Building a bridge between CIM and PLIB ontologies via IEC62656 on data parcels

Hiroshi MURAYAMA, Lan WANG, & Akira HOSOKAWA

TOSHIBA Corporate R&D Center
Objective of this paper:

Make the SGIP experts see;

the importance and necessity of an online database-oriented maintenance and update of Smart Grid ontology
What is an ontology in engineering?

- Taxonomy of technical terms
- Data dictionary for information objects
- Data dictionary for engineering concepts
- **Common computer sensible description of the engineering concepts, goods, and services, existing in human mind or in the real world**
  - Of which verbal definition, identification, characterization by a set of properties, with their data types, verbal definitions, IDs, units of measurement are explicitly described

PLIB(ISO13584-IEC61360) style of definition of ontology also adopted in POM
What role an ontology is expected to play in Smart Grid?

Ontology is used to share technical concepts and entities in a Smart Grid

- Ontology is referenced for an identification of each product and service in a Smart Grid
- Ontology must provide a common and uniform way of description for all the characteristics of the products and services in a Smart Grid
- Ontology is expected to provide a basis of database representation of the products and services of Smart Grid, for further application and service developments
CIM wanders from UML to an Ontology modeling language

- **OOP approach**: Directly modeling the domain of objects with an object-oriented programming.
  - Example: Java, C++, or XML-Schema, EXPRESS(-G), or UML.
  - **UML** as a neutral & graphic object modeling language that may be exchanged as an XMI file.

⇒ As an ontology, specification might remain incomplete.

- **Ontology Language**: Modeling the objects in a domain by defining a domain ontology (i.e., classification, properties, and their identification), specified by a domain-agnostic ontology modeling language
  - **RDF** (Resource Description Framework), used in IEC61970-501
  - **OWL** (Web ontology language), proposed
  - **PLIB** (Parts Library: ISO13584/IEC61360) for product ontology

- **POM** (IEC62656) is a tabular or spreadsheet-like exchange format of PLIB, called “Parcel sheet”, however with an extended modeling capability to model and update itself within a self-similar structure.
General advantage of ontology modeling approach

- Both OOPL (Object-oriented programming language) and ontology modeling language (OL) are computer sensible, but an OL is intended to impart (engineering) concepts and knowledge about products and services to domain experts, not intended to specify a program design to be implemented by software engineers.
  - Provide a model of integration for engineering concepts and knowledge, independent of implementation platforms
  - Minimum set of information for ontology description is in store and ready for use.
  - Version control mechanism and rules are SOMETIMES built-in
  - Reuse of predefined concepts, such as Units of Measurement, may be available.
What is PLIB and what is POM?

• PLIB is an acronym of ISO13584-IEC61360 Parts Library series of standard.

• It is adopted in more than a dozen of ISO and IEC TCs/SCs for description of product and service ontology, with classes, properties, and their identification.

• In IEC SC3D, an online database is maintained as IEC61360 CDD(Component Data Dictionary) for all sorts of electro-electric products and services.

• POM(Parcellized Ontology Model) is a tabular or spreadsheet-like exchange format of PLIB, called Parcel, being standardized in IEC SC3D as IEC62656 series that includes ISO13584-35 as subset. However, it has an extended modeling capability beyond PLIB to define and update the model itself by 4 (MOF) abstraction layers, all of which consist of a set of self-similar Parcel sheets.
IEC 61360-ISO13584 model has its own followers for technical asset management

ISO TC4
ISO TC10/SC10
ISO TC29/WG34
ISO TC172
IEC SC65E
IEC SC17B

Roller Bearings ISO21107
Process plant
Cutting tools ISO13399
Optics ISO23584
Devices IEC61987
LV-Switchgear IEC NP

ISO TC184/SC4/WG2

Fastener ISO13584-511
Measuring instruments ISO13584-501

ontologoy development principle
ISO13584-42/IEC61360-1

data model
ISO13584-42/IEC61360-2

Data Interface
ISO13584-35/IEC62656-1

IEC SC3D

IEC61360-4
Common Data Dictionary
Online server

Guideline
ISO/IEC Guide77-1,-2,-3

ISO IEC/JWG1

Common maintenance procedure
ISO/IEC Directives

IEC SMB

domain ontology
model, principle, etc
IEC CDD (Component Data Dictionary) at a glance

Visit http://std.iec.ch/iec61360

Or just search “IEC 61360 CDD”

by an Internet search engine such as Google
IEC CDD (Component Data Dictionary) at a glance

International Electrotechnical Commission

IEC 61360 - Component Data Dictionary (CDD)

Language selection

Classification

Definition

- Code: AAA031
- Version: 001
- Revision: 01
- Preferred name: Variable capacitors
- Synonymous name: variable
- Short name:
- Coded name: VAR
- Definition: A set of variable capacitors of which each capacitor can be described with the same group of data element types.
Online database approach enables wider expert participation, supports faster extension, accelerates validation, and facilitates application development and integration.
Simplified view of the constructs of CIM and PLIB
In CIM, a reference points directly to an entity that has an ID.
Some observation about Current CIM RDF Schema

• References among objects are made by directly pointing to an object by a name based URI.

• Each object or relation has no version, but the entire ontology file has one.

• No object-by-object update is foreseen.

• Frequent update of the whole ontology file may not be a welcome solution for implementers of the CIM standard.
• It may take time to agree on an update for whole
• Risk of becoming obsolete before publication when new requirements are added incessantly.
Entity reference mechanism in PLIB and POM

PLIB & POM reference an entity via its ID code
Some observation about PLIB/POM schema

- All references among entities are made thru IDs conforming to ISO/IEC11179-3, that include the version of the referenced entity within:

**ID structure :: RAI # DI ## VI**

Where
RAI means the ID of the Registration Authority,
DI means the Data Identifier,
VI means Version Identifier

- Each entity or relation in an ontology file has a version.
- Continual object-by-object update is foreseen.
- A cycle of update as an IEC standard is complete within 4 to 6 months, applying the IEC database procedure.
Why POM has a spreadsheet like interface?

- Ease of integration with other domain ontologies.
- Ease of extension for new entries
- Ease of use and application for domain engineers

⇒ Easily transformed and stored in a relational database.
⇒ Adding or deleting rows in a parcel will allow entries.
⇒ Customizing the interface is quite easy for engineers.
Extension mechanism of POM

Parcellized Ontology Model (POM) Modeling Layers
“Parcel”; a spreadsheets-like table as a building block of POM

<table>
<thead>
<tr>
<th>Instruction column</th>
<th>Cell columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>#SOURCE_LANGUAGE:EN</td>
<td></td>
</tr>
<tr>
<td>#CLASS_ID:</td>
<td>MDC_C002</td>
</tr>
<tr>
<td>#CLASS_NAME:</td>
<td>Class meta-class</td>
</tr>
<tr>
<td>#CLASS_DEFINITION:</td>
<td>Meta-class being characterized by meta-attributes that are necessary to identify and specify each class in a reference dictionary</td>
</tr>
<tr>
<td>#PROPERTY_ID</td>
<td>MDC_P001_5, MDC_P004_1.EN, MDC_P004_1.FR, MDC_P002_1, MDC_P002_2</td>
</tr>
<tr>
<td>#ALTERNATE_ID</td>
<td>CC, CP, CP, VE, RV</td>
</tr>
<tr>
<td>#PROPERTY_NAME:</td>
<td>Code, Preferred name, Preferred name, Version, Revision</td>
</tr>
<tr>
<td>#DEFINITION.FR</td>
<td>Code, Nom préféré, Nom préféré, Version, Revision</td>
</tr>
<tr>
<td>#DEFINITION:EN</td>
<td>Identifier a characterization class of parts, name of the class, name of the class, version of class, revision of class</td>
</tr>
<tr>
<td>#DATATYPE</td>
<td>STRING_TYPE, TRANSLATABLE_STRING_TYPE, TRANSLATABLE_STRING_TYPE, STRING_TYPE, STRING_TYPE</td>
</tr>
<tr>
<td>#REQUIREMENT</td>
<td>KEY, M..14, M..70, M..70, M..9, M..3</td>
</tr>
<tr>
<td>#VALUE_FORMAT</td>
<td>IEC reference collection, Collection de référence CEI, 001, 01</td>
</tr>
<tr>
<td>#UNIT</td>
<td>Components, Composants, 001, 01</td>
</tr>
<tr>
<td></td>
<td>Electric/electronic components, Composants électriques/electroniques, 002, 01</td>
</tr>
<tr>
<td></td>
<td>Amplifiers, Amplificateurs, 001, 01</td>
</tr>
<tr>
<td></td>
<td>Low-frequency amplifiers, Amplificateurs basse fréquence, 001, 01</td>
</tr>
</tbody>
</table>
Parcelized Ontology Model (POM)

- Ontology at an abstraction level is constructed with a set of Parcels, each one is dedicated to class, property, Data-types, Enumerations, UoMs, or RAlS, etc.

A Domain Ontology (4 to 12 Parcels)
A Domain Library (1 Parcel)
Why we need such an online database approach?

- CIM alone cannot provide a whole range of technical information necessary for smart grid products and services.

- Document based standardization approach cannot keep pace with the required extension of the Smart Grid product classes and properties for new DERs and related services.

- ISO/IEC database procedure allows an update of the content of a standard as database within 4 to 6 months time-frame (IEC directive Annex J).
IEC 62656-3 : Extended Interface for CIM Interoperability

For real sustainability of Smart grid, integration of the attributes is imperative.

You can’t find in the current CIM the manufacturer, spare part, life time for the switchgear!

PLIB (IEC61360/ISO13584) = IEC・ISO common dictionary model

IEC TC111 DB
IEC 62474
SC65E plant devices DB
IEC SC17B Low voltage Switchgear DB
PFI (Fr) DB
ECALS DB
eCl@ss DB

NAMUR (118 Organizations)
Aprox. 130 Organizations
Aprox. 100 Organizations
Aprox. 100 Organizations

Aprox. 100 Organizations

IEC61970/61968 CIM = Power grid specific ontology model

IEC CIM DB
IEC CDD
Parcel (IEC 62656-1)

Bridge btw CIM and PLIB
IEC62656-3

CIM -RDF

IEC61970-X?
Database maintenance of an ontology standard; case of IEC61360

IEC Regular Procedure (e-paper based)

- NP: New work item Proposal
- WD: Working Draft
  - Check by person
- CDV: Committee Draft for Vote
  - Check by person
- FDIS: Final Draft International Standard
- IS: International Standard

IEC Database Procedure (IEC61360 + IEC62656)

- Database
  - Change Request
  - Evaluation
    - Auto consistency check
  - Validation
  - Release

Several years later, it becomes possible to use new CIM standard

It's about half a year to use new CIM standard

EMS/DMS/SCADA, etc.

Register data with a spreadsheet tool
Implementational views of IEC 62656
An example of IEC 62656-1 implementation by spreadsheets

![Spreadsheet Image]

**Ontology schema**

- **A1**: #CLASS_ID:=MDC_C002
- **A3**: #CLASS_NAME.en:=
- **A6**: #SOURCE_LANGUAGE:=en
- **A9**: #DEFAULT_SUPPLIER:=0112/2///62656_1
- **A10**: #DEFAULT_VERSION:=1

**A12**: #PROPERTY_ID
- **B12**: MDC_P001_5
- **C12**: MDC_P004_1.en
- **D12**: MDC_P005.en
- **E12**: MDC_P010

**A14**: #PROPERTY_NAME.en
- **B14**: Code
- **C14**: Preferred name
- **D14**: Definition
- **E14**: Superclass

**A15**: #DEFINITION.en
- **B15**: globally unique identifier of class
- **C15**: name of an item (in full description of the class that is definition)

**A16**: #NOTE.en
- **B16**: The value must be described according to ICD.
- **C16**: The value shall be The.

**A17**: #DATATYPE
- **B17**: STRING_TYPE
- **C17**: TRANSLATABLE_STRING_TYPE

**A18**: #UNIT
- **B18**: M..255
- **C18**: M..255
- **D18**: M..0
- **E18**: M..0

**A22**: #VALUE_FORMAT
- **B22**: M..255
- **C22**: M..255
- **D22**: M..0
- **E22**: M..0

**A24**: #DEFAULT_DATA_SUPPLIER
- **B24**: Lists of Properties
- **C24**: Lists of Properties
- **D24**: 0112/2///61987_11

**A29**: #DEFAULT_DATA_VERSION
- **B29**: Block
- **C29**: Block
- **D29**: 0112/2///61987_11

**A30**: #REQUIREMENT
- **B30**: KEY
- **C30**: MAND
- **D30**: MAND

**A31**: #VALUE
- **B31**: 0112/2///61987_11
- **C31**: 0112/2///61987_11
- **D31**: 0112/2///61987_11
- **E31**: 0112/2///61987_11
An example of IEC 62656-1 implementation by spreadsheets

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>#CLASS_ID:=MDC_C003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>#CLASS_NAME:=en</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>#SOURCE_LANGUAGE:=en</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>#DEFAULT_SUPPLIER:=0112/2///62656_1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>#DEFAULT_VERSION:=1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>#PROPERTY_ID</td>
<td>MDC_P001_6</td>
<td>MDC_P004_1.en</td>
<td>MDC_P005.en</td>
<td>MDC_P022</td>
</tr>
<tr>
<td>14</td>
<td>#PROPERTY_NAME:=en</td>
<td>Code</td>
<td>Preferred name</td>
<td>Definition</td>
<td>Data type</td>
</tr>
<tr>
<td>15</td>
<td>#DEFINITION.en</td>
<td>globally unique identifier of prop name of an item (in full)</td>
<td>description of the</td>
<td>description of the</td>
<td>description of the</td>
</tr>
<tr>
<td>16</td>
<td>#NOTE.en</td>
<td>The value must be described according to CID.</td>
<td></td>
<td>data type of the</td>
<td>data type of the</td>
</tr>
<tr>
<td>17</td>
<td>#DATATYPE</td>
<td>STRING_TYPE</td>
<td>TRANSLATABLE_STRING</td>
<td>STRING_TYPE</td>
<td>STRING_TYPE</td>
</tr>
<tr>
<td>18</td>
<td>#UNIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>#VALUE_FORMAT</td>
<td>M..255</td>
<td>M..255</td>
<td>M..0</td>
<td>M..0</td>
</tr>
<tr>
<td>24</td>
<td>#DEFAULT_DATA_SUPP</td>
<td>0112/2///61987_11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>#DEFAULT_DATA_VERSION</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>#REQUIREMENT</td>
<td>KEY</td>
<td>MAND</td>
<td>MAND</td>
<td>MAND</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>0112/2///61987_11#ABC569#1</td>
<td>Enclosure color</td>
<td>Indicates the gener:</td>
<td>STRING_TYPE</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>0112/2///61987_11#ABC590#1</td>
<td>Measuring range</td>
<td>Range defined by b:</td>
<td>REAL_TYPE</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>0112/2///61987_11#ABC592#1</td>
<td>Number of sensors</td>
<td>Definition of: Num:</td>
<td>INT_TYPE</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>0112/2///61987_11#ABC599#1</td>
<td>Ambient temperature</td>
<td></td>
<td>REAL_MEASU</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>0112/2///61987_11#ABC615#1</td>
<td>Short-circuit monitor:Continuous monitor:</td>
<td>BOOLE</td>
<td></td>
</tr>
</tbody>
</table>
Generated classification view for plant devices
Summary

• SGIP should consider database maintenance of SGIP standards after its first release.

• In particular, CIM (and also IEC61850) maintenance should be performed on an online database

• Application of ISO/IEC database procedure should be considered for future releases of CIM