A Study of IEC 61850 ICT Standard Used in Hydroelectric Power Plants

(Information & Communication Technology Research Lab：Chang Liao, Chun-Kuei；Cho, Chi-Shiang；Chen, Fung-Fei)

I. Purpose

To cope with the future application requirements of smart grids, the relevant information and communication infrastructure must be implemented first. Especially in the context of electrical power automation, Taiwan Power Company (TPC) follows the footsteps of advanced countries to actively implement international information and communication standards such as IEC 61850 and to meet the goal of OT and IT information interoperability. It facilitates the integration of different data systems among various fields and automatic operation for future smart grids.

Following the core ICT standards of the Smart Grid defined by IEC TC 57, IEC 61850 is one of these standards. Its scope covers power generation, transmission, distribution, distributed energy resources, etc., from field equipment to the control center. IEC 61850 information and communication architecture develops from substation automation and expands to other application domains. Nowadays, TPC is gradually planning and retrofitting domestic substations with IEC 61850 ICT architecture. In addition, Xingda Power Plant contains a combined cycle gas turbine (CCGT) unit, including three gas turbines and one steam turbine. The supervisory system contains IEC 61850 information about generator protection, lines protection, and power generation measurement of the CCGT.

This study focuses on the application of IEC 61850 in the power generation system, especially for each subsystem, main function and parameter of the hydroelectric power plant. In this study, the IEC 61850 data model profile is built and provided to the power generation department, and our team continuously executes some communication tests by simulation in the laboratory.

II. Research Results

Fig. 1 shows the overall communication architecture of a hydroelectric power plant, which is divided into several subsystems: 1. Dam and gate control system, 2. Water turbine and governor system, 3. Excitation and power generation system, 4. Auxiliary system, 5. Protection system, 6. Monitoring system.

Here IED 1 works as the intake valve controller to control the inflow of water. IED 2 controls the water turbine and the governor, including speed control. IED 3 deals with the auxiliary system, including the oil system. IED 4 is used for the generator monitoring system. IED 5 is responsible for controlling the excitation system. IED6 is used for monitoring the bearing. IED7 works as the dam and gate monitoring system. Unit IED is responsible for the generation data collection and control. Common IED is used for communication with remote terminal equipment. Merging unit 1 to 3 are used for current and voltage measurement of generators, medium voltage, and high voltage transmission lines, respectively. PROT 1, 2 T and PROT 1, 2 G work for the primary protection and secondary protection for transformers and generators, respectively.

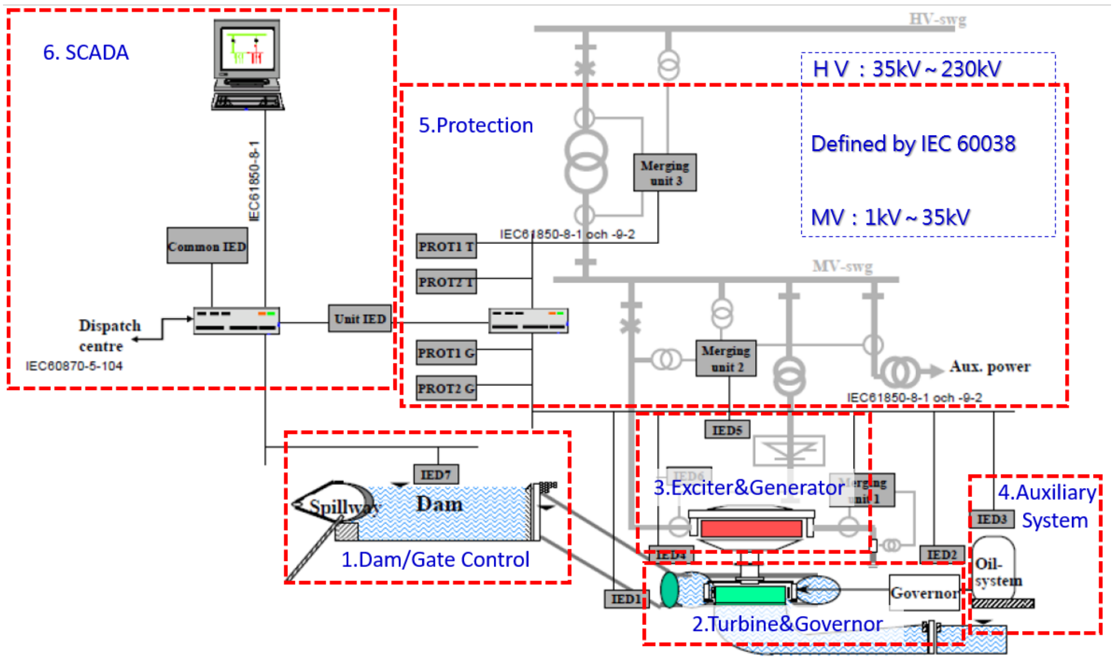

Fig. 1 Simplified network of a hydroelectric power plant and each subsystem

Reference: IEC 61850-7-510

To illustrate the data modelling process, let's take the high-pressure oil system as an example. Consider an oil system named PresOil that contains four logical devices, including an oil tank (Tnk), a pump (Pmp), a bearing (Brg), and a valve (Vlv). Each logical device contains the required logical nodes. For example, the logical device Tnk contains LLN0, LPHD1, KTNK1, TPRS1, TPRS2, and TTMP1. Here LLN0 is used to indicate the state and mode of the logical device, along with the public information about the logical device; LPHD is used to indicate the nameplate, specifications, and other information of the physical device; KTNK is used to represent the relevant information of the tank, such as the volume of the tank and the oil level, etc.; TPRS and TTMP are used to represent pressure sensor and temperature sensor respectively. IEC 61850 IED Configuration Tools (ICTs) are used to build such an information model, and Fig. 2 shows the result of data modelling.

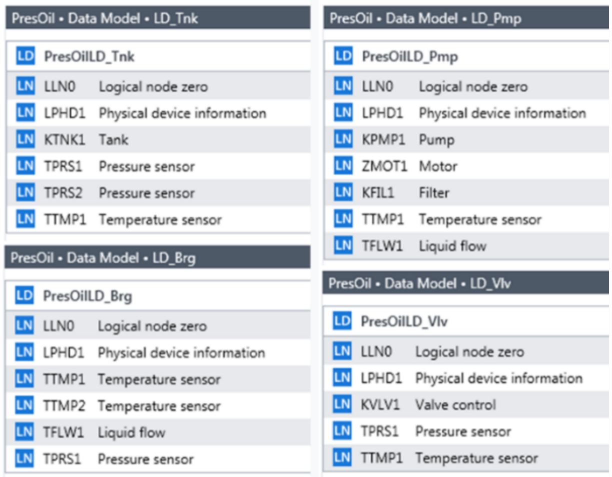

Fig. 2 Built oil system data model

After completing the aforementioned information model configuration, a communication testing system is established in the laboratory, including a simulation of the IEC 61850 MMS Server (as shown in Fig. 3) and the IEC 61850 MMS Client (as shown in Fig. 4). Here, the oil temperature, pressure, tank level, and other data values are configured as a dataset, and then the dataset is used for a Buffered Report Control Block (BRCB). After activation, the IEC 61850 MMS Server will start to trigger the MMS report and send it to the MMS Client according to changes or updates of the values in the dataset. In addition to observing the records through the IEC 61850 MMS Client interface, Wireshark is also used to capture and analyze the transmitted MMS packets (as shown in Fig. 5), verifying the correctness of each transmitted data.

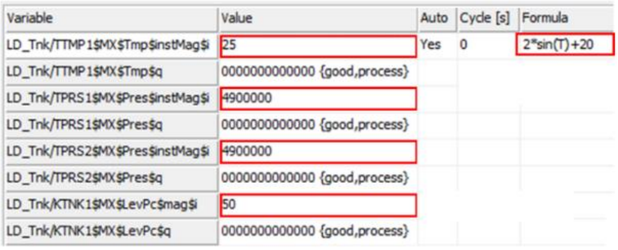

Fig. 3 Simulated IEC 61850 MMS Server

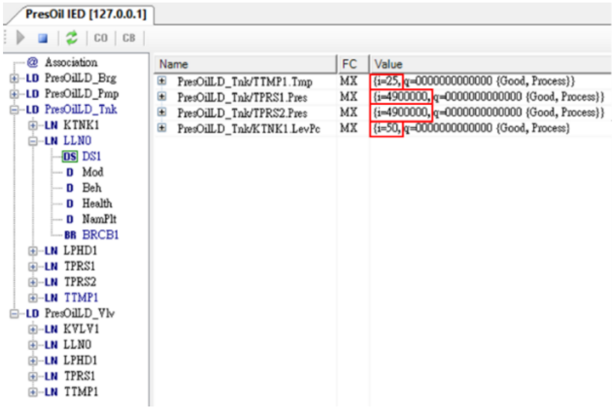

Fig. 4 Simulated IEC 61850 MMS Client

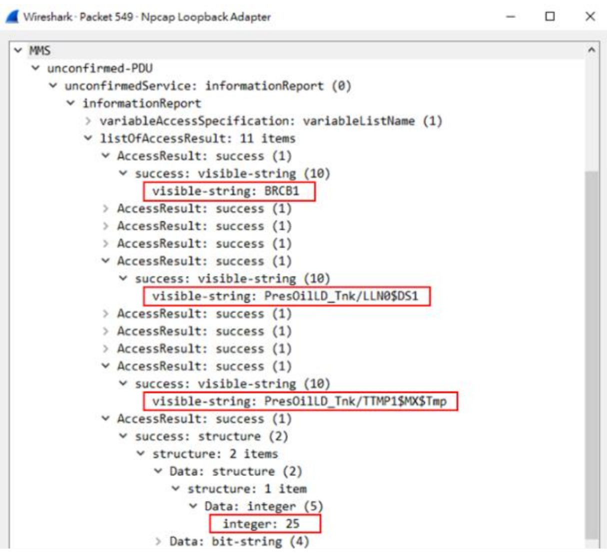

Fig. 5 Packet recoded by Wireshark

III. Conclusion and Suggestion

In this study, our team establishes the data model profile of each subsystem of the hydropower plant according to IEC 61850 standards, providing it to the power generation department for future application. In addition, a preliminary information and communication test is carried out in the laboratory to verify its feasibility. By the way, it is recommended that the application department should have an overall consideration upon implementing this standard in the hydroelectric power plant. Besides the information and communication integration of various system interfaces, some advanced and future applications should be considered, so the benefits of introducing the standards will be more prominent.