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Application of IEC61850 in Condition Monitoring of Converter Station

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Abstract

With the increasing of UHVDC transmission project in China, the design, operation management and equipment manufacturing of HVDC projects in China are also at the leading level in the world. However, the condition monitoring technology of converter station equipment in our country is developing slowly. Based on IEC61850 intelligent converter station equipment research, based on the more mature power transmission equipment status testing technology, based on the advanced computer technology, artificial intelligence technology, communication technology used in the converter station of the major equipment State maintenance, the power sector to achieve equipment maintenance gradually by the state inspection and maintenance overhaul. In this way, power grid companies can not only ensure the safe and reliable operation of electrical equipment, but also get the maximum economic and social benefits. So that the

traditional sense of the monitoring system is transferred from independent transition to a networked, integrated and intelligent monitoring system.

Keywords: HVDC transmission; IEC61850; equipment state monitoring; intelligent control

I. Introduction

Compared with the rapid development of HVDC transmission projects, the on-line monitoring of equipment condition in China's converter station has been developing slowly. On the one hand, the reason is that the on-line monitoring of equipment status of the converter station involves many disciplines such as sensor technology, computer technology, control automation, electricity and communication, with relatively high technical content. On the other hand, part of the assembly work has led to a lack of technical support and experimental data on-line monitoring of key equipment at these converter stations.

In recent years, with the application of on-line monitoring technology of AC substation electrical equipment, DC converter stations also learn lessons from the experience of some AC substation on-line monitoring to realize on-line monitoring of some electric equipment such as converter transformer in converter stations. But the existing on-line monitoring system of converter station can detect defects of equipment and reduce accidents to some extent, however, there are many defects and deficiencies such as single monitoring function, independent monitoring devices, Data not being shared, failed to achieve systematic and comprehensive online monitoring, let alone decision support [1].

The purpose of the research on on-line monitoring and decision support system of equipment operation status of converter station is to apply advanced computer technology, artificial intelligence technology and communication technology to the status of converter stations' major equipment maintenance on the basis of more mature testing techniques for power transmission and transformation equipment. The power dispatch center to achieve overhaul of equipment from the planned maintenance to the state overhaul transition. In this way, power grid companies can not only ensure the safe and reliable operation of electrical equipment, but also get the maximum economic and social benefits.

This paper will study converter station equipment operating status of on-line monitoring and the design of decision support system， and software system. In order to realize less maintenance, unattended operation, mobile inspection and digital preparation technology conditions of substation preparing technical conditions, at the same time it can improve the safety and reliability of equipment operation. Technological innovation will inevitably bring about the progress of power transmission and transformation equipment management, which will have a very far-reaching impact on the sustainable and harmonious development of the power industry. The potential benefits are immeasurable.

II. IEC61850 Standard Introduction

IEC61850 is a new generation of substation automation system international standards. The IEC61850 builds device models based on device logic functions, does not limit the logic function of the device, can be flexibly configured device model according to different logic functions , easy to mutual visits between different devices to achieve device interoperability. IEC 61850 standardizes data naming, data definition, device behavior, self-describing features of devices, and common configuration languages. Compared with other international standards, IEC61850 is not limited to a simple communication protocol [2], but a standard digital substation automation system that guides the design, development, engineering, maintenance and other fields of substation automation.IEC61850 standard through the uniform model of the object in the substation automation system, the use of object-oriented technology and independent of the network structure of the abstract communication service interface [3], enhanced interoperability between devices, devices can be realized in different manufacturers seamless operation.

The benefits of using the IEC61850 standard are:

•Communication seamless connection to weaken the device model of different manufacturers;

• Enhance the digital application of device to improve the automation performance;

Customize the standardization can make the substation special requirements of integrated scale increase;

• Enhance unmanned station reliability;

• Reduce the amount of cables used and save the cost of first and secondary equipment.

Compared with the traditional protocol, IEC61850 has the following characteristics:

•The traditional statutory information system is flat and different types of information exist side by side and can not reflect the master-slave relationship of device functions;

• Traditional devices need to communicate the contents can not be arbitrarily configured;

• The traditional protocol extension is not strictly regulated, and the substations with special communication requirements have more limitations.

• Conventional protocol is the underlying transport, IEC61850 is the upper application.

• IEC61850 is by far the most complete substation automation standard.

The use of IEC61850 international standards can greatly improve the substation automation level, improve substation automation safe and stable operation, and save development, acceptance, maintenance of human and material resources. Finally achieve full interoperability.

III. IEC61850 Basic Information Model

The IEC61850 standard information model is completely object-oriented and has the advantages of easy expansion, easy maintenance and reusability. The IEC61850 standard maps physical intelligence devices from different manufacturers to an IED (Intelligent Electronic Device) model. The model is client / server based. Each IED can act as a client and server: Act as a client when requesting services from other IEDs; act as a server when serving other IEDs. The attributes of the IED basic information object model include four levels: Logical Device (LD), Logical Node (LN), Data Object (DO), and Data Attribute (DA).

1) logic device. Logical devices consist of logical nodes and other functional services and are externally described as functional.

2) Logical node. Logical nodes are the smallest unit of function. For example, LN with PTOC type indicates time-over-current protection, MMXU indicates the analog quantity of the 3-phase system, and CSWI indicates the switch target. The LNs contained in the LD can know the features that the LD supports.

3) Data DO and data attribute DA. In the model, the subordinate data of LN is called DO. In the 61850 standard, the meaning of each DO is defined uniformly. DO can include subordinate DO and DA, so DO can be regarded as a structured data. DA is the last level of data in the model, DA can contain DA again.

The details can be seen in Figure bellow.

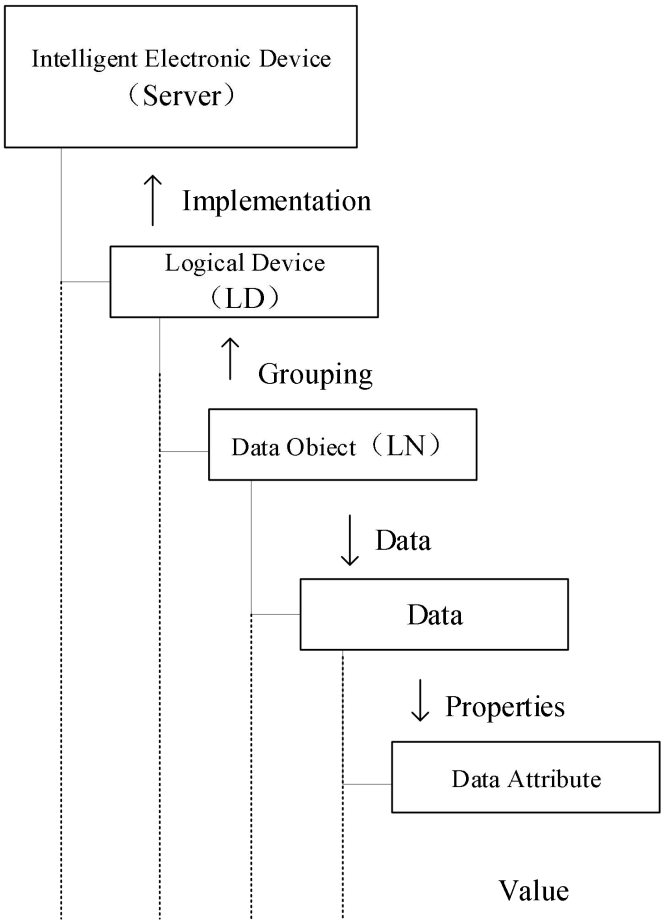

Fig. 1. IEC61850 information basic model.

In the actual implementation, each information model is defined as a class, which consists

of attributes and services. Logical Devices, Logical Nodes, Data, Data Attributes Each is a class that has its own object name (instance name) that has a unique name in the corresponding class of the same container to which it belongs. In addition, each of these four has an Object Reference, which is the concatenation of all the object names in each container, and the four object names can

be concatenated. The following figure is a practical application of an IED information model mapped to the actual program configuration point path list which is shown in Figure bellow.

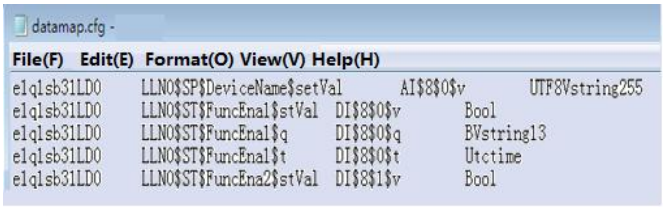

Fig. 2. The file of IEC61850 client configuration.

The second line in the above figure, for example,"$" Delimiter in order to distinguish different segments, the meaning of the information in each column as shown in the following table:

Table 1. Information Mapping Meaning

	Logic device	Logic node	Fun Cons	Data	Data attr	Map Meas. point	Data type
Object	e1q1sb31LD0	LLN0	ST	FuncEna1	stVal	DI80v	Bool

IV. The Way of Implementation

A. The Description Language of IED Communication

Substation Configuration Description Language SCL is a dedicated description language used in the IEC 61850 standard [4]. It uses a scalable markup language to clearly depict the configuration of substation IED equipment, substation systems, and substation network communication topologies [5]. The use of SCL can easily collect configuration information from different manufacturers and configure the equipment, make system maintenance and upgrade, intelligent electronic device control becomes more simple and easy[6]. The use of SCL to form a standard IED data transfer file avoids protocol translation overhead while greatly reducing data integration and maintenance costs. SCL contains 5 starring elements:

1) *Header: Describes the SCL file version and revision, as well as name mapping information;*

2) *Substation: Described the substation structure function;*

3) IED: Describe its configuration, as well as the included LD and LN and communication service functions;

4) DataTypeTemplates: Describe the type of logical node;

5) Communication: Define the contact information between logical nodes.

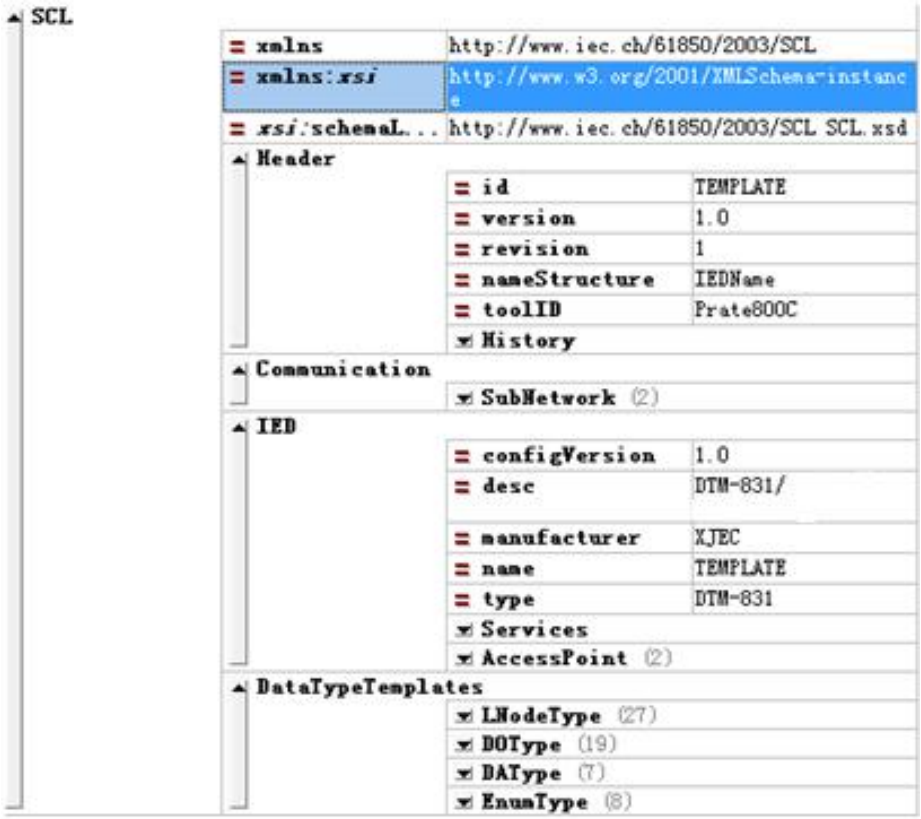

Fig. 3. ICD file framework.

IEC 61850 standard there are four main types of documents: ICD file (IED Capability Description), used to describe a single IED function; SSD Specification (System Specification Description), used to describe the substation structure; SCD file (System Configuration Description), describes the entire configuration information of the substation; CID file (Configured IED Description), is based on the actual substation configuration ICD file obtained. This article only cares about the most basic ICD files. The ICD file must contain Header, IED, DataType Templates elements. The following is an XML analysis tool XMLSpy view a

transformer integrated detection IED ICD file frame diagram and part of the source code which is shown in Figure bellow.

B. The design of IEC61850 client programs

The role of IEC61850 client program is to establish a network connection between the IED unit and the monitoring system back end. Client program flow chart is shown in Figure bellow.

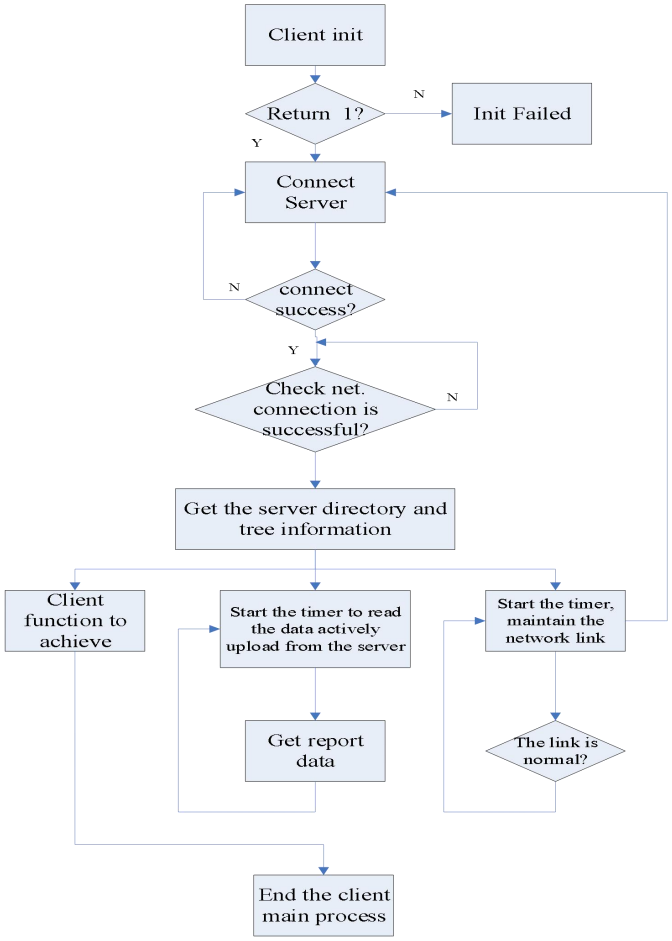

Fig. 3. IEC61850 client program flow chart.

The client program first reads the local environment configuration information, mainly to monitor the list of IEDs and the data map file datamap.cfg for each IED, as shown in the figure[7]. Then map the monitoring objects in datamap.cfg to mapped measurement points used by the program. The above process is the initialization phase. After successful initialization, the client program

dynamically connects to the server based on the network IP address of the server IED [8]. As a demonstration, we used a 61850IED simulation tool to simulate the actual IED device, using our client to connect IED simulation tools. The client program startup information is shown in Figure bellow.

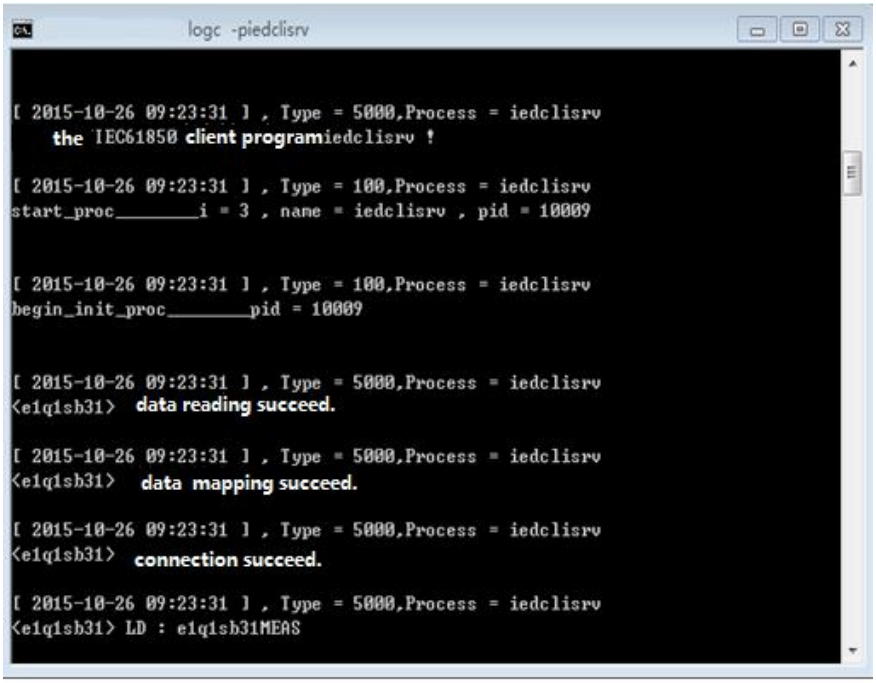

Fig. 4. IEC61850 client program initialization process.

IED simulation tool running information as shown in Figure bellow.

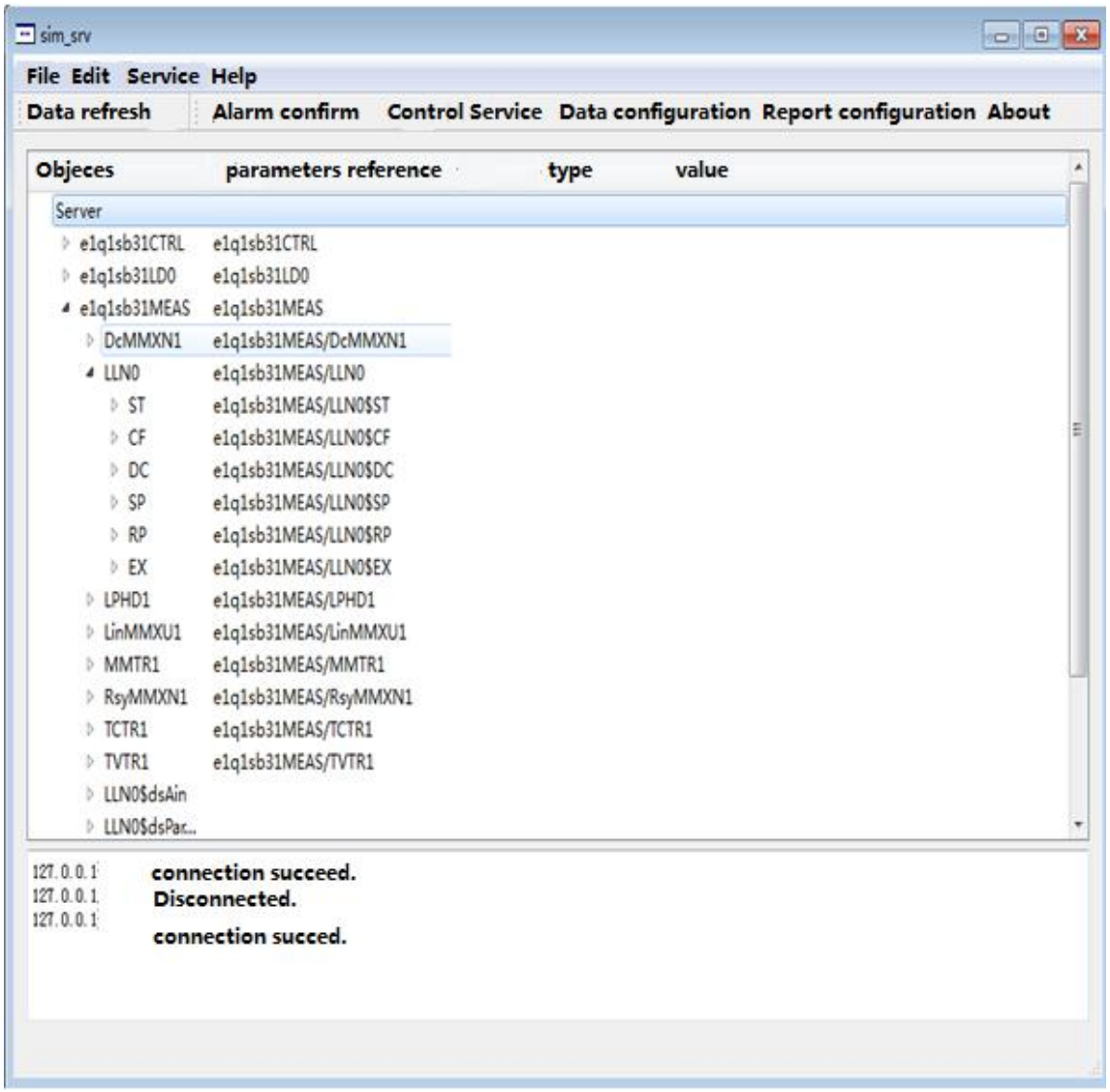

Fig. 5. IEC61850 client program connected with IED simulation tool.

V. Summary

State maintenance based on condition monitoring is the trend of converter station overhaul. At present, due to the imperfect on-line monitoring technology of the DC converter station, it takes a long time to overhaul planned maintenance to condition maintenance. In this process, we should give full play to various means to ensure the safe operation of converter station equipment.

- Status maintenance is the future direction of development. At this stage should be actively doing a great deal of meticulous basic work, such as the establishment of a sound technical files

(Including equipment and equipment factory information, installation and commissioning records, the previous maintenance test reports, operating records, etc) for the maintenance of the state to create the conditions for the future [9].

- The establishment of equipment preventive test database, through a comprehensive analysis of the previous test and maintenance, adjust preventive maintenance and repair projects and cycles according to the reliability and safety of equipment operation.

- Promote the use of advanced measuring instruments and test equipment, and improve the experimental method. In recent years, many measuring instruments and test equipment gradually digitalized, computerized, automated, the measurement accuracy and work efficiency has been improved. With the development of technology, many new methods have emerged, which not only can accurately find the defects of the equipment, but also can reduce the damage to the equipment during the maintenance.

- The development of a comprehensive state maintenance theory, full reference and use of advanced technology in related fields, establishing a standardized state of maintenance technology and management system is very necessary and urgent.

The standard content of IEC61850 is abstract and varied [10]. In this paper, the standards of the system, the construction of the system model of the IEC61850 standard content are very abstract and various. In this paper, the standards of the system, the establishment and implementation of the system model are discussed in a few pages. However, this article is not fully discussed, and there are many tasks to be done next:

- In this paper, we build related software to build and implement the system. However, due to the limited of the access equipments, we need further design and implementation of the device of the convert station.

- We need to combine theory with practice, and strive to apply this design to the hvdc projects as soon as possible, so as to promote the application and development of the IEC61850 protocol in HVDC transmission system..

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