Research on the Application of Taipower's Distribution Network Mapping Data to CIM Standard Information

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1. Background

Mapping systems play a critical role in distribution engineering, maintenance management, asset management, and customer services. In recent years, as distribution information technologies have advanced, the demand for mapping data across different systems has grown. To meet the internal needs of Taipower's various departments and to avoid redundant development of interface formats and functionalities, it is necessary to examine the data models required for integration, enhance existing mapping system functionalities and architectures, and integrate via standardized interfaces.

Taipower is currently constructing an Advanced Distribution Management System (ADMS). To ensure proper system functionality and operation, it must be integrated with the distribution mapping system to acquire basic equipment data and topology connectivity information. According to regulations, relevant Common Information Model (CIM) standards are to be adopted for data conversion and system interfacing in a standardized format. This study discusses with the relevant departments of Taipower the equipment categories within the mapping system that require conversion, along with the essential attribute data for each piece of equipment. It also cross-references this data with the CIM standards to produce documentation outlining the mapping system's conversion specifications and interface message formats.

2. Research Content

(1) CIM Structure

The International Electrotechnical Commission (IEC), founded in 1906, is the world's first international standardization organization, primarily responsible for standardization in electrical and electronic engineering. In the smart grid field, it has issued over 100 standards and designated the following seven as core standards: IEC 62357, IEC 61970, IEC 61850, IEC 61968, IEC 62351, IEC 62056, and IEC 61508.

According to IEC 62357-1, the core domains of the reference architecture for power systems management and information exchange include:

- Common Information Model (CIM)
- Power system automation
- Information security
- Long-term interoperability
- Use cases

As shown in Figure 1

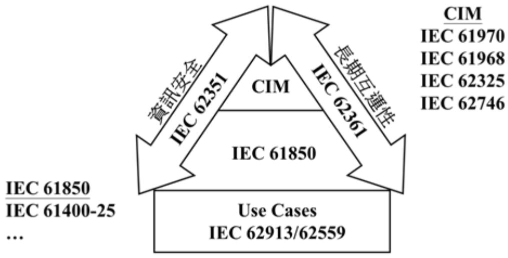

Figure 1. Reference architecture [1]

CIM consists of four main parts:

- Energy Management (IEC 61970)
- Distribution Management (IEC 61968)
- Electricity Market (IEC 62325)
- Customer Energy Management (IEC 62746)

In reference architecture, each standard is also positioned and related according to various aspects, such as generation, transmission, distribution, distributed energy, and users, as well as hierarchical levels, including process, field, substation, operation, enterprise, and market. This indicates that CIM not only functions as an information model across electric power systems but also serves as the standard for information exchange between systems.

As mentioned, IEC defines each required item in the power system as a separate class, specifying the attributes of each class. Adopting object-oriented concepts, CIM also defines relationships such as inheritance, association, aggregation, and composition between classes. Therefore, the first step in implementation is to select the appropriate standard content and version.

Since the CIM standards are extensive, and projects or utilities may only use a subset of them, the CIM Profile concept was introduced. In simple terms, a CIM Profile is a subset of the full CIM standard, including only the classes and associations used in a specific project. Additional constraints and cardinality rules may also be defined in a CIM Profile, thereby limiting the scope and adding necessary rules to the selected portion of CIM.

(2) CIM Profile

According to the Distribution Information Technology Manual, titled "Distribution Network Computer Mapping System," compiled by Taipower's Distribution Department, the mapping system includes six equipment categories:

A. High-voltage equipment
B. Low-voltage equipment
C. Street lighting equipment
D. Fiber optic equipment
E. Pipeline equipment
F. Boundary equipment, topographic symbols, and shallow-excavation pipeline fences

Each category contains equipment coded using the FSC (Functional System Code) classification. Thus, each FSC must be mapped to the corresponding CIM class defined by the IEC standard to form the CIM Profile ultimately.

Table 1 below shows an excerpt of the high-voltage equipment class mappings. Items marked "X" are excluded from conversion. For example, surge arresters are not required at the interface with ADMS and are therefore marked "X." FSC 106, representing trunk and branch conductors, is mapped to the ACLineSegment class; FSC 108, which represents circuit breakers, is mapped to the Breaker class.

Table 1. High Voltage Equipment CIM Class Mapping (Partial Excerpt)

Equipment Name	FSC	CIM Class
High-voltage Trunk/Branch Line	106	ACLineSegment
High-voltage er	107	EnergyConsumer
Circuit Breaker	108	Breaker
High-voltage Jumper	109	Jumper
High-/Low-voltage DER	110	DistributedEnergy

Source: This research

3. Conclusion

As the standard information model and exchange protocol for power systems, CIM integrates high- and low-voltage equipment, attributes, topological connectivity, and spatial data in the distribution mapping system. It establishes a standardized CIM XML file format and supports periodic updates and information-sharing platforms.

This achievement enables future application systems to interface with distribution mapping data through a single platform and standardized format, significantly reducing system workload and simplifying interface development. It allows internal Taipower departments to develop smart grid applications flexibly, based on a unified, standardized distribution mapping data system, thereby avoiding limitations due to workforce or software frameworks. This ultimately enhances development flexibility and enables cross-platform applications of power information systems.

4. Reference

[1] "Power Systems Management and Associated Information Exchange – Part 1: Reference Architecture," IEC: 62357-1, 2nd ed, Nov. 2016.