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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API)

Part 453: CIM based graphics exchange

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International Standard IEC 61970 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/XX/FDIS	57/XX/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 the maintenance result date[1)] 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- withdrawn,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.

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

1) The National Committees are requested to note that for this publication the maintenance result date is January 2010.

INTRODUCTION

This standard is one of the IEC 61970 series that define an application program interface (API) for an Energy Management System (EMS).

The Part 3 series of IEC 61970 specify a Common Information Model (CIM): a logical view of the physical aspects of EMS information. The Part 3 series includes Part 301: Common Information Model (CIM) Base.

This standard is one of the IEC 61970, Part 4 series that define utility control center component interface specifications (CIS). Part 4 specifies the functional requirements for interfaces that a component (or application) shall implement to exchange information with other components (or applications) and/or to access publicly available data in a standard way. The component interfaces describe the specific message contents and services that can be used by applications for this purpose. The implementation of these messages in a particular technology is described in Part 5 of this series of standards.

Energy Management Systems display CIM data mostly in tabular lists and graphic schematic displays. The graphics schematic definitions may be included in the CIM, as defined by the location package IEC 61968, Part 11, or they may be stored in various proprietary formats.

Part 453 specifies guidelines for the exchange of graphic schematic definitions. Part 553-4 defines the SVG format for exchanging graphic schematic definitions.

ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API)

Part 453: CIM based graphics exchange

1 Scope

This part of IEC 61970 is a member of the Part 450 to 499 series that, taken as a whole, defines, at an abstract level, the content and exchange mechanisms used for data transmitted between control center components.

Included in this part of IEC 61970 are the general use cases for exchange of graphic schematic display definitions, and guidelines for linking the schematic definitions with CIM data. Guidelines for management of schematic definitions through multiple revisions are also included.

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 61970 (all parts), *Energy management system application program interface (EMS-API)*

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

IEC 61970-402, *Energy management system application program interface (EMS-API) – Part 402: common services*

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

3 Terms and definitions

The following terms and definitions as well as the entries in the international electrotechnical vocabulary, IEC 60050, apply.

3.1
domain object
an instance of a class that models a Real-World Object with a unique identity

NOTE A domain object inherits from a CIM IdentifiedObject. A domain object is normally not a graphics object

3.2
graphics display
electronic equivalent of a seamless paper plan

NOTE The graphics display is an identified container for the graphics objects. Examples of graphics displays include substation diagrams, transportation or distribution network orthogonal schematics, or pseudo-geographical schematics. A graphics display has a well-defined coordinate space

3.3
graphics object
the graphics display is composed of graphics objects. The graphics objects define the representation of domain objects, static background, or user interaction elements.

NOTE. An example for domain objects includes breakers. An example for static background object includes lakes, and an example for user interaction elements includes buttons.

3.4
presentation logic
defines how to render graphic objects possibly based on the state of domain objects

NOTE Typically, the presentation logic is solved in a very specific way for each system.

3.5
user interaction logic
defines the possible actions a user can execute with a graphics object.

NOTE Typically, the user interaction logic is solved in a very specific way for each system.

4 General use cases for graphic exchange

Figure 1 shows a high-level view of using graphics data exchange with potential systems that can make use of the graphics data exchange.

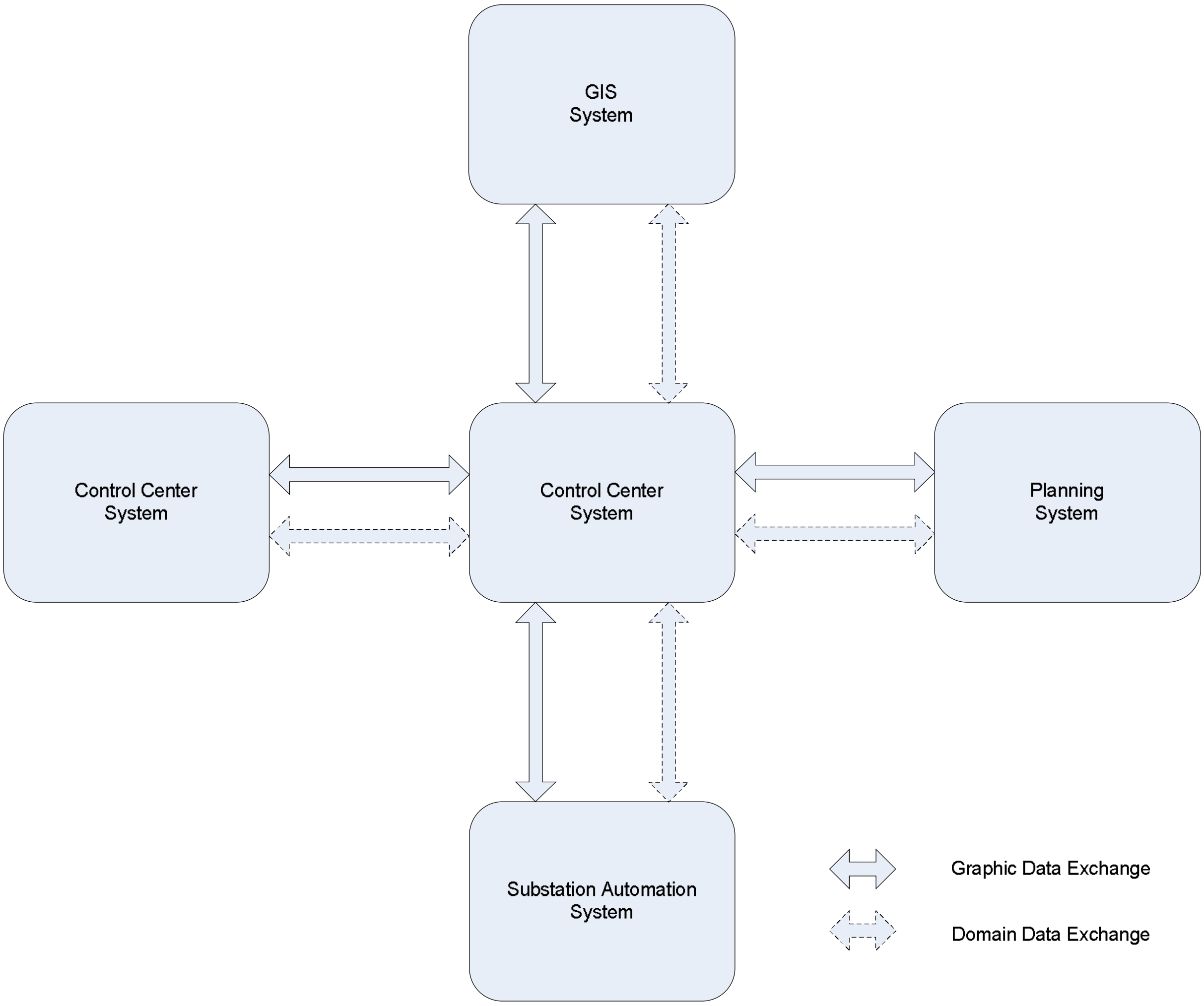

Figure 1 – System overview

With this proposed standard, instead of maintaining duplicate schematics for different applications, the schematics are exported by one system and imported by the other system. CIM based graphics exchange is an extension to the CIM XML model exchange IEC 61970-452, and it requires that references from graphics objects to domain objects can be specified by the exporting system and resolved on the importing system. In a typical case, there will always be a CIM XML model exchange followed by a CIM based graphics exchange.

This process can be applied for initial schematics construction as well as for continuous maintenance.

The importing system can create its graphics displays from the imported data, or the graphics exchange files can serve as additional documentation and means of understanding for the domain data exchange.

5 CIM based graphics exchange format

5.1 General

This standard specifies an exchange format for graphics objects with the following characteristics.

- A generic method for linking the graphics object to the domain data. Domain data and graphics data are exchanged separately from each other.
- It does not require or imply a specific domain data format. Therefore, it supports domain data modelled according to the IEC 61970-301 Common information model (CIM) that is exchanged in the IEC 61970-501 format (CIM RDF schema). Graphics data references domain data in compliance with IEC 61970-402 (common services).
- A method of mapping the graphics objects' representation rules between the different systems.
- Supports the exchange of graphics objects that have no relationship to domain data, i.e., pure static background objects.
- Supports the exchange of complex objects such as command buttons or display call-up buttons.
- Supports multiple representations of the same domain object in the same or different diagrams.
- Uses the diagram as the unit of exchange, providing a straight-forward approach to partial exchange.
- Supports assignment of graphics objects to layers or other means, for showing or hiding information based on zoom level and/or user interest.
- A generic method for proprietary extensions to enable full round tripping (export and import back into the same system) without information loss within a system, and without breaking the standard exchange format.

5.2 Relationship of CIM based graphics exchange to CIM XML domain data exchange

CIM based graphics exchange allows exchanging graphics definitions independent of and separate from domain data. Figure 2 gives an overview of this process.

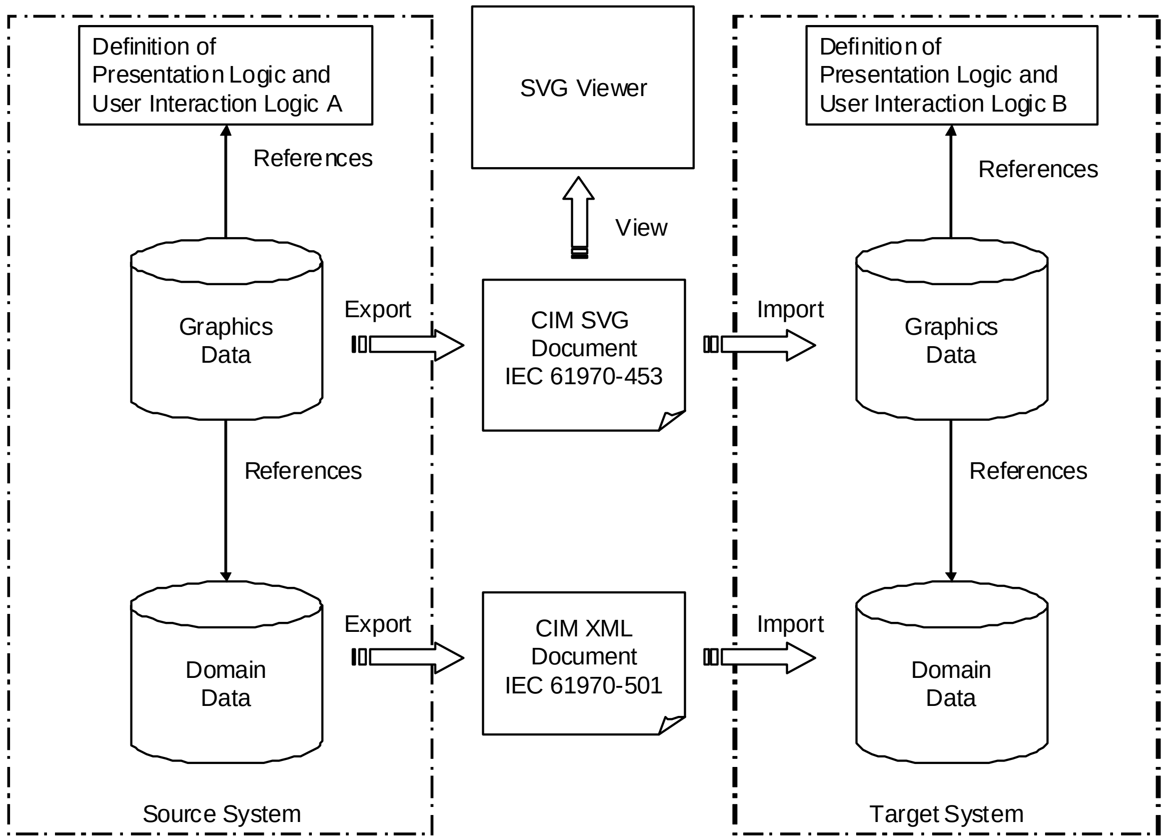

Figure 2 – Graphics and domain data exchange using IEC 61970 exchange formats

An off-the-shelf SVG viewer is not required, but it does enable a basic validation and inspection of the exported graphics data, which is important in locating problems in the transfer from the source to the target system.

When importing graphics data, the following rules apply.

a) The domain data import has to take place *before* the graphics import, otherwise it is not possible to resolve references from graphics to domain objects.

b) It is the task of the importing program to reasonably report and handle inconsistencies between graphics and domain data, for example missing domain data.

5.3 Presentation logic

The presentation logic defines how to convert the state of a domain object into a visible representation. This is typically solved in a very specific way for each system.

The CIM based graphics exchange transfers only references to the presentation logic, not the definition of the presentation logic itself. The importing system will have to map the imported references to its best matching local presentation logic. This shall be by an agreement between the sending and receiving systems, which is outside of this standard's scope.

As an example, if the importing system can derive that a domain object is representing a remote controlled pole mounted load break switch with alarm indication, this might be enough to establish a sufficiently identical visualization in the importing system.

For representing analog measurement values as numbers, properties such as field width, number of decimal digits, font type or font size can be encoded in an SVG text element.

5.4 User interaction logic

User interaction logic defines the possible actions a user can execute with a graphics object, such as object selection, alarm acknowledgement, manual status update, tagging or sending remote commands. Again, this is typically solved in a very system specific way.

CIM graphics exchange does not support explicit references to user interaction logic. Typically, systems derive the user interaction logic by combining information such as graphics object type, domain object class and properties and user rights. User rights are outside the scope of graphics exchange. CIM based graphics exchange files already include all the other information and thus do not need specific references.

5.5 Complex objects

Graphics displays often include complex objects such as picture call buttons, script or program execution buttons, bar diagrams or trending charts. Such objects require specific attributes that may vary between different classes of objects. The proposed standard includes a set of common complex objects with their attributes, and it allows for proprietary additions of other complex objects without breaking the standard exchange format.

5.6 Layers

Layers are typically used for grouping graphics elements according to themes and scales. Themes are used to display or hide certain information (e.g., lakes, borders), while scales are used for hiding or displaying information depending on the current zoom level (hide text when it is too small to be read, or when it exceeds the screen size). This is also called de-cluttering.

Some systems use a 1:*n* relationship between layers and graphics objects, other implementations allow for an *m*:*n* relationship (not all systems call this a layer, but the concepts are always similar).

In order to cover the general case, CIM based graphics exchange will support an *m*:*n* relationship between graphics objects and layers. It will be the task of the importing system to convert an *m*:*n* case into an appropriate 1:*n* representation if the importing system does not support *m*:*n*, or to map an 1:*n* import format to its *m*:*n* implementation.

5.7 Graphics objects data model

CIM based graphics exchange has been designed with the use of SVG in mind. A future IEC 61970-500 series document will define the use of SVG in detail. However, the definition of this series of IEC 61970-400 standards is not limited to using SVG. Graphics objects might well be exchanged using a different format, as long as a relationship between graphics objects and metadata can be represented. Figure 3 shows the top-level data model of graphics objects.

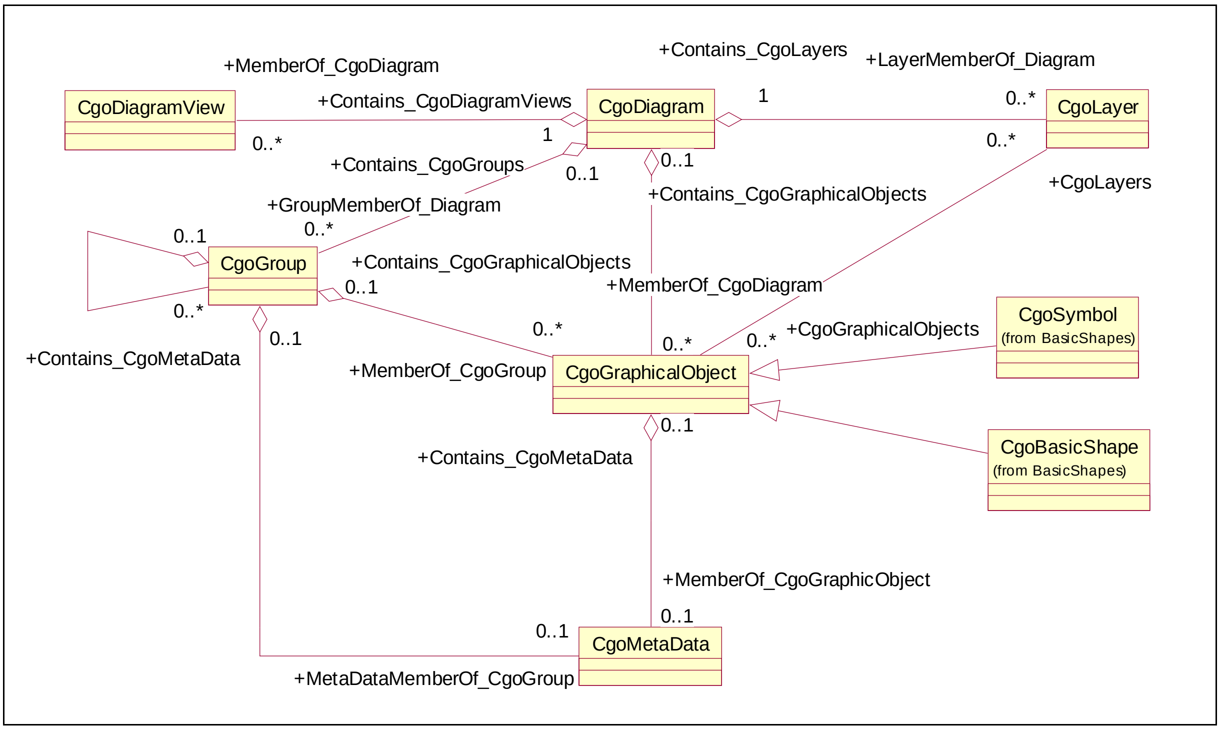

Figure 3 – Graphics object data model

The purpose of the graphics objects and their mapping to SVG are summarized in Table 1:

Table 1: Graphics object summary

Object	Purpose	SVG implementation
Diagram object *CgoDiagram*	Represents one graphics diagram.	SVG element
Graphical object *CgoGraphicalObject*	Contains the graphics definitions. Can contain metadata elements.	SVG basic shape or SVG symbol
Group object *CgoGroup*	Allows grouping of graphics objects. Can contain metadata elements.	SVG group element
Layer definition *CgoLayer*	Contains layer properties. Can be referenced by graphical objects.	Metadata of SVG element
DiagramView definition *CgoDiagramView*	Defines rectangular areas of the diagram that can be used as initial view when displaying a diagram.	Metadata of SVG element
Metadata object *CgoMetaData*	Container for general non-graphical information, such as references to domain data, presentation logic, or layers.	SVG metadata element

5.8 Identification of graphics objects

Graphics objects have an identifier that shall be unique within the diagram. When updating a diagram that has previously been exchanged, this identifier shall be stable and persistent, i.e., in that case it shall never be changed, and never be re-used for another graphics object within the same diagram. This identifier need not be globally unique, that is, it need not be a master resource ID (MRID) as specified in IEC 61970-402, EMSAPI – Part 402: Common services.

5.9 Metadata model

5.9.1 Class diagram

Figure 4 shows the data model for the metadata, and the references to the IEC 61970-301 PowerSystemResource and measurement classes.

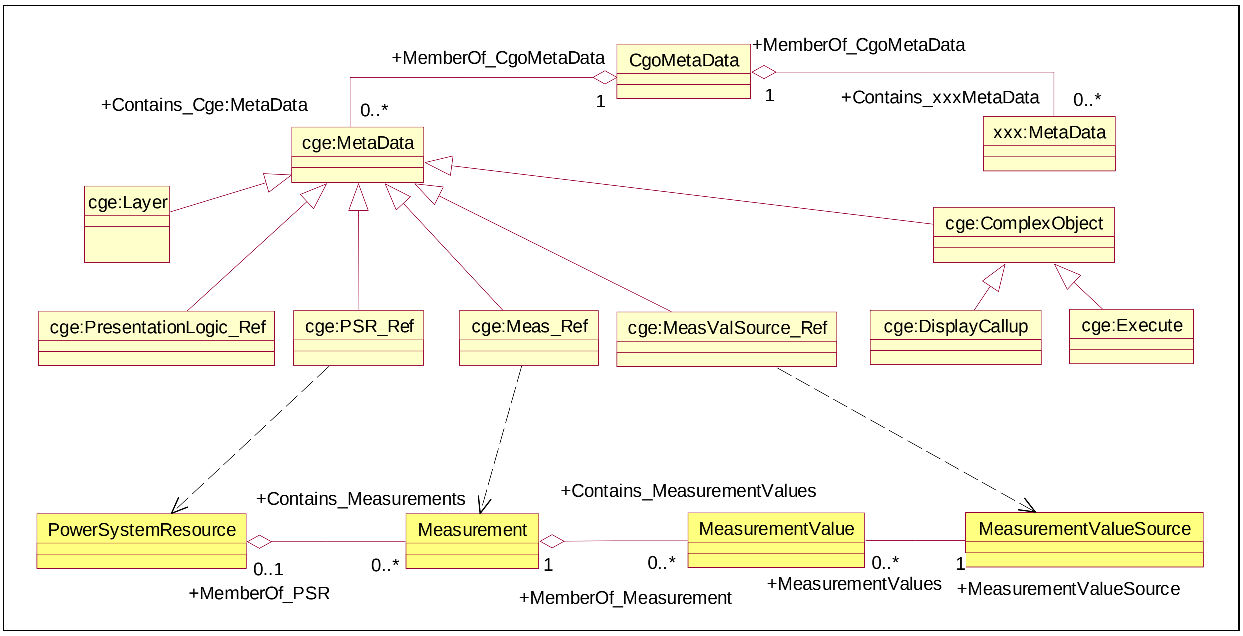

Figure 4 – Metadata model and references to IEC 61970-301 classes

Cge:Metadata elements are XML data contained in a CgoMetadata element. With SVG, the standard metadata element SvgMetaData serves as a container for cge:metadata elements. If another graphics format other than SVG was used, this graphics format would require its own implementation of the CgoMetaData container. The CgoMetaData element links the cge:Metadata elements to the graphics objects, as shown in Table 2.

Metadata elements are either defined by this standard (namespace cge: (***C***im based ***G***raphics ***E***xchange), or they have a proprietary format (any namespace, here shown as namespace xxx).

The cge:Metadata element has a number of common attributes that allow referencing the CIM domain objects and presentation logic. A separate subclass for each type of reference identifies the reference type. Another subclass is used for the complex object, as briefly described in 5.5. This element is then further sub-classed for each class of complex object.

The xxx:Metadata element can be used to include any data that is not part of the standard format. A typical use might be to include system proprietary data for supporting round-trip exchange within one type of system without loss of data (e.g., for version upgrade or system deployment). If such elements are modelled similar to the standard complex metadata elements, the standard could gradually be enhanced with new complex metadata elements.

Table 2 shows the use of metadata reference elements for various cases. Metadata references support the measurement model as described in IEC 61970-301.

Table 2: Use of metadata reference elements

Graphical information on display	Metadata elements used for linking to domain data			
	PSR_Ref	**Meas_Ref**	**MeasValSource_Ref**	**PresentationLogic_Ref (example)**
Breaker State	Breaker	Discrete Measurement	-	Breaker-OnOff
Busbar Voltage	Busbar	Analog Measurement	-	Analog_4.1
Busbar Voltage (SCADA)	Busbar	Analog Measurement	"SCADA"	Analog_4.1
Busbar Voltage (SE)	Busbar	Analog Measurement	"Estimated"	Analog_4.1
Busbar Topology	Busbar / Connectivity Node	-	-	Busbar-Topology

5.9.2 Cge:Metadata attributes

The cge:Metadata element has the attributes as shown in Figure 5.

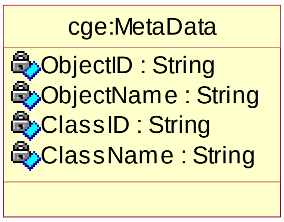

Figure 5 – Attributes of cge:Metadata

Different attribute combinations can be used in expressing references to domain data, presentation logic, or layers. The recommended use is summarized in Table 3.

Table 3: Use of metadata reference attributes

Exchange type or reference case	Metadata Element	Metadata attributes			
		ObjectID	**ObjectName**	**ClassID**	**ClassName**
Round trip or repeated exchange	PSR_Ref Meas_Ref	Mandatory	Optional	Optional	Optional
One-time exchange, or no common identifiers	PSR_Ref Meas_Ref	Optional	Mandatory when ObjectID missing	Optional	Optional
Instance based presentation logic	PresentationLogic_Ref	Optional	Mandatory when ObjectID missing	Optional	Optional
Class based presentation logic	PresentationLogic_Ref	n/a	Optional display_type number	Optional	Mandatory when ClassID missing
Measurement value source	MeasValSource_Ref	n/a	Measurement Value Source	n/a	n/a
Layer	Layer_Ref	Optional layer number	Optional layer name	n/a	n/a

Comments on optional attributes.

- Including names in addition to the IDs is highly recommended, as it makes the exchange document human-readable, allows better error messages in case of problems and also adds redundancy that may help detect inconsistencies.
- Including class information in addition to the object information is also highly recommended for the reasons mentioned above. It also may make the import process more efficient, as the object class is known up-front.

Bibliography

IEC 60050, *International electrotechnical vocabulary*

IEC 61970-1, *Energy management system application program interface (EMS-API) – Part 1: Guidelines and general requirements*

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

IEC 61970-452, *Energy management system application program interface (EMS-API) – Part 452: CIM model exchange specification*

IEC 61968-11, *Application integration at electric utilities - System interfaces for distribution management – Part 11: Distribution information exchange model*