# IEC 61970-401

Edition 1.0 2022-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside

## Energy management system application program interface (EMS-API) – Part 401: Profile framework

## Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 401: Cadre de profils



IEC 61970-401:2022-05(en-fr)

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## Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 401: Cadre de profils



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

## Part 401: Profile framework

## FOREWORD

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IEC 61970-401 has been prepared by IEC technical committee 57: Power systems management and associated information exchange. It is an International Standard.

This first edition cancels and replaces IEC TS IEC 61970-401 published in 2005. This edition constitutes a technical revision.

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

a) The previous edition of IEC TS 61970-401:2005 provided an overview of the Component Interface Specifications (CIS) IEC 61970-402, IEC 61970-403, IEC 61970-404, IEC 61970-405, and IEC 61970-407. IEC 61970-402 to IEC 61970-407 are duplicates of existing OPC interfaces from OPC Foundation and the DAIS/HDA interfaces from OMG. Hence IEC 61970-402 to IEC 61970-407 have been withdrawn and IEC TS 61970-401:2005 no longer serves a purpose.

b) IEC 61970-401 (this document) does not contain an overview of Component Interface Specifications (CIS) but instead a description of how to create profile specifications that describes dataset contents (or message contents). Hence it has been renamed "Profile framework". The profile specifications IEC 61970-450 (all parts) and IEC 61970-600 (all parts) describe dataset contents. The purpose of this document is to define the rules to be followed in the process of creating profile specifications.

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|---|---|
| 57/2482/FDIS | 57/2494/RVD |

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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



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# INTRODUCTION

This document is one of the IEC 61970 series that defines message interfaces for network application data exchange.

The IEC 61970-300 series of documents specify a canonical Common Information Model (CIM) describing network application data. The CIM is an information model that represents all the major objects in an electric utility enterprise needed to describe data used by power network applications. The Canonical CIM provides the semantics for IEC 61970-450 (all parts) and IEC 61970-600 (all parts) profile specifications dedicated to specific data exchanges.

This document describes the framework in which profile specifications are created from the Canonical CIM. It describes the structure of profile documents and the rules for selection of information from the Canonical CIM to be included in profile specifications.

The reasons for creating this document are

1) The IEC 61970 profiles have for a long time been created using a profiling method not described by an IEC 61970 document.
2) The IEC 61970 profiling method has issues that need resolution. Issues and solutions are described in Annex A.

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

# Part 401: Profile framework

## 1 Scope

This document describes how IEC 61970-450 (all parts), IEC 61970-600 (all parts) profile specifications are structured and created. Profile specifications describe a subset of the Canonical CIM dedicated to a specific data exchange. The Canonical CIM is described in IEC 61970-300 (all parts) as well as in IEC 61968-11.

Rules for creation or extension of Canonical CIM are outside the scope of this document.

This document specifies the structure of a profile specification and the rules for selecting subsets of information from the Canonical CIM. It standardizes the operations used to create the profile elements from the Canonical CIM. As Canonical CIM is described in UML the operations are described in terms of UML classes, attributes, and roles.

It is possible to map UML to RDFS or OWL, so any of the languages UML, RDFS or OWL can be used to describe the created profiles. Specification of languages (UML, RDFS or OWL) used to describe profiles as well as how profiles are presented and edited in user interfaces are outside the scope of this document. Languages used to describe profiles are specified in other specifications. Relevant specifications are referenced in Clause 2.

UML supports adding free text that describes further restrictions on UML constructs, e.g. classes, attribute values, association roles and cardinalities. Languages such as OCL and SHACL are dedicated to describing constraints. OCL is used to describe constraints for object data described in UML while SHACL is used to describe constraints on graph data described by RDFS or OWL. OCL is within the scope of this document, but SHACL is not.

This document supports profiles describing data exchanged as CIMXML datasets or messages. The exchange format within the scope is in accordance with IEC 61970-552 but other formats are possible.

Tool interoperability and serialisation formats are outside the scope of this document.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes the 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 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 61970-300 (all parts), *Energy management system application program interface (EMS-API)*

IEC 61970-501:2006, *Energy management system application program interface (EMS-API) – Part 501: Common Information Model Resource Description Framework (CIM RDF) schema*[1]

IEC 61970-552, *Energy management system application program interface (EMS-API) – Part 552: CIMXML Model exchange format*

OMG Unified Modeling Language®, OMG document number: formal/2015-03-01, available at http://www.omg.org/spec/UML/2.5

World Wide Web Consortium (W3C), RDF 1.1 Primer from 24 June 2014, available at https://www.w3.org/TR/rdf11-primer/

World Wide Web Consortium (W3C), RDF 1.1 Concepts and Abstract Syntax from 25 February 2014, available at https://www.w3.org/TR/rdf11-concepts/

World Wide Web Consortium (W3C), RDF 1.1 XML Syntax from 25 February 2014, available at https://www.w3.org/TR/rdf-syntax-grammar/

World Wide Web Consortium (W3C), RDF Schema 1.1 from 25 February 2014, available at https://www.w3.org/TR/rdf-schema/

World Wide Web Consortium (W3C), OWL 2 Web Ontology Language Primer (Second Edition), W3C Recommendation 11 December 2012, available at https://www.w3.org/TR/owl2-primer/

World Wide Web Consortium (W3C), OWL 2 Web Ontology Language Structural Specification and Functional-Style Syntax (Second Edition), W3C Recommendation 11 December 2012, available at https://www.w3.org/TR/owl2-syntax/



## 3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC TS 61970-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

### 3.1 Terms and definitions

**3.1.1**
**Canonical CIM**
agreed semantic information model describing the power system domain; the information model aims at describing the power system domain in a normalized way without overlap

Note 1 to entry: The Canonical CIM is described in UML. UML can be serialized (saved as a document) in the standardized data format XMI for exchange between UML tools. Ecore is another serialization format with capability to describe UML.

[1] This specification is based on the W3C specification RDF Schema 1.0 from early 2000 which has since been revised multiple times.

**3.1.2**
**profile**
subset derived from Canonical CIM supporting the exchange of a specific set of data in a specific context

Note 1 to entry: A semantic information model in the same way as Canonical CIM, can be serialized in several different formats:

- XMI that is the serialisation format of UML as described by OMG, see clause 2;
- RDF/XML used to serialize RDFS or OWL;
- RDF/XML as described by IEC 61970-501. IEC 61970-501 contains several custom extensions to the RDFS specification from 1999;
- Ecore for exchange with Eclipse Modelling Framework (EMF).

Note 2 to entry: The serialisation of IEC 61970 profiles is standardised by IEC 61970-501. A collection of profiles supports a specific use case.

**3.1.3**
**profiling**
process of creating profiles

**3.1.4**
**dataset**
set of data described by a profile which means that the data in a dataset align with the information described by the profile

Note 1 to entry: A profile does not say anything about the data format.

**3.1.5**
**data format**
datasets carrying data described by profiles as defined in this document using CIMXML described in IEC 61970-552 and RDF/XML based on RDFS as described in IEC 61970-501

### 3.2 Abbreviated terms

The abbreviated terms are given in Table 1.

**Table 1 – Abbreviated terms**

| Abbreviated term | Description |
|---|---|
| CIMXML | CIMXML is an RDF/XML data format and is described in the specification IEC 61970-552. |
| RDF/XML | A serialization format for RDF and graph data. For more details refer to the W3C specification RDF 1.1 XML Syntax. |
| RDF | RDF stands for Resource Description Framework and is an information model for graph data consisting of a:<br>– Resource, in CIMXML this is an object identifier.<br>– Predicate, in CIMXML this is an attribute or role name.<br>– data item, in CIMXML this is a value or a resource reference.<br>For an introduction to RDF refer to the W3C specification RDF 1.1 Primer. |
| RDFS | RDFS stands for RDF Schema and is an extension of RDF with capability to describe a vocabulary for data-modelling. Hence it is an information modelling language but with less capability than UML. For more details refer to the W3C specification RDF Schema 1.1. |
| OWL | OWL is an ontology language supporting the semantic web, it is a further development and extension of RDFS. For an introduction to OWL refer to the W3C recommendation OWL 2 Web Ontology Language Primer (Second Edition). |
| UML | UML stands for Unified Modelling Language. For more details refer to the OMG specification formal/2015-03-01. |



# 4 Overview

## 4.1 Profiles and profiling



Profiling is the process of selecting information from the Canonical CIM and including it in profiles.

The Canonical CIM is described in IEC 61970-300 (all parts) and IEC 61968-11.

The guiding principle for the profiling method is that the information described by a profile is a true subset of the Canonical CIM and retains class, role names, attribute names and datatypes from the Canonical CIM. The datatypes in CIM are described by classes stereotyped Primitive, CIMDatatype, and Compound. CIMDatatype is a composition of three attributes: value, unit, and multiplier while Compound consists of an arbitrary set of attributes.

The main objective is that different datasets (see Clause 3) exchanged using different profiles based on Canonical CIM solely rely on the definitions and basic principles of the Canonical CIM. This is key to make interoperability feasible. This also enables different profiles to relate data between them by using the Canonical CIM as a hub and supports a reader of a dataset or a message to easily find descriptions of elements in both the profiles and the Canonical CIM. The support for relating data in different datasets or messages described by different profiles is needed when data is divided across different datasets governed by different profiles. Such use cases are defined for network models where the network description is separated from the operational conditions of the network (seen as an input) and the results.

There are several languages that can describe profiles, e.g. UML (serialized as XMI), RDFS, Ecore or OWL. UML includes a graphical language that is implemented by UML editors. OWL does not have a graphical language, but several editors exist that support the display and editing of OWL data.

Current profile specifications, IEC 61970-450 (all parts) and IEC 61970-600 (all parts) use UML to describe the information and OCL to further restrict the information. A profile in UML is described by classes, attributes, associations, roles and datatypes, the common way to describe information in UML. The UML language includes the concept of stereotypes and tagged values that enables custom extensions of the UML language. Hence profiling with UML means copying and updating classes, attributes, associations, stereotypes and tagged values from the Canonical CIM. A profile in RDFS or OWL is described by classes and properties but UML stereotypes and tagged values do not have a direct mapping to RDFS/OWL. Profiling using OWL mean creating OWL classes and properties by selecting UML classes, attributes, and roles from Canonical CIM the same way as for profiling with UML. UML stereotypes and tagged values need a specific mapping depending on the meaning of the stereotypes or tagged values. Clause A.1 presents a mapping of the Canonical CIM UML to OWL.

Figure 1 gives an overview of the IEC 61970 specifications in the context of profiling.

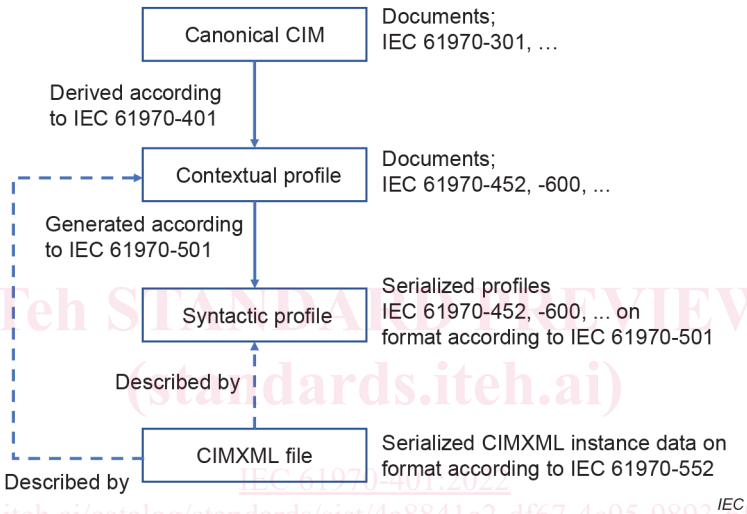




**Figure 1 – Relations between standards and profiling**

The Canonical CIM is shown at the top in Figure 1. Based on the Canonical CIM and a context for the usage, a contextual profile is created. A serialisation of the contextual profile is a syntactic profile. The serialisation format for contextual profiles is described by IEC 61970-501. IEC 61970-501 is the only graph based syntactic profile. Other syntactic profile exists, e.g. a UML based tool can serialize the profile in the XMI format, a tool based on Eclipse Modelling Framework (EMF) can serialize a profile in Ecore and an OWL based tool can use RDF/XML. All these syntactic profiles describe the same contextual profile but, in a format, specific for the chosen serialisation (UML/XMI, Ecore, RDFS, OWL, etc.). Each possible syntactic profile has its own specification, e.g. like IEC 61970-501.

Datasets on CIMXML format are serialized according to IEC 61970-552 and the data in a CIMXML dataset is described by a profile. The contextual and syntactic profile describe the same information, the only difference being that the syntactic profile is machine readable and can be used in processing or validation of CIMXML datasets.

Tools that process data described by profiles, created according to this document, need a machine-readable serialization of the profiles, the syntactic profile. IEC 61970-501 is an RDFS based serialization intended for this. Profiling tools shall support the generation of profiles in the IEC 61970-501 serialisation format. Any tool, regardless of whether it is based on UML or OWL, will have to serialize profiles into a syntactic profile that is used for exchange with other tools or saved for persistency. IEC 61970-501 does not contain all information needed by profiling tools, e.g. it is possible to generate a IEC 61970-501 syntactic profile from a UML representation but not possible to recreate UML from a profile on IEC 61970-501 format. Hence IEC 61970-501 cannot be used as an exchange format between UML based profiling tools.

Standardized vocabularies, that may be used in addition to Canonical CIM, are available from many sources, e.g.:

- The Dublin Core™ from the Dublin Core Metadata initiative dated 18 December 2006,
- The Profiles Vocabulary (DX-PROF) from W3C, a note dated 18 December 2019,
- Profile Guidance from W3C, a draft dated 24 November 2021.

How such vocabularies may be used together with Canonical CIM is not described and requires further development.

### 4.2 Relations between Canonical CIM, profiles and datasets

The CIM specifications can be divided in two groups:

- Canonical CIM,
- Profile derived from Canonical CIM.

The Canonical CIM is an information model for the power system domain standardized by IEC and it is intended to be normalized (information is described only once) without duplicate definitions of the same concept. Canonical CIM is intended to be an information model for the concepts in a domain and not a description of data exchanged by messages.

A profile is a subset of the Canonical CIM intended for a specific data exchange in a specific context, hence a profile is an information model for exchanged data. Information from Canonical CIM is divided into profiles that describe data exchange in different contexts; examples are equipment data that is relatively stable with a low change frequency and power system state that change in times from milliseconds up to hours depending on the use case. The context for equipment data is typically a data modeller tool where the equipment data is maintained while the context for power system state could be real time systems (WAMS, SCADA) or operational planning systems.



IEC 61970 (all parts) support analytical functions used in studies of power systems. A case used in a study is assembled by several datasets described by different profiles, e.g. to run a power flow both equipment data and power system state are needed. Hence the IEC 61970 profiles are dependent on each other and use cases typically involve multiple datasets described by different profiles.

This Subclause (4.2) explains the relationship between the information discussed above and in 4.1. Figure 2 shows the dependencies.

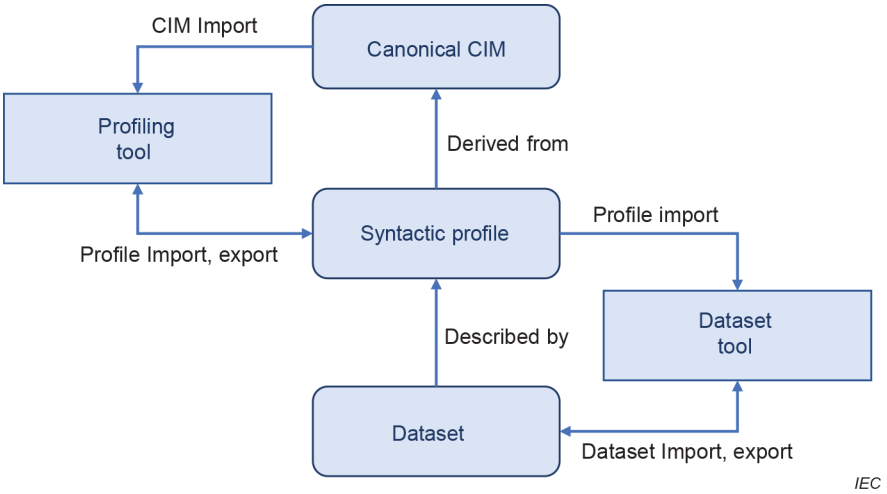


**Figure 2 – Relation between Canonical CIM, profiles and datasets**