framework
RDF
language recommended by the W3C for expressing metadata that machines can process simply

Note 1 to entry: RDF uses XML as its encoding syntax.

3.12
RDF Schema
schema specification language expressed using RDF to describe resources and their properties, including how resources are related to other resources, which is used to specify an application-specific schema

3.13
Real-World Object
objects that belong to the real world problem domain as distinguished from interface objects and controller objects within the implementation

Note 1 to entry: The real-world objects for the EMS domain are defined as classes in IEC 61970-301 Common Information Model.

Note 2 to entry: Classes and objects model what is in a power system that needs to be represented in a common way to EMS applications. A class is a description of an object found in the real world, such as a PowerTransformer, GeneratingUnit, or Load that needs to be represented as part of the overall power system model in an EMS. Other types of objects include things such as schedules and measurements that EMS applications also need to process, analyze, and store. Such objects need a common representation to achieve the purposes of the EMS-API standard for plug-compatibility and interoperability. A particular object in a power system with a unique identity is modeled as an instance of the class to which it belongs.

3.14
Standard Generalized Markup Language
SGML
international standard for the definition of device-independent, system-independent methods of representing texts in electronic form

Note 1 to entry: HTML and XML are derived from SGML.

3.15
Unified Modelling Language
UML
object-oriented modelling language and methodology for specifying, visualizing, constructing, and documenting the artefacts of a system-intensive process

3.16
Uniform Resource Identifier
URI
Web standard syntax and semantic for identifying (referencing) resources (things, such as files, documents, images)

3.17
eXtensible Markup Language
XML
subset of Standard Generalized Markup Language (SGML), ISO 8879, for putting structured data in a text file

Note 1 to entry: This is an endorsed recommendation from the W3C. It is license-free, platform-independent and well-supported by many readily available software tools.

3.18
eXtensible Stylesheet Language
XSL
language for expressing style sheets for XML documents

4 CIMXML version

The CIMXML version is implemented as an XML processing instruction that appears before the CIMXML document, refer to Table 1.

Table 1 – CIMXML version

XML processing instruction	Version	Revision date
iec61970-552	2.0	2014-03-12

Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<?iec61970-552 version="2.0"?>
<rdf:RDF
      xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:cim="http://iec.ch/TC57/2004/CIM-schema-cim10#"
      …
</rdf:RDF>
```


5 Model exchange

5.1 General

Model exchange typically involves the exchange of a collection of documents, each of which contains instance data, referred to as a model, and a header. The structure and semantics of each model as well as the header are described by a profile, which is not included in the exchanged data. The overall exchange is governed by a collection of profiles in a Profile Document.

A CIMXML document shall consists of a header and a model section.

A header section describes the content of the model section contained in a document e.g. the date the model was created, description etc. The header may also identify other models and their relationship to the present model. Such information is important when the models are part of a work flow where, for example, the models have relations to each other, e.g. a model succeeds and/or depends on another.

5.2 Rules for CIMXML documents and headers

A CIMXML document is described by a single header. Multiple headers in a CIMXML document are not allowed.

The header section shall always be the first element in a CIMXML document. The header section elements are

- FullModel element, refer to 7.2.3.4.
- DifferenceModel element, refer to 7.2.4.6.

The data in the model section is defined by one or more profiles listed within the header.

Elements in a CIMXML document may have references to elements (resources) in other CIMXML documents.

As a single header element is allowed in a CIMXML document the model section may only contain elements that the header can describe. If multiple headers are needed a CIMXML document shall be created for each header.

5.3 Model and header data description

A description of a model is attached as header data to the model. Figure 1 describes the model with header information.

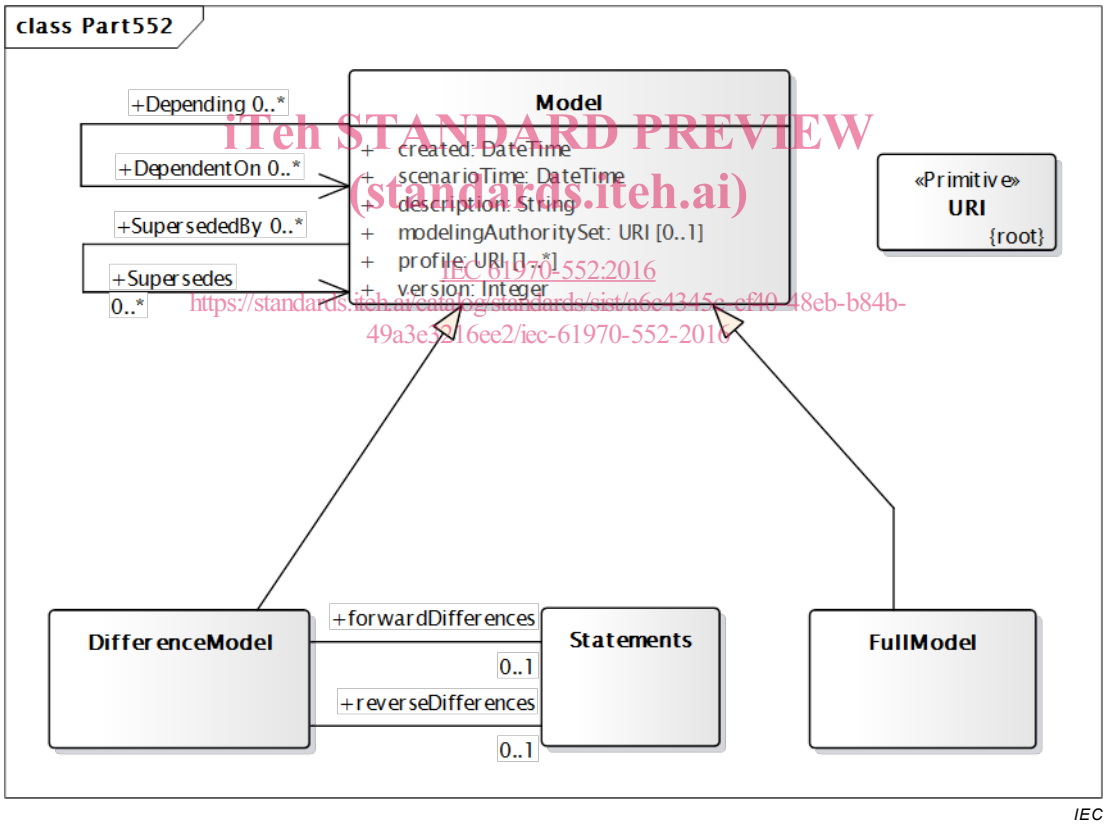

Figure 1 – Model with header

In Figure 1 the classes FullModel, DifferenceModel and Statements describe the model data while the header is described by the class Model. The following is a bottom up description of these classes:

- The Statements class represent a set of Definition (refer to 7.2.3.5) and/or Description (refer to 7.2.3.6) elements.
- The FullModel (refer to 7.2.3.4) class represent the full model header and its contents is described by the Model class.

- The DifferenceModel (refer to 7.2.4.6) class represents the difference model header. The content is described by the Model class, the association role forwardDifferences and association role reverseDifferences. Both association roles may have one set of Statements.
- The Model class describes the header content that is the same for the FullModel and the DifferenceModel. A Model is identified by an rdf:about attribute. The rdf:about attribute uniquely describe the model data and not the CIMXML document A new rdf:about identification is generated for created documents only when the model data has changed. A repeated creation of documents from unchanged model data should have the same rdf:about identification as previous document generated from the same model data.

The ordering of xml elements in the generated document is insignificant except for the FullModel element that always appear first in a document. The Model class attributes are described in Table 2.

Table 2 – Header attributes

Class	Attribute	Description
Model	created	The date when the document was created.
Model	scenarioTime	The date and time that the model represents, e.g. the current time for an operational model, a historical model or a future planned model.
Model	description	A description of the model, e.g. the name of person that created the model and for what purpose. The number of UTF-8 characters is limited to 2000.
Model	modelingAuthoritySet	A urn/uri referring to the organisation or role sourcing the model in the CIMXML document. Models from the same organisation or role but for different profiles shall have the same urn/uri.
Model	profile	A urn describing the Profiles that governs this model. It uniquely identifies the Profile and its version.
Model	version	A description of the version of the model sourcing the data in a CIMXML document. Examples are – Variations of the equipment model for the ModelingAuthoritySet – Different study cases resulting in different solutions. The version attribute is an integer that is changed in synchronisation with the rdf:about identifier, refer to description of the Model class preceding this table.
Model	DependentOn	References to other models that the model in this document depends on, e.g. – A load flow solution depends on the topology model it was computed from – A topology model computed by a topology processor depends on the network model it was computed from. The referenced models are identified by the FullModel rdf:about attribute (see 7.2.3.4) for full model documents and by DifferenceModel rdf:about attribute (see 7.2.4.6) for difference model documents. The references are maintained by the producer of the CIMXML document and the references are valid for the model with version and identifier (see description of Model class preceding this table) for which the document was created. The use of DependentOn by a consumer is optional. If a consumer of a document have also consumed the DependentOn documents it is expected that no dangling references are present in the currently consumed document.
Model	Depending	All documents depending on the model described by this document. This role is not intended to be included in any document exchanging instance data.

Class	Attribute	Description
Model	Supersedes	When a model is updated the resulting model supersedes the models that were used as basis for the update. Hence this is a reference to the models that are superseded by the model in this document. A model can supersede one or more models, for each superseded model one Supersedes reference is included in the header. The referenced models are identified by the FullModel rdf:about attribute (see 7.2.3.4) for full model documents and by DifferenceModel rdf:about attribute (see 7.2.4.6) for difference model documents. The references are maintained by the producer of the CIMXML document and are valid for the model with version and identifier (see description of Model class preceding this table) for which the document was created. The use of Supersedes by a consumer is optional. If a consumer of a document have also consumed the Supersedes documents it is expected that no dangling references are present in the currently consumed document.
Model	SupersededBy	All models superseding this model. This role is not intended to be included in any document exchanging instance data.

If a document is regenerated from a received and unchanged model all attributes in Table 2 shall be the same as in the originally received document. But if a received model is in any way modified none of the attributes may be different depending on the nature of the modifications.

DependentOn, Depending, Supersedes and SupersededBy describe the situation in the system where the document was generated at the time of generation. The use of the references in a receiving system is optional and a receiving system may or may not use the references depending on the use case, refer also to 5.4.

The profile attribute is a URI having the following format for IEC profiles:

- *http://iec.ch/<committee>/<year>/<standard>-<part>/<profile>/<version>/<minor_version>*

where text in *<italic>* is replaced by a describing text, e.g.

- http://iec.ch/TC57/2011/61970-452/Equipment/2/1

The profile URI shall be treated as indivisible where the full string conveys the identification of a profile. Hence software is not supposed to parse and interpret substrings of the profile URI, e.g. year, standard, part etc.

Other organizations using the CIMXML serialization may have other profile URIs.

The UML in Figure 1 translates into CIMXML elements as follows:

1) A leaf class in Figure 1 (DifferenceModel, Statements and FullModel) appears as class elements under the document element (7.2.3.3).
2) Statement elements appear as Definition (7.2.3.5) or Description elements (7.2.3.6).
3) Literal attributes, e.g. Model.created, appears as literal property elements (7.2.3.8).
4) Roles appear, e.g. Model.Supersedes, as resource property elements (7.2.3.11).
5) Inherited attributes and roles appear directly as elements under the leaf class following the rules 3, 4 and 5 above.
6) A CIMXML model document is identified by a Model rdf:about attribute (implicit in the UML). Hence the roles DependentOn and Supersedes are references to the Model rdf:about attribute.
7) A document may be regenerated multiple times from the same model. Documents regenerated from an unchanged model keep the identification (Model rdf:about) unchanged from a previous document generated from the same model.

8) A DifferenceModel or FullModel document generated from the same model will have the same identification and same Supersedes. Hence a DifferenceModel and a FullModel document can be used interchangeably. However, if a receiving system want a full model equivalent with the model in the FullModel document the DifferenceModel document must be applied to a full model corresponding to the superseded.

5.4 Work flow

A work flow is described by a sequence of exchange events. The model description in 5.3 supports work flow events related in time with the Model.Supersedes attribute and events related to profiles with the Model.DependentOn attribute. An example of this is shown in Figure 2.

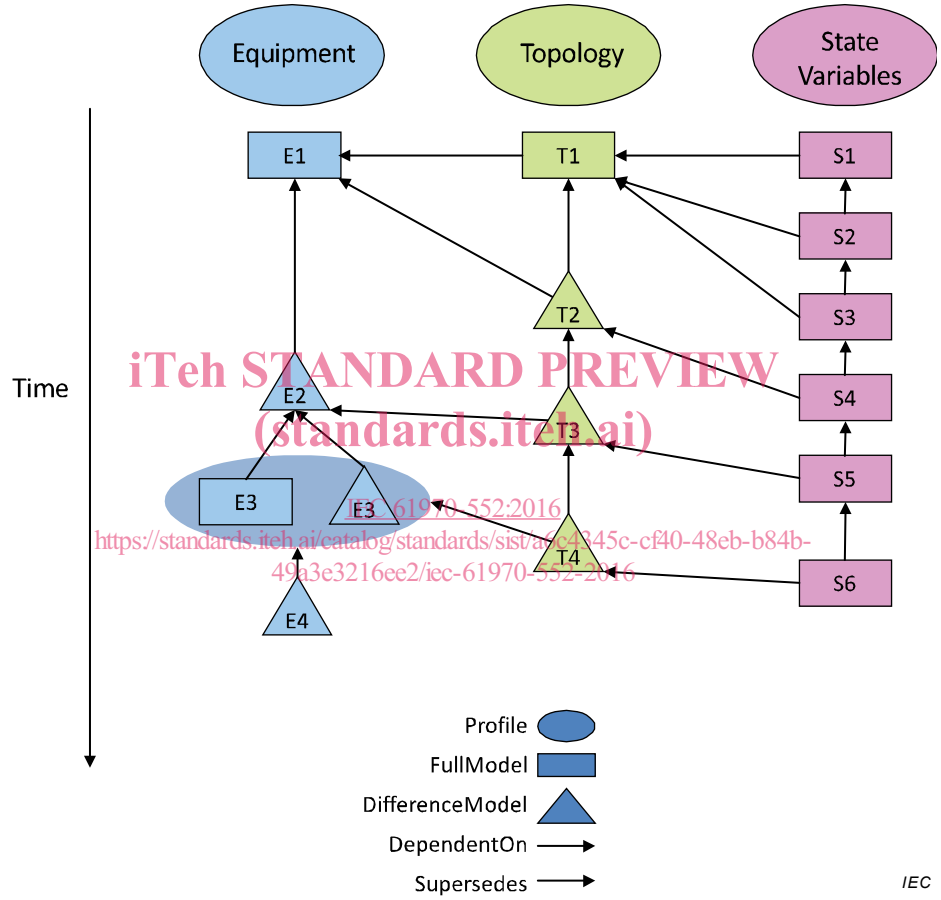

Figure 2 – Example work flow events

In this example, a solved network model is exchanged as a collection of models governed by a Profile Document comprising Equipment, Topology, and State Variables documents. The left time line in Figure 2 represents how the Equipment model document is exchanged over time. The center time line shows how new Topology results are exchanged over time and the Equipment models on which each depends. The right most time line shows how multiple State Variable documents are exchanged and the Topology documents on which they depend. Also note that the equipment model E3 is represented both by a full and a DifferenceModel document. The situation in Figure 2 represents a simple case. A more complex situation is shown in Figure 3.