

User Experiences Implementing IEC61850 in Intelligent Electronic Devices

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The availability of the IEC 61850 standard has enabled the original equipment manufacturer (OEM) to produce advanced intelligent electronic devices (IED) that lower substation automation system deployment costs due to the many unique features of IEC 61850. These unique features include self-describing IEDs, standardized object definitions and naming conventions, standardized configuration language, and high-performance IED-to-IED communications that all contribute to lowering substation automation costs by reducing manual configuration and custom programming extensions. The typical user, an electric utility, is rewarded for their purchase of IEC 61850 IEDs through lower installation, configuration, and maintenance costs.

Another user of the IEC 61850 standard that is not so often considered is the OEM that develops, manufactures, and tests these IEDs. The advanced features of IEC 61850 can result in the burden of device configuration, that was typically assumed by the purchaser of the IED, being transferred to the OEM that builds the IED. Therefore, the experiences of the OEM user of IEC 61850 is an important consideration when examining the usefulness of IEC 61850. This paper will examine the implementation experiences of 3 different OEMs that have developed IEC 61850 compatible devices:

- Doble Engineering Company (<http://www.doble.com>) - A manufacturer of power system test equipment.
- Maschinenfabrik Reinhausen GmbH (<http://www.reinhausen.com>) - A manufacturer of load step switches for regulating transformers.
- THYTRONIC S.p.A. (<http://www.thytronic.it/>) - A manufacturer of power system protection, control, and measurement devices.

Doble Engineering

Doble Engineering has been serving the electric power industry by providing diagnostic instruments, services and knowledge for 85 years. Doble provides diagnostic test instruments and technical support services for transformers, circuit breakers, and relay protection systems. Doble Engineering also provides the on-line diagnostic systems for transformers and gas insulated apparatus. Doble has close working relationships with energy generation and delivery companies, as well as industrial power users, working in partnership to improve the performance of their systems and operations.



Figure 1: F6150 Power System Simulator

Doble recently embarked on a project to add IEC 61850 support to its F6150 power system simulator. By integrating the test equipment with a protection scheme, testing can be performed without touching the connections between the protection relay and other IEDs involved in the substation. This new method provides increased safety and reliability for the protection scheme while undergoing testing. Adding the GOOSE support has opened a new spectrum of testing procedures, making the testing capabilities faster, safer and more repeatable. Combining IEC 61850 with the F6150's ability to accurately simulate power system events and evaluate the performance of protection schemes under actual system conditions, allows users to be provided with more detailed technical information to optimize the customization of their protection schemes when performing tests. The ability to customize protection schemes reduces the fault clearing time while limiting the potential damage and improving the availability of the power system.

The initial implementation phase involved a careful analysis of the IEC 61850 requirements. Doble spent considerable time devoted to sorting out the various layers of standards that make up IEC 61850. Once this task was accomplished, the code implementation was completed using the MMS-EASE *Lite* product by Doble's in-house staff of firmware engineers in less than 4 weeks. There were no major problems encountered during the implementation of the code on a Motorola 8250 Power Quicc CPU running the pSOS operating system. The entire project met timeline expectations and was completed in 12 weeks.

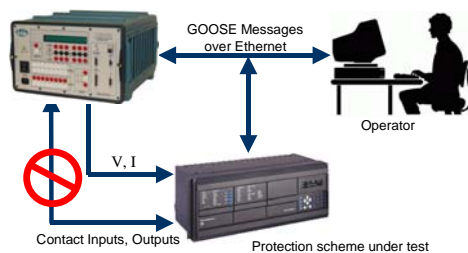


Figure 2: Application of IEC 61850 GOOSE

The addition of GOOSE support to the F6150 involved minimal overhead of the processor and did not impact the response time of the instrument. GOOSE uses the same logic for detecting the events as older non-GOOSE protection schemes, allowing for easy comparison between the two. This is an important feature for performing tests involving the upgrade of the protection scheme. This feature guarantees that the instrument does not add any delay or alter the response of the test.

Maschinenfabrik Reinhausen

Maschinenfabrik Reinhausen (MR) is a highly-specialized, globally active manufacturer of high-voltage equipment. With over 110,000 step switches in trouble-free operation around the world, MR is a world leader in the control of regulating transformers. The TAPCON® Tap-Changer Control is a new generation voltage regulator that is the world's first with IEC 61850 compatibility.

MR's customers had been seeking a supplier independent method of achieving interoperability of IEDs that can leverage the

many advantages of Ethernet for high-performance and flexibility along with a standardized object-oriented method for information exchange. As the IEC 61850 standard was developed, MR actively participated so that they could be ready to implement as the standard became real.

MR began their IEC 61850 product development in early 2004 with the purchase of SISCO's MMS-EASE *Lite* source code for the IED and the AX-S4 MMS client software for testing. After obtaining product training from AMA-Systems in Germany, MR was ready for factory tests of the first IEC 61850 systems by the summer of 2004. MR found that the implementation of IEC 61850 within their TAPCON product was no more difficult than the typical serial link protocols that had been used in the past. With the standardized logical nodes of IEC 61850 to provide a precise definition of the Automatic Tap Changer Control (ATCC), MR was able to deliver a more standardized controller that enabled easier integration with the other participants during the initial testing. Furthermore, the greatly enhanced speed of IEC 61850 running over Ethernet running at 100 megabits per second (even up to 10 gigabits/second on fiber optic cables) versus the typical 19.2 kilobits/second offered by a serial link protocol, significantly enhanced control performance.



Figure 3: TAPCON 260 Tap Changer

In early 2005, MR has successfully completed several pilot projects involving IEC 61850 applications of high-voltage tap-changers in Germany, Italy, and Spain. Based on the success of these projects the use of IEC 61850 is gaining ground across Europe. Because of this MR is planning to make IEC 61850 functionality the standard application for MR voltage regulators.

THYTRONIC

THYTRONIC is a provider of products and services for protection, monitoring, and control of electric power systems. THYTRONIC'S mission is *Ensuring Safe and Secure Power Distribution*. THYTRONIC currently provides a range of single and multifunctional digital protective relays for power distribution (feeder and bus-bar protection, motor protection, and transformer protection) and power generation (generator protection and synchronizing devices).



Figure 4: THYTRONIC Headquarters

THYTRONIC'S electric power utility and industrial customers were undergoing tremendous changes due to deregulation that demanded maximizing efficiency while minimizing down time. When THYTRONIC first began its investigation of IEC 61850, customers had not yet begun to specifically request this advanced protocol. However, these same customers were demanding interoperability, flexibility, and cost reduction and IEC 61850 seemed a good solution. Driven by its core value to be on the leading edge of innovation and a desire to expand its product and service offerings in response to increasing demand for automation, communications, and system integration; THYTRONIC set out to implement IEC 61850 in late 2004.

The initial steps involved investigation and analysis of the IEC 61850 standard and its capabilities by the THYTRONIC R&D department. This involved both intensive study and training seminars from multiple sources. With the fundamental knowledge of IEC 61850, THYTRONIC then acquired the MMS-EASE *Lite* software and began the implementation of IEC 61850 for the generator multifunction protection relay (NTG).



Figure 5: THYTRONIC NTG Relay

THYTRONIC'S development team has completed the porting of the MMS-EASE *Lite* software to the hardware and software environment of the NTG. No exceptional difficulties have been encountered. THYTRONIC is now in the process of integrating the IEC 61850 logical nodes and GOOSE functions into the NTG. The NTG product is expected to make its market debut in early 2006.

Summary

In order for electric utility users to receive the many benefits of IEC 61850, they must first be able to purchase a variety of products at reasonable prices. The developments discussed in this paper have either already been completed or are underway without significant difficulties proving that the development of IEC 61850 devices and applications is both realistic and practical for OEMs. A variety of vendors have already implemented IEC 61850 and many more developments are underway which will benefit both kinds of IEC 61850 users: electric utilities and their suppliers. SISCO and AMA-Systems are ready to help all users of IEC 61850 implement this important new standard in their products and systems in a practical and cost-effective manner using field-proven technology.



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