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IEC 1850 AND CIM-BASED INTELLIGENT SUBSTATION DATA INTEGRATION PLATFORM

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ABSTRACT
In order to solve the consistency and security of smart grid information models, reduce engineering configuration and system maintenance workload, and minimize system operational risks caused by the inconsistency of models, in this paper, on the basis of IEC61850 / non-standard device adaptation gateway studies, authors absorb the model-driven ideology and adopt the distributed system technology to build the high-performance integrated data service platform for the entire substation, constitute part of intelligent applications, and use the CIM/GID standard model and interface to serve the remote dispatch master system.

INTRODUCTION

IEC61850 [1] and IEC61970 [2], as important components of smart gid standards system, respectively have different applications. For the dispatching main station, the Energy Management System (EMS) follows the IEC61970 standard, using the Common Information Model (CIM) [3] to describe the grid model. For the substation automation systems, IEC61850 has been recognized as a new generation of integrated substation automation system to international standards, using the object-oriented technology to build a relatively complete semantic information model for substation automation system. The formal description of semantic information model is realized by Substation Configuration Language (SCL). Because of the different application scopes of different standards, during the data exchange between dispatching center and substation system, these differences can lead to insufficient information exchange between the two of them. Therefore, how to achieve the integration of standards IEC61970 and IEC61850 and realize the information sharing of dispatching center and substations has become the urgent problem.

On the basis of the latest relevant international standards and currently the most advanced digital and intelligent theories and technologies, realize the intelligent functions of the entire substation system and build the substation integration data service platform that is capable of achieve the comprehensive data integration. On this basis, further achieve some intelligent functions. The platform uses the CIM/GID model and interface standards to serve the remote dispatching main station system or local intelligent applications.

Model coordination and expansion

To achieve the data integration of substations and build the standard integrated data service platform, the first is to establish the object information model of substation system, while the IEC61850 and IEC61970 supported models cannot represent all the substations. The two needs to be coordinated. Meanwhile, the two needs to be extended in terms of state supervision, environmental state, video streaming, etc. Studies of model coordination include semantic model coordination and configuration model coordination. Model extension is object-oriented, for the uncovered part of CIM [4] and coordinated model.

Semantic model coordination

IEC61850 configuration model data file format is SCL (Substation Configuration Description Language) [5],

which defines a set of elements and attributes in the form of an XML file, containing all IED data in operation. SCL describes the substation, communication and IED, the three object models. Objects are layered. IEC61970 CIM is based on UML (Unified Modeling Language) standards and the standard object modeling. It describes the data structure and defines the data relationship according to the objects class. Information model has two ways of descriptions. One is the UML, describing the class, class attributes, and class relations. The other is a kind of ontology web language (OWL) [6] developed by W3C, which is an extension of the XML, describing the independent information of the application.

The best way is to combine the two languages, follow these steps:

(1) Modeling the abstraction runtime class by UML and adding to CIM.

(2) Modeling by integrating the substation functions class of SCL and the OWL runtime class.

(3) Modeling on the relations of IEC61850 substation function model and CIM by OWL.

(4) Use the UML to integrate the abstraction class elements of IEC61850 runtime model and CIM model.

(5) Use the OWL to integrate the connected details of IEC61850 runtime model and CIM.

Configuration model coordination

A successful standard integration depends on two necessary factors, i.e. the capability of creating CIM model by IEC61850 configuration, and creating the 61850 configuration from CIM model. The information model consistency needs to process the three levels of information. See the description in Figure 1. The first process is to describe how to make semantic connection of CIM and 61850. It is the "semantic establishment phase". The second process is to handle the actual deployment of the system. For the sake of practical running, it requires to establish all connected information. The third process is to run the model.

Model extension

For the entire substation, the data content is not completely contained within the current CIM. It needs to be extended further, such as equipment condition monitoring data, images or multimedia data, environmental monitoring data, etc. The principle of extension is to follow the IEC61970 CIM thoughts and ideas.

Standard data service platform

On the basis of standard information model (CIM) and data operation interface (GID), integrate all data of substation and provide with standard data service, i.e. build the so-called integrated data service platform for the entire substation. The platform will provide with the panoramic view of substation data for data users, shown in Figure 3. Various substation data, including the substation basic attribute data, real-time monitoring data section, historical data, images or multimedia data, equipment condition monitoring data, and environmental monitoring data, have been integrated into the data service platform, which provide standard CIM/GID services for data users (dispatching main system or local users). The GDA agent technology of GID logically unifies all physically independent data resources and constitutes a virtual substation integrated data service center, allowing the related applications to transparently face a complete view of the data, thus realizing the comprehensive and effective use of various data.

Through the platform internal GID integration bus, it can achieve the connection of data recourses of GID service provided by multiple ACSI-GID gateway (placed in multiple substations, for the condition of multiple substations under control station), and logically result in integrated CIM/GID data service platform providing integrated data services for intelligent applications.

The standardized (IEC61850) adaptation of non-standard secondary equipment

To achieve the standardized conversion gateway of the IEC61850/non-standard smart equipment adaptation, the first is to establish a model of current non-standard smart equipment. Non-standard smart devices generally do not have clear and precise information model. Define it by referring to IEC61850 7-3 CDC and IEC61850 7-4 LN, match the information of device to the standard information, and achieve the standardized modeling.

On the basis of model standardization, by referring to the model coordination methods between IEC61970 CIM/IEC61850 SCL, coordinate the device information model and CIM, and achieve the seamless matching with CIM.

Gateway needs information model coordination and interface adaptation. Non-standard smart devices are mostly not well defined for the application programming interface. But the communication layer is defined. These devices mostly use the IEC60870 5-103-based communication protocol, with necessary modification and expansion. To achieve communication with the device, it must develop relevant protocol adaptation module for the modified version of each communication protocol.

Intelligent alarm

Intelligent alarm helps to achieve the online integrated intelligent analysis and process of alarm information, and realize the class management and integration / compression of a large number of alarm information based on intelligent reasoning. Develop different alarm display program for various needs and present comprehensive alarm in a vivid and direct way.

The system can achieve the intelligent alarm via a state machine mechanism. The generation of an event is triggered by changing the state of logic nodes of intervals. A series of states and triggering mechanism can constitute a state machine. The core of the development of events lies in the realization of these state machines.

Figure 1. Summary of the Consistency Issue.

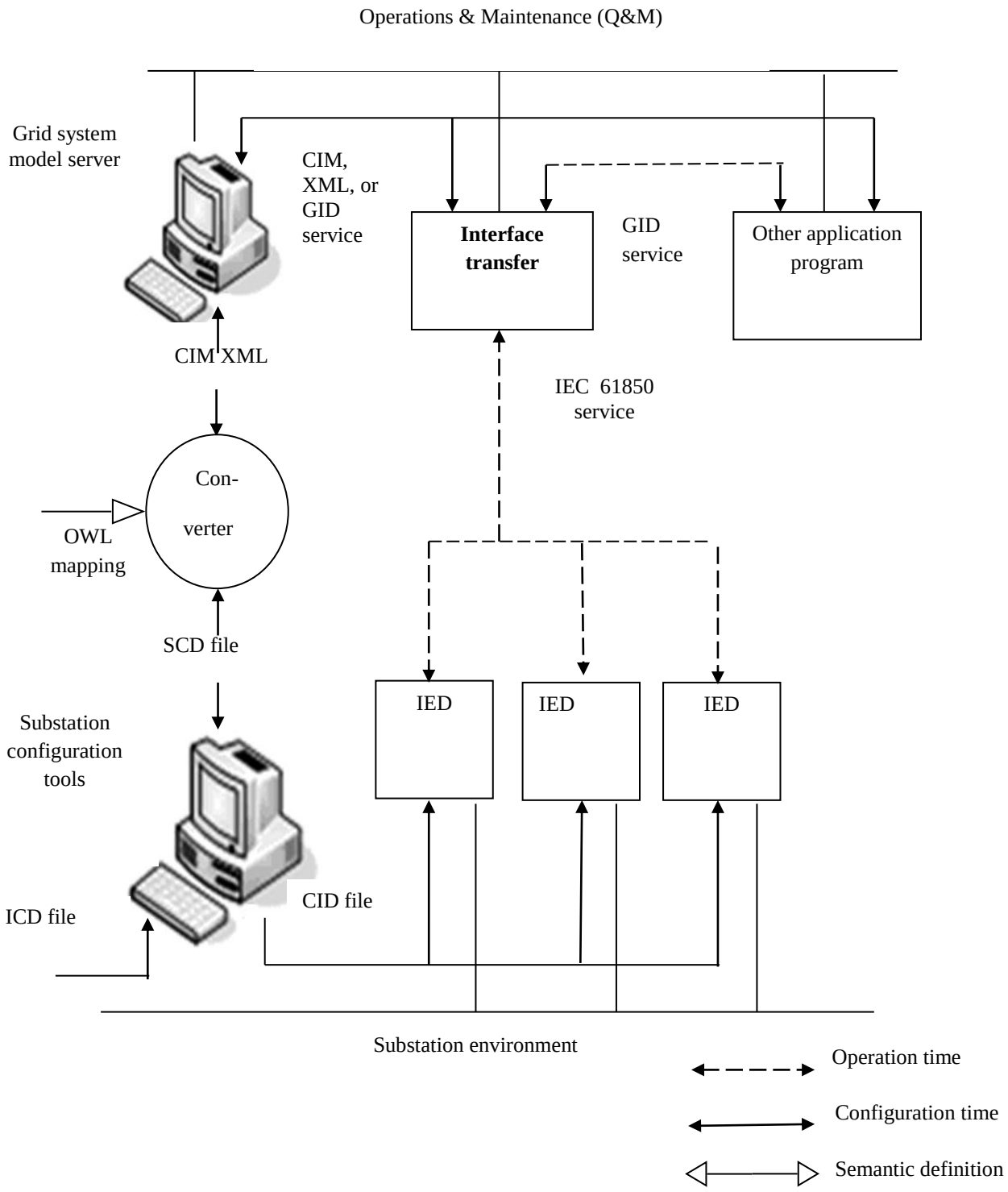

Figure 2. CIM Equipment Hierarchy Diagram

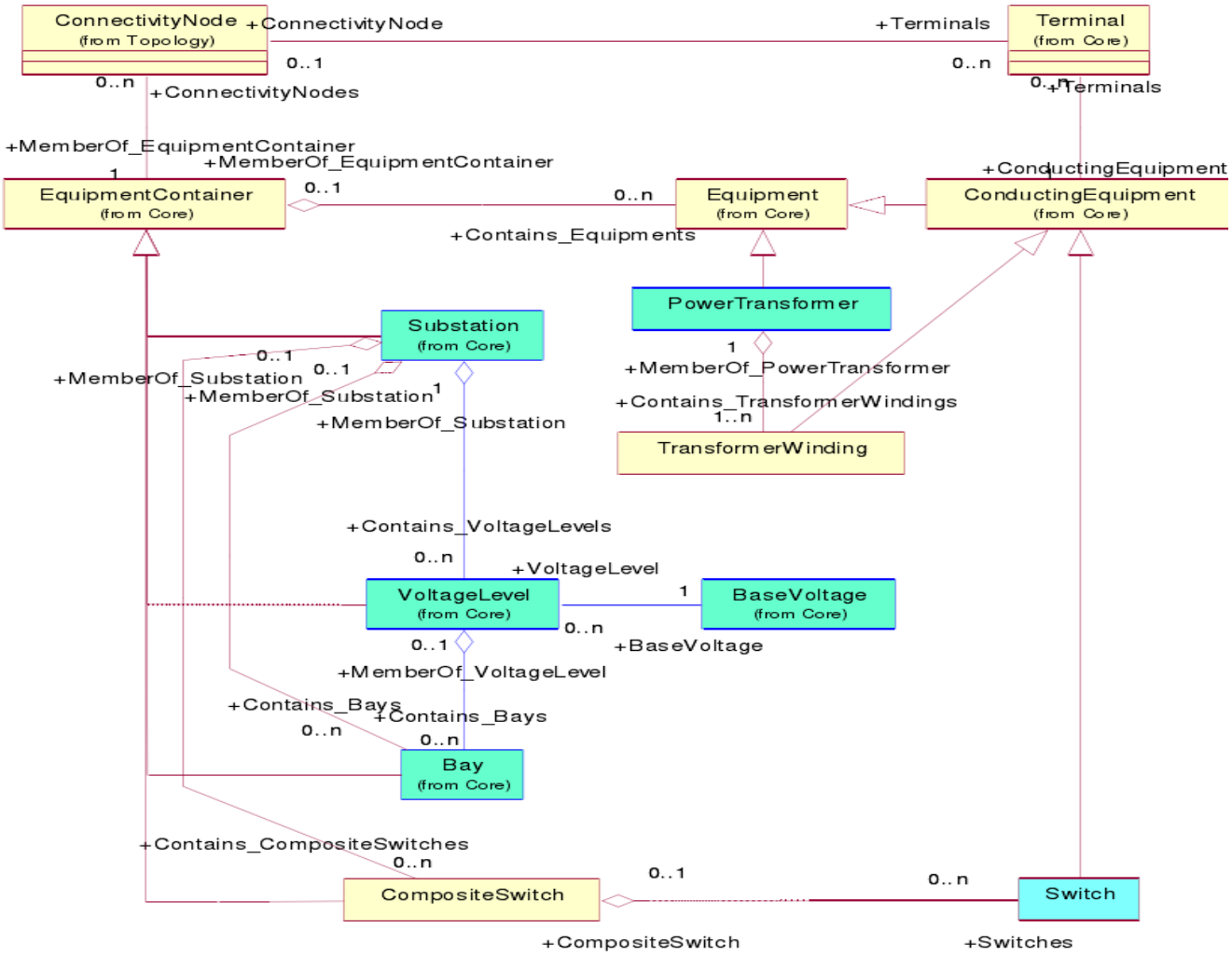

Figure 3. Conception of Substation Intelligent Integrated Data Service Platform

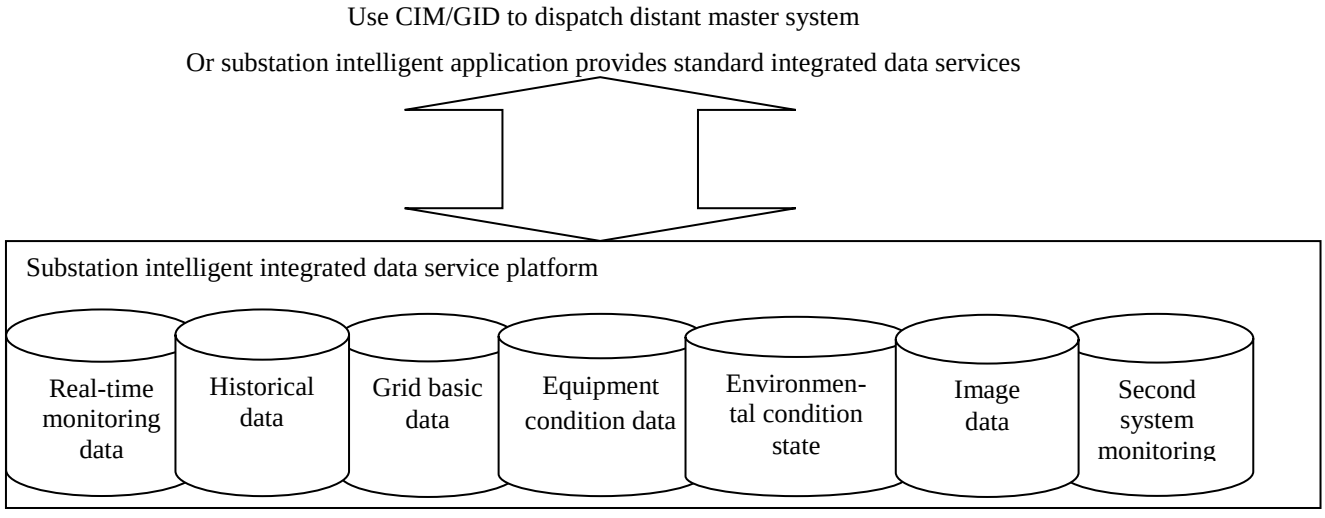

Figure 4. The UML State Diagram

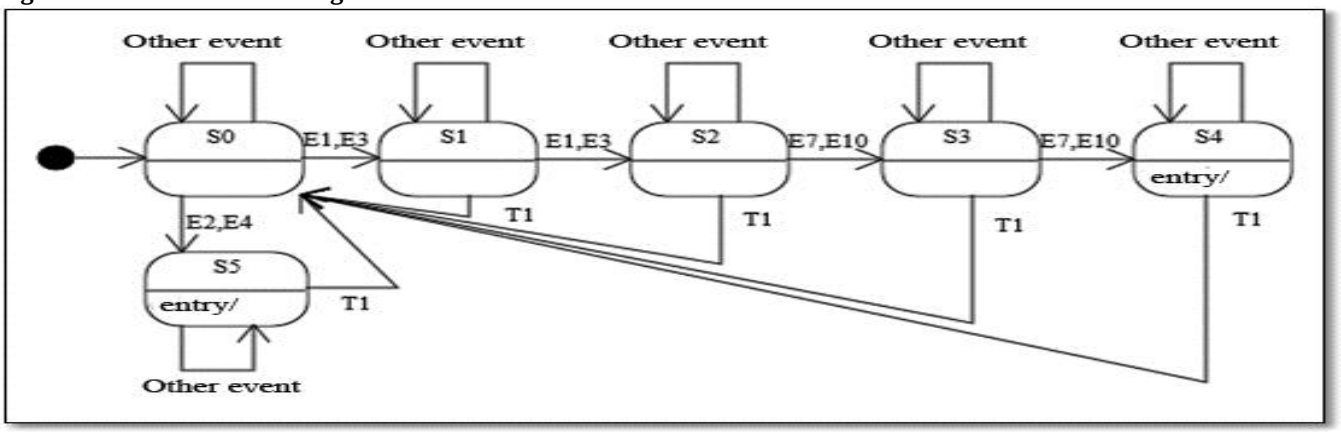

Table 1. Event Table

Serial number	LN	DO	DA	Value change
E1	SIML_1	GasFlwTr	stVal	False->True
E2	SIML_2	GasFlwTr	stVal	False->True
E3	SIML_1	GasInsAlm	stVal	False->True
E4	SIML_2	GasInsAlm	stVal	False->True
E5	XCBR_01	Pos	stVal	On_>Intermddiatestate
E6	XCBR_01	Pos	stVal	Intermddiatestate_>off
E7	XCBR_01	Pos	stVal	=off
E8	XCBR_02	Pos	stVal	On_>Intermddiatestate
E9	XCBR_02	Pos	stVal	Intermddiatestate_>off
E10	XCBR_02	Pos	stVal	=off
T1	Timer timeout			=1000ms

SUMMARY

This system follows the latest international standards, absorbs the model and interface standardization technology thoughts and ideas, depends on the distributed system technology, and builds the standard integrated data service platform for the entire substation, to achieve the integrated effective application of various data of substation and fundamentally solve the problem of substation intelligent data integration. On the premise of realizing substation data integration, the platform can achieve the function of intelligent alarm for the entire substation, effectively improving the intelligent level of substation, and establishing sound technological foundation for the realization of intelligent grid dispatching.

ACKNOWLEDGMENT

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