

Maximizing the user benefits . . .

. . . of IEC 61850 in substation automation systems



The substation Laufenburg (EGL), Switzerland

Based on the vast experience in substation automation (SA) and expertise in IEC 61850, ABB has fully implemented the new standard in its portfolio. Through the combination with excellent system integration capabilities, ABB can offer optimized solutions for new installations, modernization and migration projects.

Klaus-Peter Brand,
Petra Reinhardt,
Ivan De Mesmaeker

Competent partner

Customers have long been seeking a communication standard to realize fully integrated substation automation systems. Placing the interests of its customers at the top of its agenda, ABB has been committed to the elaboration and verification of the standard from the onset. Not only has ABB been delegating up to thirteen of its renowned experts from the substation domain to the IEC61850-related working groups of the Technical Committee TC57 and provided the conveners for two out of the three groups. It has also implemented and verified the validity of the standard in interoperability tests conducted together with other TC57

members and is today strongly involved in the ongoing maintenance and further development of the standard. The expert IEC 61850 knowledge and verified interoperable systems, products and tools as well as comprehensive system integration capabilities make ABB a competent partner in IEC 61850-based projects.

The new standard is gaining acceptance with utilities and suppliers all around the globe. ABB supports customers in fully exploiting the benefits of IEC 61850. The combination of deep know-how and long experience with an innovative portfolio assures customers of getting state-of-the-art solutions for new stations, migration and refurbishment projects at all voltage levels. From single IEDs, via subsystems and system integration to complete systems, customers can rely on ABB to make the advantages of

IEC 61850 work for them. The broad spectrum of well-coordinated equipment, optimized solutions and competent services offered minimizes project-to-production time and risks.

To ensure efficient management of IEC 61850 projects, ABB offers comprehensive services throughout the value chain, from specifying to commissioning and from maintenance to system extension or upgrade. What is more, we combine global experience with local presence to offer competent service within easy reach of our customers worldwide.

Utility and industry customers all around the globe rely on us as their partner. To them we owe our market-leading position in substation automation and protection. This is our constant source of motivation for further innovation and enhancement of our portfolio to help the

users to achieve operational excellence.

Conformant solutions

ABB has proven solutions for new installations, refurbishment as well as migration projects to meet users' availability and operational requirements and safeguard the investments throughout the lifecycle of a substation. These are based on a complete portfolio of:

- ▶ station HMI and gateways, protection and control IEDs as well as interfaces to the process and to legacy products
- ▶ comprehensive SA functionality for today's and tomorrow's requirements
- ▶ powerful tool environment ensuring efficient system design, commissioning and maintenance.

To verify the proper implementation of IEC 61850 throughout its portfolio, ABB has established a System Verification Centre (SVC). Each and every product, system component, application and tool is tested in a real-life system environment to prove its appropriate working and performance - functionally and interactively. Complete protection and substation automation systems are verified to ensure they fully meet the requirements in terms of communication, integration, functionality and performance.



Dr. Klaus-Peter Brand is presently working at the ABB University Switzerland as instructor and consultant. Since 1995, he is a member of the working group of IEC TC 57 defining the standard IEC61850. He has been acting as editor and co-editor for different parts thereof and is still engaged as an expert and editor in the maintenance and extension of the standard.

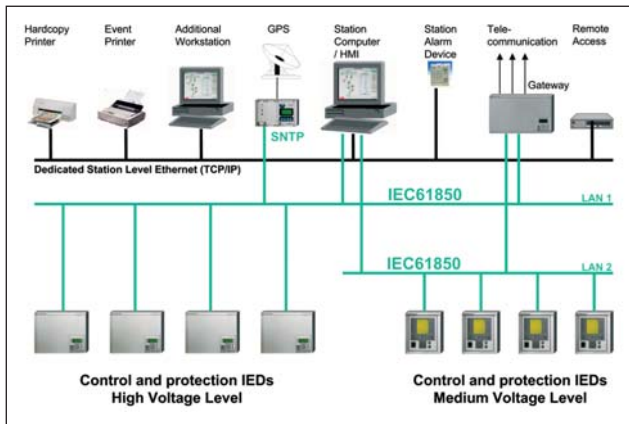


Petra Reinhardt is working as Marketing Communication Manager with ABB Switzerland Ltd., Power Technology Systems, Baden/Switzerland after having gained several years experience in substation automation and protection in Switzerland and South Africa where she has been working as sales engineer and key account manager.

www.abb.com/substationautomation



Ivan De Mesmaeker is presently working with ABB Switzerland Ltd. as Area Sales Manager and Senior Technical Manager. He is also the chairman of the Study Committee B5 (Protection and Substation Automation) of CIGRÉ.



Example of a typical SA solution for a new transmission substation

Being a system integrator, ABB also offers to verify the compliance to IEC 61850 of each and every component from other vendors that shall be integrated into a system from ABB.

A typical solution for a new transmission substation with two voltage levels consists of a fully distributed arrangement of the station level equipment. Its main components being station HMI, gateway for the communication to the remote control centre and time master are completely independent functional units. To ensure highest performance and availability, the solution supports more than one LAN for the communication to the bay level devices and allows the separation of e.g. the transmission and the medium voltage level devices. The fully distributed approach at station and bay level and the use of high-quality substation-graded devices guarantee very long lifetime and minimal loss in case of component failure.

Features and benefits

The consistent and systematic use of the features of IEC 61850 enables ABB to maximize the user

benefits in substation automation. Over and above the benefits gained through the use of the standard such as higher flexibility, increased efficiency and safeguarded investments, ABB provides the following main features and benefits:

- ▶ ABB designs optimized solutions with scalable system architectures for any type, size and topology of substation, based on the use of interoperable devices, the free allocation of functions and exploitation of the functional capabilities of products. In combination with ABB's well proven applications, this not only allows customers' availability and performance requirements to be fully met, but also to accommodate user-specific operational philosophies and to enhance safety and efficiency of system operation.

- ▶ ABB ensures proficient project execution in every phase, i.e. system design, engineering, testing, commissioning and maintenance through efficient and reliable project management. This is supported by a powerful tool environment that is based on the strongly formal Substation Configuration

description Language (SCL) and the use of the object-oriented data model with its semantics. It warrants user-understandable and consistent data in a high-quality system. The reusability and portability of the engineering data makes the system easy to extend both by size and functionality and even supports system refurbishment thus optimally supporting life cycle management and safe-guarding customer's investments.



The new 380 kV hybrid switchgear

- ▶ ABB ensures a maximum level of product integration for enhanced performance and advanced functionality of the systems based on excellent system integration capabilities as well as a complete IEC61850-conformant product portfolio. A common, easy-to-use engineering environment for the complete range of applications over the entire life cycle, guaranteeing outstanding engineering and maintenance productivity, supports this. As a result, ABB can offer comprehensive, high-quality service and support for systems and products that is responsive and customer-oriented.

- ▶ ABB offers systems with all substation functions supported by IEC61850, from the switchgear to the NCC gateway. The systems are future-proof and open for further optimization possibilities like usage of e.g. IEC 61850-conformant non-conventional instrument transformers. As IEC 61850 is earmarked to even become the standard for communication beyond the substation, e.g. between the substation and remote control centers for telecontrol or to power stations, ABB's systems leave the door open for further integration.

The importance of the numerous benefits varies with the specific project conditions. Building on a very deep know-how of the standard, long experience in the substation and SA domain as well as excellent capabilities in system integration, ABB is able to maximize the advantages for the customer in any type of IEC 61850-based project.

First projects

IEC 61850-conformant products as well as complete projects have been offered for some time now. ABB has been awarded several turnkey contracts for IEC 61850-based solutions already. The projects range from bulk contracts with high volumes and tight time schedules via sizeable contracts requiring stringent homologation of large numbers of typical feeders to challenging retrofit projects. They span the full range of voltage levels, from

transmission to distribution, and require system integration of 3rd party IEDs resp. subsystems. The first installations are already in service since December 2004.

Specific benefits for different types of projects

The projects mark ABB's capability to supply fully integrated, interoperable IEC 61850-based solutions. With respect to specific project types, some key success factors and benefits are:

- ▶ The efficient handling of *bulk contracts* with large volumes and critical time schedules profits from highly qualified project management and strong support of powerful engineering tools using the standardized SCL.

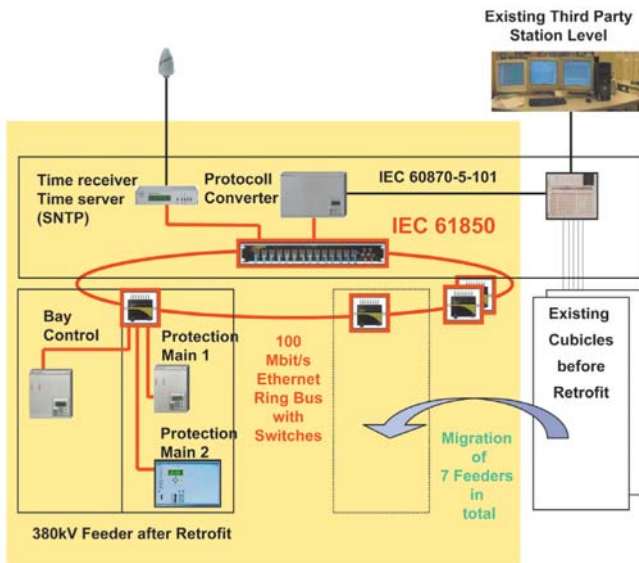
- ▶ Contracts involving comprehensive *homologation* of e.g. a large variety of typical feeder solutions are supported by a deep understanding of the customer requirements and a comprehensive know-how of IEC 61850 allowing customized profiles without losing interoperability.

- ▶ *Refurbishment* projects may be very complex because of the large variety of scenarios and goals. These are characterized by the need for parallel operation of existing and new components even if only for a limited period of time. Apart from full system integration capabilities, they need future-proof migration scenarios considering also the benefits of IEC61850.

Through its experience, expertise and efficient project management, ABB is able to realize the different contract types with full benefits for the users. Whilst the advantages for new installations are well known already, those applying to refurbishments may be hidden by the mixture of existing and new parts or by the stepwise procedure. The following refurbishment project highlights some of these aspects.

Retrofit of EGL's 380kV Laufenburg substation

The Swiss utility Elektrizitätsgesellschaft Laufenburg AG (EGL) owns and operates an important part



The new SA system configuration

of the Swiss 380/220kV grid. The 380kV Laufenburg substation, built in 1967, is a key node in the European interconnected power system. Its configuration is a triple busbar system with by-pass busbar and several longitudinal sections. After almost 40 years in operation the primary and secondary equipment of 7 out of 17 feeders has to be replaced in several steps over a two-year period.

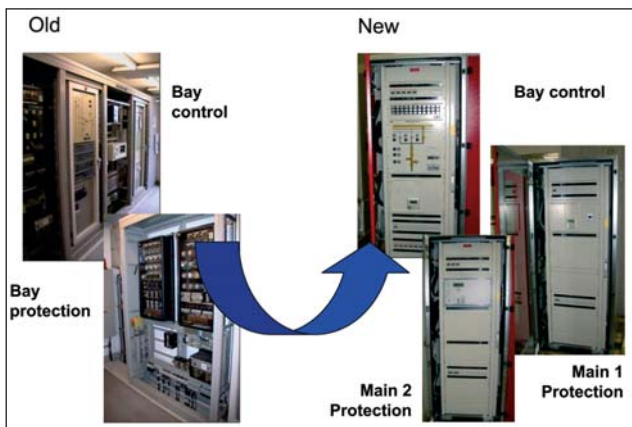
Requirements and Goals of the Refurbishment

Reliable overall refurbishment of five line bays, one transformer feeder as well as one bus-coupler had to be performed without service interruption and within a highly critical time span. A future-proof retrofit concept was required for the switchgear as well as for the automation and protection system so that they meet today's' and

tomorrow's' requirements in terms of efficient operation, high functionality and open integration. The special problem of varying life cycles of bay and station level equipment had to be addressed and the latter be kept. The customers' philosophy called for the integration of 3rd party main 2 protection. A sustainable migration strategy should ensure smooth transition to the new technology; it should allow selective refurbishment of components to suit operational and economic needs as well as freedom of choice in suppliers for various parts and stages of the project and future extensions.

The solution for the switchgear

New 380 kV switchgear had to be installed in the limited space given. For the retrofit, a compact hybrid solution from ABB is combining gas insulated switchgear (GIS) modules with silicon



The migration of bay control and protection

bushings for connection to the existing air insulated switchgear (AIS) busbar (Figure). Apart from needing minimum space, the encapsulated solution offers immunity to the environmental conditions. It was fully tested and installed in minimal time. To perform the refurbishment without service interruption, it was done bay by bay, i.e. in three months' time intervals. The new switchgear offers simplified maintenance, as replacement of a complete pole can be performed in less than 24 hours. The first refurbished bay is in service since December 2004.

The solution for substation automation

During the stepwise refurbishment, new control and protection IEDs (Intelligent Electronic Devices) from ABB were installed and provide all the functions needed for the bay. ABB's tool environment ensured efficient integration of a main 2 protection device from a third party featuring an IEC 61850 interface.

An IEC 61850-conformant Ethernet ring was used to realize the serial communication between the bays and from the bays to the existing station level (station bus). The latter connection was made via an ABB gateway converting from IEC61850 to IEC60870-5-101. A GPS receiver was connected to the Ethernet ring for time synchronization of all connected devices. Moreover, a protection expert's workplace is available for monitoring and evaluation of the disturbance records.

The stepwise procedure applied equally to the switchgear and the substation automation and protection equipment. Any interruption-free refurbishment, whether it involves the primary and secondary side or only the secondary part, requires a stepwise approach. In Laufenburg the three months' time intervals were dictated by the replacement of the switchgear.

Summarized migration scenario

In close cooperation with a competent supplier, EGL sustainably achieved its project goals through a future-proof refurbishment and migration concept:

- ▶ Bay-wise refurbishment to avoid service interruption
- ▶ Stepwise upgrade of the bay data in the gateway both to station and NCC level was achieved by preconfiguring and pre-testing the system data using the SCL-based tool to ensure data consistency
- ▶ The hardwired station interlocking used may be replaced later by a topology-based software solution using the serial communication, once the overall refurbishment has been completed
- ▶ A protection engineers workplace for monitoring, disturbance record handling and evaluation was connected to the IEC 61850-conformant Ethernet ring from the beginning
- ▶ Sequential connection of the refurbished bays to the existing station level (operators' workstation) via a gateway converting both data and services between IEC61850 and IEC60870-5-101.

This solution may easily be applied to the remaining bays in future and is also open for the later replacement of the existing station level by an IEC 61850-conformant one. The open communication as per IEC61850 introduced in the refurbishment of the secondary system allows extensions of the substation as well as the integration of new functionality.

The outlined migration scenario proved to be successful and can be used for other substations as well.

Conclusion

In addition to the expertise and innovation to create optimized substation automation solutions for new stations, ABB also has the experience to successfully handle challenging refurbishment projects. By combining its long experience and comprehensive expertise both in substation automation and in IEC61850 with its portfolio of fully conformant solutions, ABB maximizes the benefits of the new global standard for its customers.

ABB also has comprehensive expertise in current and voltage measuring and has already gained first practical experiences with IEC61850-conformant, non-conventional instrument transformers. These further enhance the benefits of IEC61850-based solutions.