A Study of Interoperability in IEC 61850 Substation with Process Bus and Station Bus

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I. Purpose:

Taiwan Power Company is committed to promoting the IEC 61850 international standard and expects to integrate the standard data model and communication services with the Smart Grid Architecture Model to link the energy supply chain of power generation, transmission, distribution, decentralized energy, and customer side. In addition, the smooth connection of the energy hierarchy control of IT and OT segments is also considered and expected to be achieved by integrating the interoperability levels from the component level, the communication level to the business level with the latest communication technology.

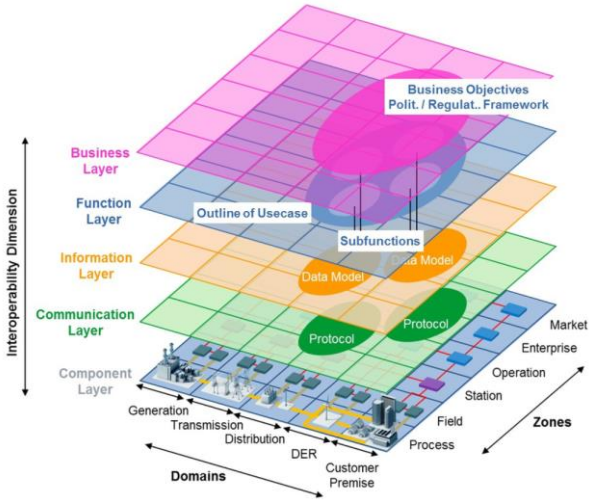

Figure 1　Smart Grid Architecture Model

Reference: CEN-CENELEC-ETSI Smart Grid Co-Ordination Group Smart Grid Reference Architecture

According to the development framework proposed by the International Electrotechnical Commission (IEC) for substations, substation communication network architecture can be divided into the following three categories: (1) Station bus and process bus separated. (2) Station bus and process bus connected by proxy servers. (3) Station bus and process bus interconnected. Considering the voltage level and the number of equipment in the

substation in Taiwan, this study adopts the structure of station bus and process bus separated.

At present, the communication structure of Taipower's substation uses station level and bay level as well as station bus. In the IEC standard, the communication between the bay level and the process level is not only connected by copper wire to transmit the information from the potential transformer and the current transformer, but also by configuring the merging unit at the process level and converting the voltage and current data into digital signals through the sampled value technology, and distributing the data to multiple devices at the same time through multicast. With the IEC standard, wiring cost and space can be saved.

Taipower Company focuses on the many developments of IEC 61850 for subsequent applications, which require detailed planning and overall arrangement. Therefore, this project provides suggestions for the future implementation of the process bus in the substation.

II. Research Results:

This study was conducted using IEDs and merging units that were certified by UCA conformance test. IEDs and merging units are configured using the IED Configuration Tool and integrated through the System Configuration Tool. Unlike the current Taipower substation network architecture, the process bus must be planned independently to ensure that the bandwidths of the station bus and process bus switches are independent to improve the overall information flow efficiency and reliability of the substation.

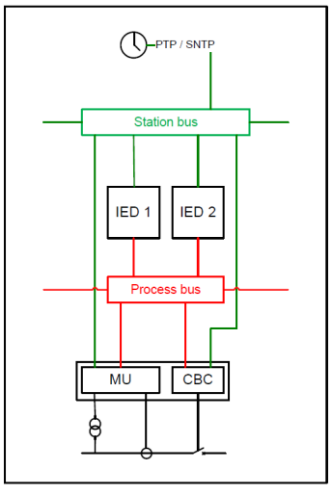

Figure 2 Station bus and process bus separated
Reference: IEC TR 61850-7-500

This study refers to IEC TR 61850-7-500 on the communication architecture and time synchronization in substations. The communication between station level and bay level is mainly transmitted through MMS protocol, and most of the transmitted data are non-time-critical data. Therefore, SNTP protocol is used for time synchronization, and the time packets are sent to the station bus switch through the GPS time source set up in the laboratory and parallel redundancy protocol technology for time synchronization by SCADA. The communication between bay level and process level is mainly transmitted through GOOSE and Sampled Value protocols, and most of the transmitted data are analogy data of real-time voltage and current of time-critical or circuit breaker protection trip control command. Therefore, the time synchronization method uses the PTP protocol, also through GPS time source, and uses parallel redundancy protocol technology to send time packets to the process bus switch for time synchronization of the bay level IEDs and the process level merging units.

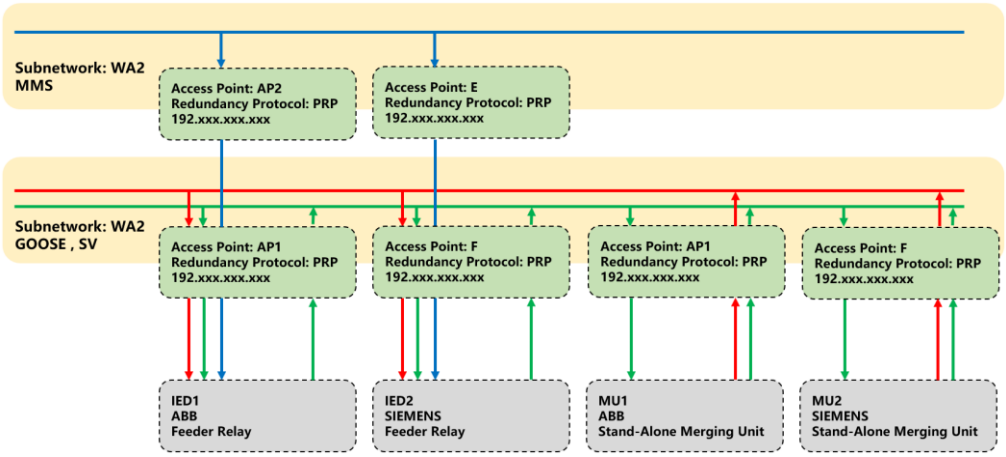

Figure 3 Network communication configuration

Reference: This project

When planning, we need to pay attention to the GOOSE and Sampled Value settings, including multicast address, App ID, Subnetwork, VLAN ID, VLAN Priority, Access Point, and other parameters needed to be set, in addition to the equipment of different brands need to refer to their original design for understanding.

Table 1　Recommended multicast addressing example

Reference: IEC 61850-9-2

Service	Recommended address range assignments	
	Starting address (hexadecimal)	Ending address (hexadecimal)
GOOSE	01-0C-CD-01-00-00	01-0C-CD-01-01-FF
GSSE	01-0C-CD-02-00-00	01-0C-CD-02-01-FF
Multicast sampled values	01-0C-CD-04-00-00	01-0C-CD-04-01-FF

In addition to the integration of IEDs and merging units from two different brands, this study also analyses the standardization of data objects and data attributes in the integration of IEDs and merging units from different brands. Considering that Taipower Company will need to integrate multiple brands of equipment when introducing sampled value technology and merging unit in the future, we need to ensure the availability of equipment before purchasing, and these are the issues that should be considered in the subsequent planning and construction.