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Research on Source Maintenance Key Technology of the Smart Substation

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Abstract

The source maintenance technology of the smart substation offers the base for the models, data and graphs sharing between the substation and the dispatch center. This paper researches on the conversion technology between SCD model in IEC 61850 Ed. 2 and the CIM model in IEC 61970. The substation provides SVG and SCD documents to the dispatch center, which includes primary equipment information and the network topology. The dispatch center's automation system completes the conversion between the two models. This paper researches on the smart remote technology, which uses IEC 61850 as communication protocol. It can filter and restructure communication data based on the needs of different dispatch center. At the same time, it can provide quality control of communication link, to ensure that the important data be sent in real time.

Keywords

IEC 61850; IEC 61970; Model Conversion; SCD; CIM; Smart Remote; Source Maintenance

1. Introduction

Source maintenance technology is an important part of smart substation advanced applications. It requests that the substation provides a variety of self-described configuration parameters as the data source of the dispatch center. We can use the unified configuration tool to generate the standard configuration files including substation wiring diagrams, network topology and other parameters and data model when we are maintaining in the substation. The dispatch centers don't have to rebuild the data model; they can receive the standard configuration files automatically, and import them into their own system database. The sharing of graphs, data and models are implemented by model information mapping technique [1].

Source Maintenance Technology can provide forceful guarantee for data consistency at dispatch centers, ensure the data model consistency between the substation terminal side and dispatch centers, eliminate the potential risks caused by the data model inconsistencies, and improve the system reliability. Smart substation source maintenance technology includes unified modeling of full station data which meets IEC61850 standard; model mapping between the SCD files based on IEC61850 standard and the CIM files based on IEC61970 standard [2]; smart remote technology which uses IEC61850 standard protocol as the communication protocol between smart

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substation and dispatch center [3]. This paper studies the above key technologies. Specific program is shown in **Figure 1**.

2. Model Mapping between IEC61850 and IEC61970

Currently, IEC61850 Ed.2 standard has been upgraded to the electric power enterprise automation system communication architecture standard, which supports the coordination of the IEC61970 CIM in the dispatch centers, and realizes the functions that master dispatch terminal can access to field device information seamlessly [4]. Both the SCD model and the CIM model use the object-oriented technology to build the data model, and the XML as their own description language, so the SCD model and CIM model have many similarities. By establishing the mapping relationship between the two models, we can convert the SCD model to CIM model, which mainly includes device containers, conductive device, topological relations, and measurement model [5], as shown in **Table 1**.

The conductive devices in SCD model are relatively general, only including the attributes of devices. On the other side, the devices in CIM/E model are defined as classified. As a result, the conductive devices in SCD model and the specific devices class can map by the attributes [6]. As shown in **Table 2**, some of the devices type have no mapping devices in CIM/E, for example, the lightning arrester and the cathead. For those devices, we don't establish mapping relationship.

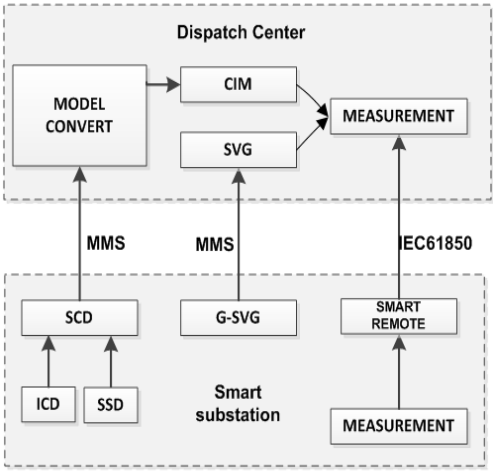

Figure 1. Source maintenance framework map.

Table 1. Mapping of SCD and CIM Model.

Mapping Type	SCD Model	CIM Model
device containers	Substation	Sub Control Area
	Voltage Level	Base Voltage
	Bay	AC Line Segment, Energy Consumer, Busbar Section
conductive device	Conducting Equipment	Power-Transformer
		Breaker
		Disconnecter
		AC Line Segment
topological relations	Terminal	I_node
	Connectivity Node	J_node
measurement model	L node	Discrete
	…	Analog

Table 2. Conductive devices mapping relationship.

Conductive devices type	CIM Model
CBR	Breaker
DIS	Disconnecter
LIN	AC Line Segment DC Line Segment
…	…

3. Intelligent Remote Technology Meeting the IEC Protocol

Currently, the communication between the smart substation and the dispatch center still use traditional IEC60870-5-101 or 104 protocols. The system need to transform the IEC61850 to the 101/104 protocol so that the communication complete successfully [7]. Because the traditional protocol does not support the object-oriented modeling methods, the system must transform the IEC61850 object to certain information points, leading to extremely complex configuration tasks of forwarding information, which greatly increases the workload of the system and results in many errors, for example, unable to achieve seamless interconnection, as shown in **Figure** 2.

To solve the problems, it is necessary to develop a new generation of smart remote device, which use IEC61850 as communication protocol. It can make sure the consistent between the communication model and the substation data model, avoid series of project implementation and maintenance issues, such as model conversion, secondary configuration and transmission test. The smart remote device solves the following two technical difficulties, as shown in **Figure** 3.

Firstly, for the dispatch system, the IEC61850 describes the substation data model over detailed. The SCD file contains full data of various voltage levels. But the dispatch center of different levels concerns various contents. For example, the junior dispatch center cares about 110 kV voltage level, while the senior dispatch center cares about 220 kV or 500 kV voltage level. It is obviously unrealistic if the substations upload the whole SCD file to every different level of dispatch center, and ask them to pick out the data they need from the massive data.

Secondly, different from 101/104 protocol, the iec61850 protocol don't control the priority of data, which means that the data isn't divided into junior and senior level data, and rapid transmission of important data cannot be guaranteed. For example, when a large number of telemetry data is sent to the dispatch center cyclically, meanwhile, the switcher operates and the information must be sent to the dispatch center. It is likely the data can't be delivered on dispatch center immediately because the communication bandwidth is limited. Therefore, in order to achieve the communication sharing based on IEC61850, the remote device must be smarter. It is not only the communication gateway device forwarding message transparently, but also the server filtering and restructuring data. It gathers, filters and groups the IED's data, to form a new dataset such as 500 kV dataset, 220 kV dataset, etc. and send to the dispatch centers, depending on the information content required for the different dispatch center. Considering the problem that the iec61850 don't have priority control, it is proposed to revise the current mechanisms of MMS services, to interrupt the data being transmitted and insert the higher- priority data in this paper. Additionally, we may reinforce communication channel's quality controlling or use another channel to transmit the important data such as the switcher operation information, to ensure that the important data be sent in real time.

4. Conclusions

Currently, source maintenance functions still remain in the preliminary stage, and there is no practical engineering solution. This paper researched on the source maintenance key technology of the smart substation, proposed practical techniques method. The substation provides SVG and SCD documents to the dispatch center, which includes Primary equipment information and the network topology. The dispatch center's automation system completes the conversion between the two models. The dispatch center and substation communicate through the smart remote device, which based on IEC61850 protocol. The dispatch center's automatic system does not need to model the data, and the data modeling work is done at the substation side. By doing this, the workload of the dispatch center is reduced substantially. Furthermore, the need of manual configuration of substation sending

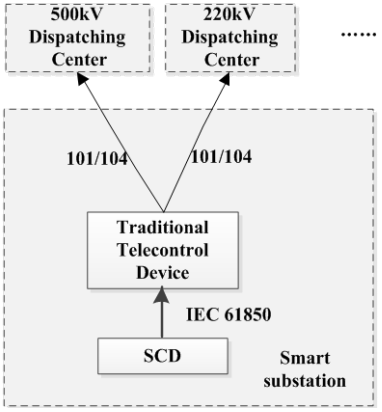

Figure 2. IEC61850 to 101/104.

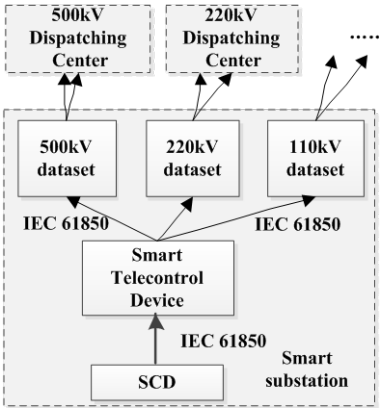

Figure 3. New approach to exchange real-time data.

data and dispatch center receiving data does not exist. The technical staff doesn't need to experiment a lot of test to verify the correctness of the configuration and the system's reliability is improved.

With the continuous development of network communication technology, the Source maintenance functions will be more extensive and practical, the data sharing technology and application integration will be further developed, which is useful for the advanced function's progress, such as real-time automatic control of the grid, smart regulation, on-line analysis and decision, etc.

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