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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 61970-552:2013

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

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FOREWORD

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International Standard IEC 61970-552 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

FDIS	Report on voting
57/1386/FDIS	57/1402/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 web site 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- withdrawn,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.

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INTRODUCTION

This International standard is part of the IEC 61970 series 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.

IEC 61970-552 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 International Standard specifies a Component Interface Specification (CIS) for Energy Management Systems Application Program Interfaces. This part 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 standard 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.

This document is the Level 2 Component Interface Specification document that describes in narrative terms (with text and examples based on the CIM) the detailed definition of the CIMXML format.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 series, *International Electrotechnical Vocabulary*

IEC 61968-11, *Application integration at electric utilities – System interfaces for distribution management – Part 11: Common information model (CIM) extensions for distribution*

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

IEC 61970-301, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

IEC 61970-501, *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: Extensible Markup Language (XML) 1.0

W3C: XSL Transformations (XSLT)

W3C: Document Object Model (DOM)

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions contained in IEC 60050 (for general glossary) and IEC 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 objects or entities real or computed

Note 1 to entry: In the context of CIM the semantics of the data is defined by profiles; refer to 3.9.

Note 2 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 Modeling Language
UML
object-oriented modeling language and methodology for specifying, visualizing, constructing, and documenting the artifacts 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 stylesheets for XML documents

4 Model exchange header

4.1 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 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 header describes the content of the model 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.

Subclauses 4.2 to 4.4 define the model with header data and work flow it is designed to support.

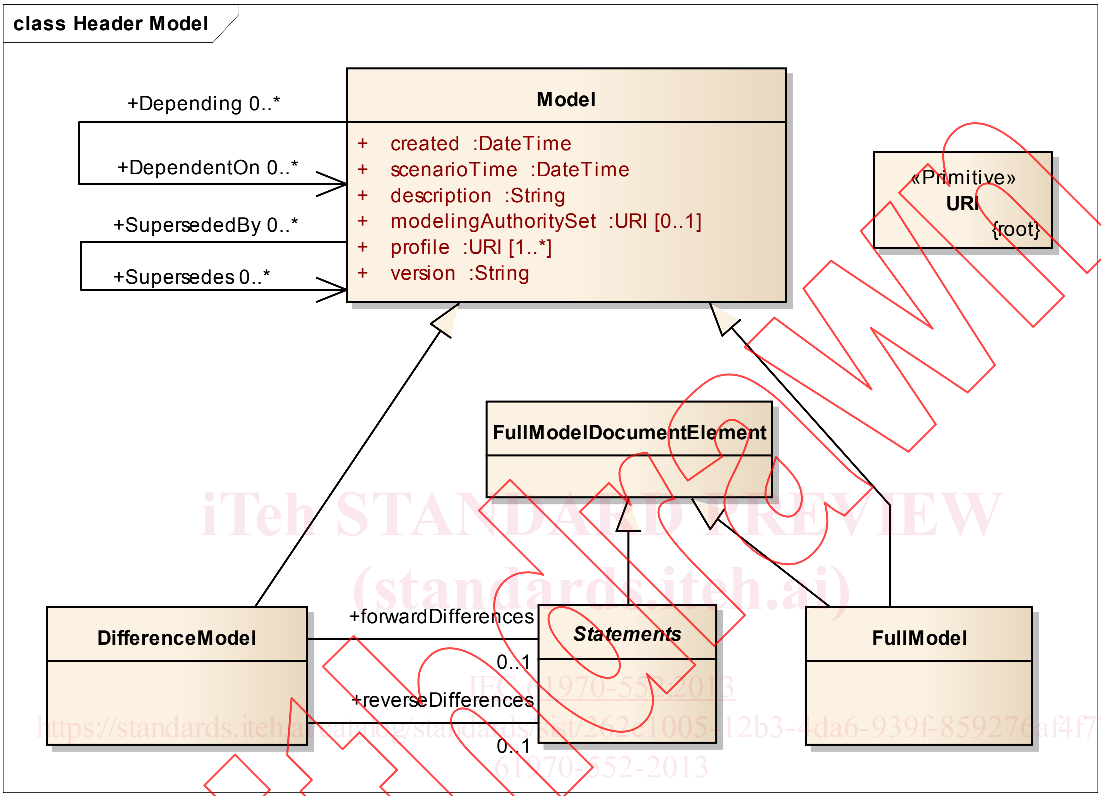
4.2 CIMXML documents and headers

A CIMXML document is described by a single header. Multiple headers in a CIMXML document are not allowed. Hence instance data in a CIMXML document adhere to a single profile.

In case multiple and possibly related CIMXML documents need to be kept together they shall be collected in an archive, e.g. zip.

4.3 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.



IEC 2767/13

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 classes Model and Description. The following is a bottom up description of these classes:

- The FullModelDocumentElement class represents any of the elements that may appear in a full model document. It has the two sub types Statements or FullModel, both are further described below. A full model document typically contains one FullModel element and one set of Definition elements.
- The Statements class represent a set of Definition (refer to 6.2.3.5) and/or Description (refer to 6.2.3.6) elements.
- The FullModel (refer to 6.2.3.4) class represent the full model header and its contents is described by the Model class.
- The DifferenceModel (refer to 6.2.4.6) 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 and not the document where the header exists. Hence multiple documents created from the same unchanged data model will have the same rdf:about. This also means that a model change result in a new rdf:about next time a document is created.

The Model class attributes are described in Table 1.

Table 1 – Header attributes

Class	Attribute	Description
Model	created	The date when the model was created (note this is typically not when the CIMXML document was created which is after this time).
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.
Model	modelingAuthoritySet	A URN describing the equipment model sourcing the data in a CIMXML document, e.g. a model for the whole or a part of a country.
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 a custom string that is changed in synchronisation with the rdf:about identifier, refer to description of the Model class above.
Model	DependentOn	A reference to the models that the model described by 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.
Model	Depending	All models depending on this model. This role is not intended to be included in any document exchanging instance data.
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 CIMXML documents describing the updated models.
Model	SupersededBy	All models superseding this model. This role is not intended to be included in any document exchanging instance data.

The profile attribute is a URI having the following format:

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

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

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 (6.2.3.3).
2) Statement elements appear as Definition (6.2.3.5) or Description elements (6.2.3.6).
3) Literal attributes, e.g. Model.created, appears as literal property elements (6.2.3.8).
4) Roles appear, e.g. Model.Supersedes, as resource property elements (6.2.3.10).
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 full model document may be regenerated multiple times from the same source data. Full model documents regenerated from unchanged source data keep the model identification (Model rdf:about) unchanged from the original full model document.

8) When generating a full model document superseding a differential the new full model document will have the same model identification (Model rdf:about) as the differential if the model is unchanged since the differential was created. Hence it is an alternate to the differential.

4.4 Work flow

A work flow is described by a sequence of exchange events. The model description in 4.3 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.

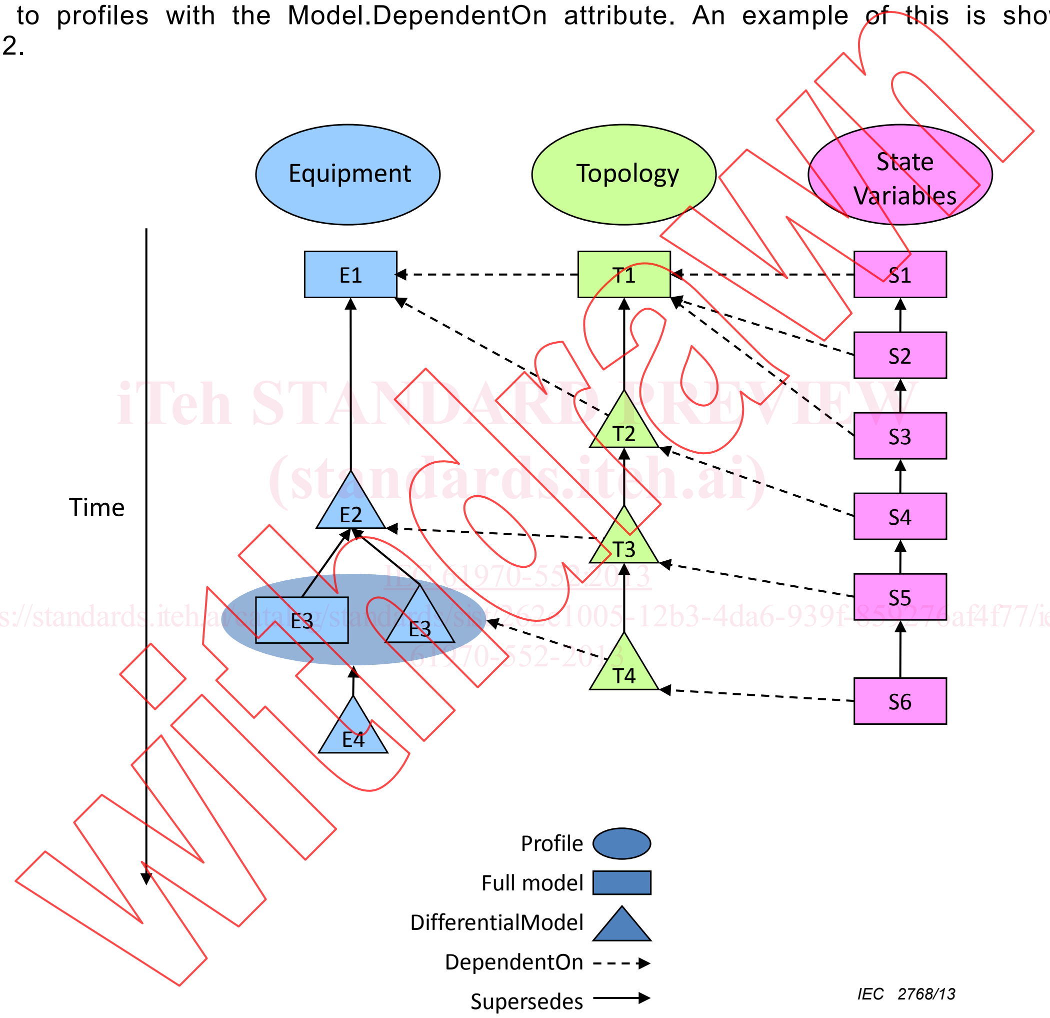


Figure 2 – Example work flow events

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 an incremental document. The situation in Figure 2 represents a simple case. A more complex situation is shown in Figure 3.

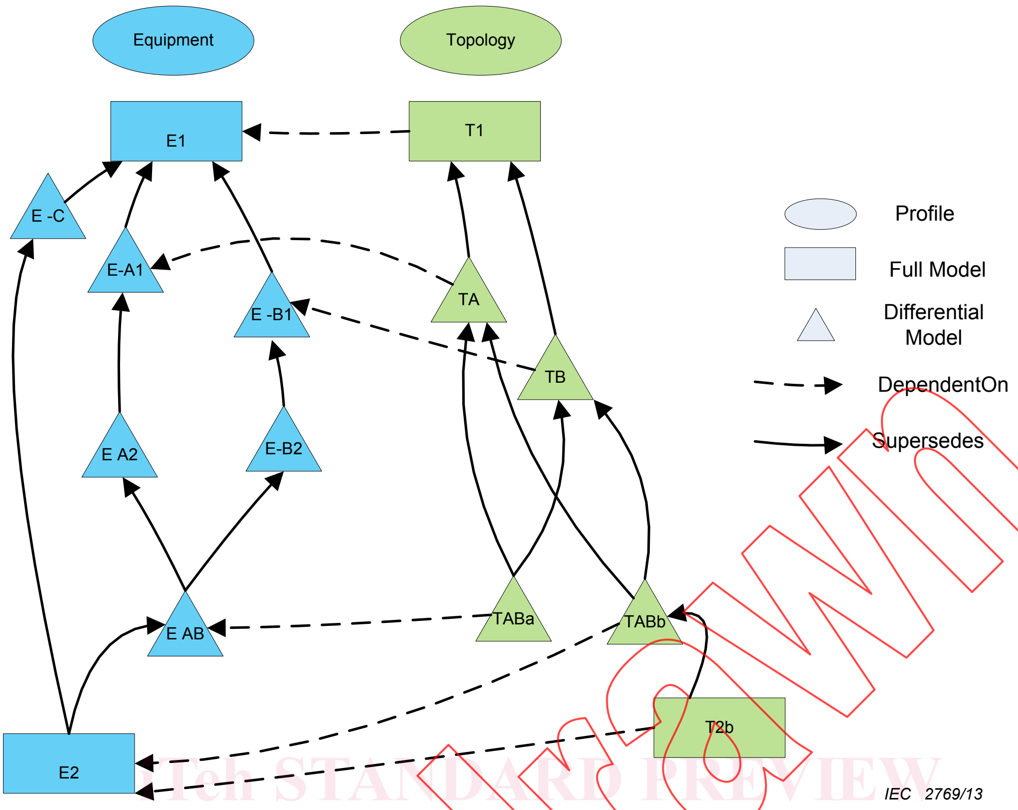


Figure 3 – Example work flow events with more dependencies

The CIMXML documents in Figure 3 may be created from a data modeller environment where multiple change tracks of a model appear in parallel, e.g. the equipment model has three tracks E-Ax, E-Bx and E-C that eventually merge into the full model E2 superseding the equipment model tracks.

A receiver of the CIMXML documents may use any of the topology documents TA, TB, TABa or T2b with the equipment model from E2. As the sender (the data modeller in this example) only verified T2b with E2 this is the only combination that is supposed to fit together. Concerning T2b the receiver may choose to apply TB and TABb to T1 instead of using T2b.

5 Object identification

5.1 URIs as identifiers

UUIDs (Universally Unique IDentifier), also known as GUIDs (Globally Unique IDentifier) can be used to identify resources in such a way that the

- identifiers can be independently and uniquely allocated by different authorities. This is a big advantage with the UUID.
- identifiers are stable over time and across documents.

If, in addition, the UUID is embedded in a Uniform Resource Name (URN) then the document can be simplified by the elimination of XML base namespace declarations (xml:base attributes). The URN is a concise, fixed-length, absolute URI.

The standard for an URN containing a UUID is defined by the Internet Engineering Task Force RFC 4122.