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Part 301: Common Information Model (CIM) Base

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 301: Common Information Model (CIM) Base

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International Standard IEC 61970-301 has been prepared by IEC technical committee 57: Power system control and associated communications.

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

FDIS	Report on voting
57/656/FDIS	57/682/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.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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- withdrawn;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

A bilingual version of this standard may be issued at a later date.

INTRODUCTION

This standard is part of the IEC 61970 series, which defines an Application Program Interface (API) for an Energy Management System (EMS). This standard is based upon the work of the EPRI Control Center API (CCAPI) research project (RP-3654-1). The principle objectives of the EPRI CCAPI project are to:

– reduce the cost and time needed to add new applications to an EMS;

– protect the investment of existing applications or systems that are working effectively with an EMS.

The principal task of the CCAPI project is to produce requirements and draft text for standards to facilitate 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 Systems (DMS). This is accomplished by defining application program interfaces to enable these applications or systems access to public data and exchange information independent of how such information is represented internally. The Common Information Model (CIM) specifies the semantics for this API. The Component Interface Specifications (CIS) specify the content of the messages exchanged.

This part of the series, IEC 61970-301, defines the CIM Base set of packages which provide a logical view of the physical aspects of Energy Management System information. Future IEC 61970-302 defines the financial and energy scheduling logical view. Future IEC 61970-303 defines the SCADA logical view. The CIM is an abstract model that represents all the major objects in an electric utility enterprise typically needed to model the operational aspects of a utility. This model includes public classes and attributes for these objects, as well as the relationships between them.

The objects represented in the CIM are abstract in nature and may be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This standard should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

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

Part 301: Common Information Model (CIM) Base

1 Scope

The Common Information Model (CIM) is an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations. 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 Energy Management System (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. This is accomplished by defining a common language (i.e., semantics and syntax) based on the CIM to enable these applications or systems to access public data and exchange information independently of how such information is represented internally.

The object classes represented in the CIM are abstract in nature and may be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This standard should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into a number of logical Packages, each of which represents a certain part of the overall power system being modeled. Collections of these Packages are progressed as separate International Standards. This part of IEC 61970 specifies a base set of packages which provide a logical view of the physical aspects of Energy Management System (EMS) information within the electric utility enterprise that is shared between all applications. Other standards specify more specific parts of the model that are needed by only certain applications. Subclause 4.2 below provides the current grouping of packages into standards documents.

2 Normative references

The following referenced documents are indispensable for the application 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 61850 (all parts), *Communication networks and systems in substations*

ISO 8601, *Data elements and interchange formats - Information interchange - Representation of dates and times*

3 Terms and definitions

For the purposes of this part of IEC 61970, the terms and definitions given in IEC 60050, Annex A of this document and the following apply.

3.1
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

3.2
Application Program Interface
API
set of public functions provided by an executable application component for use by other executable application components

4 CIM specification

4.1 CIM modeling notation

The CIM is defined using object-oriented modeling techniques. Specifically, the CIM specification uses the Unified Modeling Language (UML) notation, which defines the CIM as a group of packages.

Each package in the CIM contains one or more class diagrams showing graphically all the classes in that package and their relationships. Each class is then defined in text in terms of its attributes and relationships to other classes.

The UML notation is described in Object Management Group (OMG) documents and several published textbooks.

4.2 CIM packages

The CIM is partitioned into a set of packages. A package is a general purpose means of grouping related model elements. There is no specific semantic meaning. The packages have been chosen to make the model easier to design, understand and review. The common information model consists of the complete set of packages. Entities may have associations that cross many package boundaries. Each application will use information represented in several packages.

The comprehensive CIM is partitioned into the following packages for convenience, where packages are grouped to be handled as a single standard document as shown:

IEC 61970-301

- Core
- Domain
- Generation
- Generation Dynamics
- LoadModel
- Meas
- Outage
- Production
- Protection
- Topology
- Wires

Future IEC 61970-302

– Energy Scheduling
– Financial
– Reservation

Future IEC 61970-303

– SCADA

IEC 61968

– Assets
– Consumer
– Core2
– Distribution
– Documentation

Note that the package boundaries do not imply application boundaries. An application may use CIM entities from several packages.

Figure 1 shows the packages defined for IEC 61970-301 CIM Base and their dependency relationships. The dashed line indicates a dependency relationship, with the arrowhead pointing from the dependent package to the package on which it has a dependency.

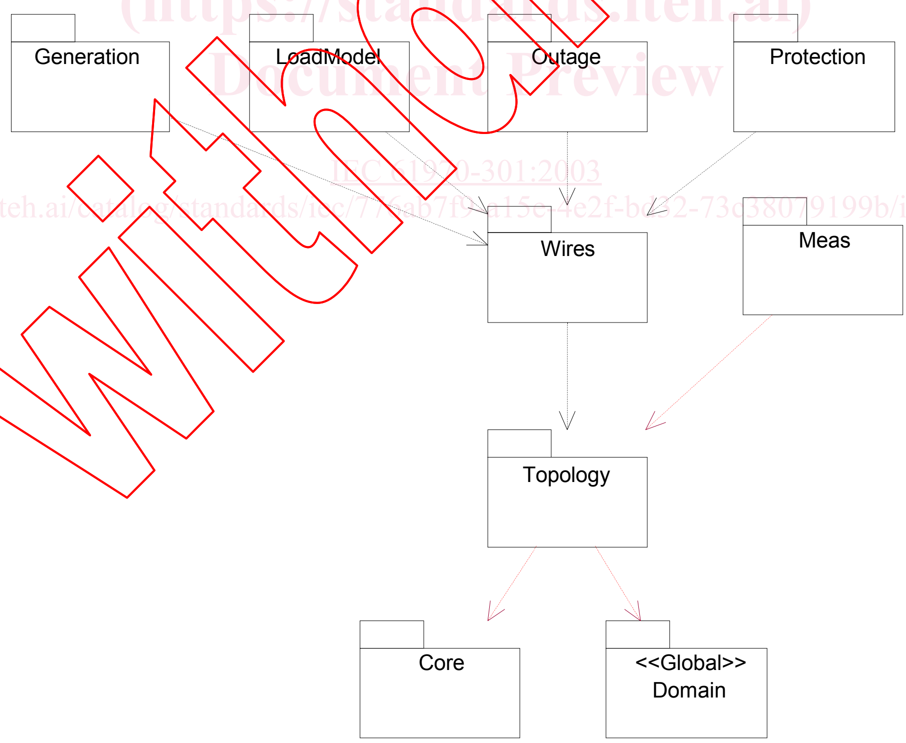

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Figure 1 – CIM Part 301 Package Diagram

The following Subclauses summarize the contents of each CIM package. Annex A contains the specification for each of the CIM packages.

NOTE 1 The package definitions are loosely based on the "Conformance Blocks" that were defined for the CIM specification version 7 defined in the EPRI CCAPI project.

NOTE 2 The contents of the CIM defined in this specification were obtained from a straight conversion of the CCAPI CIM static information model defined in the CCAPI CIM Version 10.

NOTE 3 Annex B contains a mapping of the information modeling notation used in the CCAPI CIM Version 7 to the UML used in this standard specification. This Annex is intended to assist those readers who have previously worked with the CCAPI CIM and who now need to adopt the new UML notation. Those readers not acquainted with the previous CCAPI CIM notation may choose to not read Annex B.

4.2.1 Core

This package contains the core Naming, PowerSystemResource, EquipmentContainer, and ConductingEquipment entities shared by all applications plus common collections of those entities. Not all applications require all the Core entities. This package does not depend on any other package, but most of the other packages have associations and generalizations that depend on it.

4.2.2 Topology

This package is an extension to the Core package that in association with the Terminal class models Connectivity, that is the physical definition of how equipment is connected together. In addition, it models Topology, that is the logical definition of how equipment is connected via closed switches. The Topology definition is independent of the other electrical characteristics.

4.2.3 Wires

The Wires package is an extension to the Core and Topology package that models information on the electrical characteristics of Transmission and Distribution networks. This package is used by network applications such as State Estimation, Load Flow and Optimal Power Flow.

4.2.4 Outage

This package is an extension to the Core and Wires packages that model information on the current and planned network configuration. These entities are optional within typical network applications.

4.2.5 Protection

This package is an extension to the Core and Wires packages that model information for protection equipment such as relays. These entities are used within training simulators and distribution network fault location applications.

4.2.6 Meas

The Meas package contains entities that describe dynamic measurement data exchanged between applications.

4.2.7 LoadModel

This package provides models for the energy consumers and the system load as curves and associated curve data. Special circumstances that may affect the load, such as seasons and daytypes, are also included here.

This information is used by Load Forecasting and Load Management.

4.2.8 Generation

The Generation package is divided into two subpackages: Production and Generation Dynamics.

4.2.8.1 Production

This package provides models for various kinds of generators. It also models production costing information which is used to economically allocate demand among committed units and calculate reserve quantities.

This information is used by Unit Commitment and Economic Dispatch of Hydro and Thermal Generating Units, Load Forecasting, and Automatic Generation Control applications.

4.2.8.2 Generation dynamics

This package provides models for prime movers, such as turbines and boilers, which are needed for simulation and educational purposes.

This information is used by the Unit Modeling for Dynamic Training Simulator applications.

4.2.9 Domain

The Domain package is a data dictionary of quantities and units that define datatypes for attributes (properties) that may be used by any class in any other package.

This package contains the definition of primitive datatypes, including units of measure and permissible values. Each datatype contains a value attribute and an optional unit of measure, which is specified as a static variable initialized to the textual description of the unit of measure. Permissible values for enumerations are listed in the documentation for the attribute using UML constraint syntax inside curly braces. String lengths are listed in the documentation and are also specified as a length property.

4.3 CIM classes and relationships

The class diagram(s) for each CIM package shows all the classes in the package and their relationships. Where relationships exist with classes in other packages, those classes are also shown with a note identifying the package which owns the class.

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 power transformer, generator, 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.

It should also be noted that the CIM is defined to facilitate data exchange. As defined in this document, CIM entities have no behavior other than default create, delete, update and read. In order to make the CIM as generic as possible, it is highly desirable to make it easy to configure for specific implementations. In general it is easier to change the value or domain of an attribute than to change a class definition. These principles imply that the CIM should avoid defining too many specific sub-types of classes. Instead the CIM defines generic classes with attributes giving the type name. Applications may then use this information to instantiate specific object types as required. Applications may need additional information to define the set of valid types and relationships.

Classes have attributes that describe the characteristics of the objects. Each class in the CIM contains the attributes that describe and identify a specific instance of the class. Only the attributes that are of public interest to EMS applications are included in the class descriptions.

Each attribute has a type, which identifies what kind of attribute it is. Typical attributes are of type integer, float, boolean, string, and enumeration, which are called primitive types. However, many additional types are defined as part of the CIM specification. For example, Compensator has a MaximumkV attribute of type Voltage. The definition of data types is contained in the Domain Package described in Subclause 4.2.9.

Relationships between classes reveal how they are structured in terms of each other. CIM classes are related in a variety of ways, as described in the Subclause below.

4.3.1 Generalization

A generalization is a relationship between a more general and a more specific class. The more specific class can contain only additional information. For example, a Power Transformer is a specific type of Power System Resource. Generalization provides for the specific class to inherit attributes and relationships from all the more general classes above it.

Figure 2 is an example of generalization. In this example, taken from the Wires package, a Breaker is a more specific type of Switch, which in turn is a more specific type of ConductingEquipment, which is itself a more specific type of PowerSystemResource. A PowerTransformer is another more specific type of PowerSystemResource.

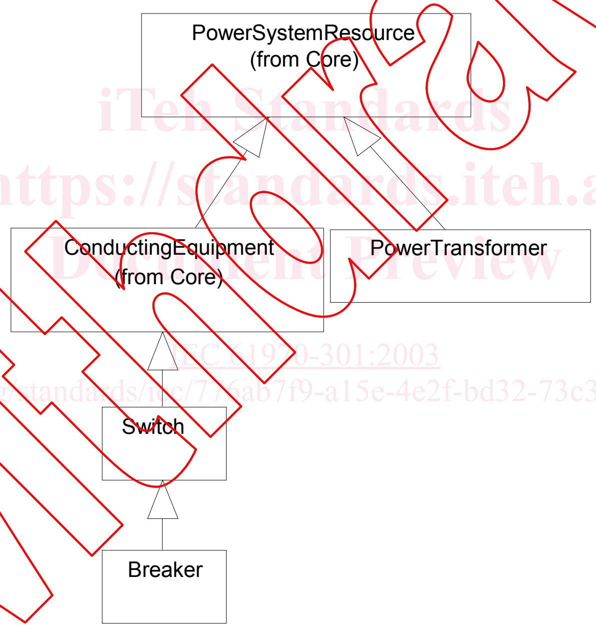

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Figure 2 – Example of generalization

4.3.2 Simple association

An association is a conceptual connection between classes. Each association has two roles. Each role is a direction on the association that describes the role the target class (i.e., the class the role goes *to*) has in relation to the source class (i.e., the class the role goes *from*). Roles are given the name of the target class with or without a verb phrase. Each role also has multiplicity/cardinality, which is an indication of how many objects may participate in the given relationship. In the CIM, associations are not named.

For example, in the CIM there is an association between a TapChanger and a Regulation Schedule (See Figure 3, which is taken from the Wires package).