IEC 61970-600-1

Edition 1.0 2021-06

INTERNATIONAL STANDARD

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colour inside

Energy management system application program interface (EMS-API) – Part 600-1: Common Grid Model Exchange Standard (CGMES) – Structure and rules

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) – Partie 600-1: Norme pour l'échange de modèle de réseau commun (CGMES) – Structure et règles

IEC 61970-600-1:2021-06(en-fr)

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

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FOREWORD

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International Standard IEC 61970-600-1 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This first edition cancels and replaces IEC TS 61970-600-1 published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC TS 61970-600-1:2017:

- Terms and definitions were updated.
- The "Type" column in all tables was deleted to increase readability of the document as all the rules are considered required, hence categorisation is not necessary.
- Requirement HGEN4 was added to define additional rules to the file header compared to IEC 61970-552:2016.

- Annex B on “Summary of specific rules for naming conventions” is deleted as the information was either integrated in the UML or considered outdated.
- Annex D referring to the PST modelling is deleted as it will be fully integrated in IEC 61970-301:2020+AMD1[1].
- Annex E “Implementation guide” is deleted as all rules and implementation guidance is or will be integrated in either Clause 5 of this document or IEC 61970-301:2020 (and its future Amendment 1) or IEC 61970-452 or IEC 61970-456 as referenced by this document. Note that former Subclause E.11.2 on ConformLoadGroup and NonConformLoadGroup was implemented differently due to another issue, please refer to IEC 61970-600-2:2020.
- Rules GENC17, GENC18, GENC19, EQ__4, EQ__5, SV__4, BPPL12, BPPL13, MVAL5, EXCH9, TP__4 and MARP12 were added.
- Rules GENC3, GENC6, PROF2, PROF4, PROF5, PROF8, PROF9, EXCH5, EXCH6, EXCH7, MAS_4, MAS_6, MAS_9, MAS_10, MAS_11, MAS_13, EQ__1, HREF2, HREF3, HREF5, MVAL3, TPBD1, TPBD2, BPPL10, NAMC12 and NAMC13 are deleted as they are considered not relevant due to other changes.
- The following rules were modified: GENC1, GENC2, GENC4, GENC5, GENC7, GENC8, GENC9, GENC10, GENC16, EQBD2, BPPL11, EXCH2, EXCH3, EXCH8, FBOD3, FBOD5, PROF10, PROF11, MAS_1, MAS_8, HGEN3, HREF1,EEXT1, EQ__2, TP__1, TP__2, TP__3, MARP10, MARP11, NAMC1, NAMC4, NAMC11, NAMC14, BPPL1, BPPL2 and BPPL3.
- Explicit equipment boundary profile definition (EQBD) has been deprecated (refer to Subclause 4.6.5 of IEC 61970-301:2020 and future Amendment 1 for details on deprecations) in this edition in favour of using its full profile counterpart (EQ) for exchange of boundary datasets. The topology boundary profile (TPBD) is not included in the CGMES as TP is considered output and therefore it is no need to exchange Topology information part of the boundary model authority set.
- Annex F has been deleted.

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

FDIS	Report on voting
57/2366/FDIS	57/2382/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.

[1] An amendment to IEC 61970-301:2020 is currently under consideration.

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.

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

The purpose of this document is to define the Common Grid Model Exchange Standard (CGMES) based on Common Information Model (CIM) standards defined in IEC 61970-series, IEC 61968-series and IEC 62325-series and to address requirements defined by the European legislation. However, the document is not limited to the European legislation requirements and business processes, it is created to support data exchange between applications that support power system model management and analysis. The data exchange can be between internal applications or between applications at System Operators (SO) and Reginal Coordination Centre (RCC). This covers DSO-DSO, DSO-TSO, TSO-TSO, TSO-RCC/ISO/RTO and RCC-RCC interfaces, but not limited to these.

The CGMES is created to address the information exchange requirements provided in Common Grid Model methodologies (CGMm) in accordance with the legal requirements stated in various European network codes guidelines. The CGMES applies to applications dealing with power system data management, as well as applications supporting the following analyses:

- power flow and contingency analyses,
- short circuit calculations,
- market information and transparency,
- capacity calculation for capacity allocation and congestion management, and
- dynamic security assessment.

The conformity of applications used for system operation and system development data exchanges with the CGMES is crucial for the needed interoperability of these applications. This document provides the grouping of all principle requirements for the CGMES Conformity Assessment Framework and the guiding principles for assessing applications' CGMES conformity. The description of the CGMES Conformity Assessment Process is currently not part of the IEC 61970-600-series, but it is planned to be included as an international standard in order to validate that the CGMES is correctly implemented by suppliers of the applications used by system operators (ISO/TSO/DSO etc) and for Regional Coordination Centres (RCCs).

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

Part 600-1: Common Grid Model Exchange Standard (CGMES) – Structure and rules

1 Scope

This part of IEC 61970, which covers the definition of Common Grid Model Exchange Standard (CGMES), defines the main rules and application's requirements to meet business requirements for assembled and merged model to fit relevant business services. This document does not define the business requirements, business processes nor how applications are implemented. This document defines how relevant Common Information Model (CIM) standards work together so that specific business requirements can be resolved.

It also includes extensions to the Common Information Model (CIM). The current extensions are defined in IEC 61970-301:2020 and will be covered in its future Amendment 1, but additional extensions can be defined in other standards in the IEC 61970-600-series. The extensions can be used to define additional profiles or to expand IEC 61970-450-series or IEC 61968-13 profiles. However, primary CGMES includes additional constraints on existing profiles and validation of assembled and merged models that is based on existing profiles. This can be done by making optional attributes and associations mandatory (required).

In addition, this document includes the specification of the serialisation that must be supported by referring to an existing standard defined in IEC 61970-550-series, e.g., IEC 61970-552, and making relevant constraints related to it.

The goal is to achieve interoperability between applications using CGMES in a high-performance environment with combined minimum effort so that relevant business processes are satisfied.

An overview of IEC 61970-600 series is provided in the following table, which also presents identified needs that are not yet addressed.

Part	Description	Scope
61970-600-1	Structure and rules. This part defines the structure of the series of standard and the rules that needs to be applied on the assembled and merged models that are defined by the different profile standards.	In the scope
61970-600-2	Exchange profiles specification. This part defines the IEC 61970-450-series and IEC 61968-13 related profiles that are included in CGMES. It includes the references to published standards and additional constraints defined to the relevant standard. If the relevant edition of a standard is not published, it also includes the profile definition and the standard's constraints.	In the scope
to be defined (TBD)	Information extension. This part defines additional information model that is not included in the relevant edition of IEC 61970-301, IEC 61970-302 or IEC 61968-11 that is needed to meet business requirement.	Identified as a need and not yet addressed neither in this document nor in IEC 61970-600 series
to be defined (TBD)	Extended exchange profiles specification. This part defines additional profiles that is not included in IEC 61970-450-series and IEC 61968-13 that is needed to meet business requirement.	
to be defined (TBD)	Conformity Assessment Scheme (CAS). This part defines the Conformity Assessment Scheme (CAS) including test use cases and references to test configurations to evaluate if an application tool conforms to the CGMES.	

Clause 4, Data exchange context, describes the context the CGMES is developed to support.

Clause 5, Specifications and functionalities, defines the rules that shall be applied for validating a model part, an assembled and a merged model. When the rule is defined in the relevant profile it will include a refence to the rule.

Clause 6, CGMES governance, defines the governance of CGMES and the version strategy.

Annex A is left blank.

Annex B (normative), File header guidelines, explains the usage of the file header that is defined in IEC 61970-552.

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 61970-552:2016, *Energy management system application program interface (EMS-API) – Part 552: CIMXML Model exchange format*

IEC 61970-301:2020, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

IEC 61970-302:2018, *Energy management system application program interface (EMS-API) – Part 302: Common information model (CIM) dynamics*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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

NOTE For definitions which are not specified in the CGMES the definitions in the IEC 61970 standard series shall be applied.

3.1 Terms and definitions

3.1.1
assembled model
model of a Model Authority Set with internal references resolved

3.1.2
boundary point
BP
connection point between two Model Authority Sets, that has been agreed on by both relevant Model Authority

3.1.3
boundary set
set containing all boundary points necessary for a merge model

3.1.4
CIM XML document/distribution
instance file which is serialised according to IEC 61970-552

3.1.5
distribution
specific representation of a dataset. A dataset might be available in multiple serializations that may differ in various ways, including natural language, media-type or format, schematic organization, temporal and spatial resolution. The level of detail in the distribution is defined by one or more profiles that the dataset conforms to

3.1.6
Common Grid Model Exchange Standard
CGMES
collection of standards defined in IEC 61970-600 series that support the exchange of power system models (e.g. individual grid model or common grid model) between model authorities (TSOs, DSOs, etc.) for the purpose of coordinated set of services to be performed on the same model according to legislation or general data exchanges in the frame of system operation, system development or utilities' projects

3.1.7
European extensions
collection of classes, attributes and associations, which either extend or are defined in the standard IEC CIM model (IEC 61970-300 series, IEC 91968-11 and IEC 62325-300 series). The European extensions aim at satisfying requirements by the European legislation hence not necessarily applicable to other continents. The worldwide adoption of these extensions may not be exactly the same as the defined extension

3.1.8
external references resolved
no dangling references are present across the models of Model Authority Sets

3.1.9
header references resolved
references defined in model header are resolved

3.1.10
internal references resolved
no dangling references are present within the model of a Model Authority Set

3.1.11
merged model
model that is a union of different assembled models with external and header references resolved

3.1.12
profile
data model to describe instance file for exchange of CIM data. A profile is a subset of classes, associations and attributes needed to accomplish a specific type of interface and based upon a CIM data model. Profiles may impose stricter rules on original classes and associations. A profile is usually converted to schema (XSD, RDF, OWL, etc.) that can be used to create, read and validate instance files for data exchange

Note 1 to entry: This term may be used to define either the semantic model for an instance data payload or the syntactic schema for an instance data payload. A profile may be expressed in XSD, RDF, and/or OWL files. An instance data conforming to a profile can be tested in exchanges between applications. A profile is necessary in order to “use” the canonical model.

3.1.13
solved model
model containing instance of State Variables (SV)

3.2 Abbreviated terms

BP	Boundary point
CIM	Common Information Model (electricity)
CGMES	Common Grid Model Exchange Standard
DL	Diagram Layout profile
DSO	Distribution System Operator
DY	Dynamics profile
ENTSO-E	European Network of Transmission System Operators for Electricity
EQ	Core Equipment profile
EQBD	Equipment Boundary profile
GL	Geographical Location profile
HVDC	High Voltage Direct Current
IEC	The International Electrotechnical Commission, headquartered in Geneva
IOP	Interoperability Test
ISO	Independent System Operator
MAS	Model Authority Set
mRID	CIM Master Resource Identifier
OCL	Object Constraint Language

OP	Operation profile
OWL	Web Ontology Language
RCC	Regional Coordination Centres
RDF	Resource Description Framework
RDFS	RDF Schema
SC	Short-Circuit profile
SHACL	Shapes Constraint Language
SSH	Steady State Hypothesis profile
SV	State Variables profile
TP	Topology profile
TSO	Transmission System Operator
URI	Uniform Resource Identifier
UUID	Universally Unique Identifier
XML	Extensible Markup Language
XSD	XML Schema Definition

4 Data exchange context

There are various levels at which an exchange of power system data/models is necessary. A pan-European model exchange level covers the territory of all system operators (TSOs and DSOs). Regional model exchanges can be realised between different TSOs in one or more synchronous areas. A model exchange on the national level includes interfaces between TSOs (in case there are multiple TSOs on a national level) as well as between different DSOs.

The purpose of model exchanges is not only to exchange the data from one authority to another but also to satisfy the ultimate goal, namely, to perform common studies using shared data. All parties involved in the process should be able to perform the same types of studies and share project tasks between different parties which are using different power system analysis applications. Indeed, the interoperability between different applications used in the exchange process is therefore crucial in both reaching seamless data exchange and obtaining comparable study results when using this data.

The CGMES covers these European and system operators (TSOs and DSOs) business processes by defining the following main types of exchanges valid for a particular study or process:

- Exchange of boundary set: An exchange of a boundary Set is necessary to prepare an exchange of an internal system operator model and to merge a common grid model. E.g. the ENTSO-E Network Modelling Database (NMD) is used to maintain the Boundary Set covering the pan-European area where all TSOs negotiate and agree on the boundary information.

- Exchange of an internal TSO model, i.e. individual grid model (IGM[2]): A number of business processes require each TSO to provide models of its internal territory. To describe its internal territory in a single stand-alone exchange, a TSO is treated as a single model authority set and shall be able to exchange datasets complying with profiles defined in the CGMES. The TSO prepares its internal model in such a way that it is easily and unambiguously combined with other TSO internal models to make up complete models for analytical purposes. This type of exchange can also be applied for the interface between a TSO and a DSO, where models covering transmission or distribution parts of the power system can be exchanged based on a mutual agreement between the TSOs and the DSOs. In this case, and if a TSO requests a DSO model, the DSO would provide its model in accordance with CGMES definitions.
- Exchange of a common grid model: A common grid model refers to the concept of having one model which can be used for multiple purposes. The specification describes what is needed to create a merge model of multiple TSOs' Individual Grid Models (IGM) of their responsible territory into a regional or pan-European model. Various business processes will require specific implementation of the profiles part of the CGMES and the exchange of respective instance files to meet interoperability inside the business process. The Common Grid Model meta-model description will ensure interoperability across the business process.

Business processes (e.g. system development planning, protection planning, operational planning, operation, fault study/simulation, market operation, etc.) are, of course, more complex than these operations, but what is important to note is that all processes are supported using only these basic kinds of interoperation. In addition, business processes shall define or precise, where necessary, the content of the data exchange within the scope of the defined profiles. For instance, OperationalLimitSet can be used to constraint any conducting equipment. It is up to the business process to define if any equipment is mandatory to have operational limits.

Note that each power system model normally consists of multiple datasets (distribution) as defined in CIM standards and further specified by CGMES.

The CGMES supports node-breaker (NB) and bus-branch (BB) model exchanges.

NOTE 1 A network model representation including the connectivity details of all the switching equipment and bays in substations and other equipment containers. Switching equipment is normally not retained, except for those carrying power flow that needs to be monitored, e.g. coupler bays. In order to be used in steady-state analysis calculations, this model representation usually requires topology processing, to produce a BB representation.

NOTE 2 A network model using a simplified representation of a network, typically resulting from topology processing (where the detailed switching equipment and bays get reduced to typically single bus per voltage level in a substation). The only switching equipment used shall be flagged as retained. This model representation is ultimately used in steady-state analysis calculations.

Moving forward the procedures of the model exchanges using the CGMES, it is expected that equipment and steady state hypothesis data (EQ and SSH distribution) will be the input source data for all processes. This type of model should be the fully detailed model with all disconnectors/breakers, etc. Any configuration changes will be made by changing switch statuses.

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[2] IGM: EU Regulation 2015/1222 Article 2 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R1222.