



When two become one

IEC 61850 in combination with ABB's award-winning Extended Automation System 800xA is opening doors to new and cost-effective solutions.

JOHAN HANSSON, STEFAN BOLLMEYER – The successful introduction of the IEC 61850 standard some six years ago has already brought huge benefits to power distribution and substation automation in terms of scalability, interoperability, safety and data management. Even though it was drafted by substation automation domain experts, it is by no means exclusively reserved for that domain alone. In fact, IEC 61850 is more than capable of operating in other areas, such as in

process and power generation plant automation. These plants are controlled and monitored from a central control room in which there are typically two different systems deployed; one for process control and the other for monitoring and controlling the electrical system. Plant operators, in their quest to reduce complexity and optimize efficiency have been actively seeking solutions that overcome the separation of the systems and the extra costs associated with it.



Even though it was drafted by substation automation domain experts, the IEC 61850 standard is capable of operating in process and power generation plant automation.

The integration of field instruments into process control applications is based on a limited set of industry standards that provide harmonized access to process data and diagnostics. For electrical equipment, however, a multitude of different, often proprietary communication protocols is deployed. Therefore electrical systems, especially those composed of equipment from different vendors, are often characterized by multiple different interfaces, a broad variety of engineering tools, protocol converters and gateways.

Process control systems typically do not offer built-in support for those communication protocols and data models. And because of this significant engineering and adaptation efforts need to be made on a project-by-project basis to make the increasing amount of information, which modern intelligent electronic devices (IEDs) provide, available to a monitoring and control system. Nowadays to mitigate the impact on the process con-

trol system, IED monitoring and control is usually implemented by a separate substation automation (SA) system while connectivity between the electrical system and process control is limited to the most essential data, eg, for interlocking purposes. Although only a limited set of signals is selected for data exchange, today's practice for this type of electrical and control system interfacing, such as hardwiring or Modbus connectivity, still requires significant hardware and engineering efforts. The presence of two different systems also increases costs because, for example, different spare parts and a duplicated effort to ensure integration with enterprise level systems are required → 1.

To help plant operators overcome these expensive complexities, IEC 61850, with its standardized communication protocols and data model, in combination with ABB's award-winning Extended Automation System 800xA is opening doors to new and cost-effective solutions.

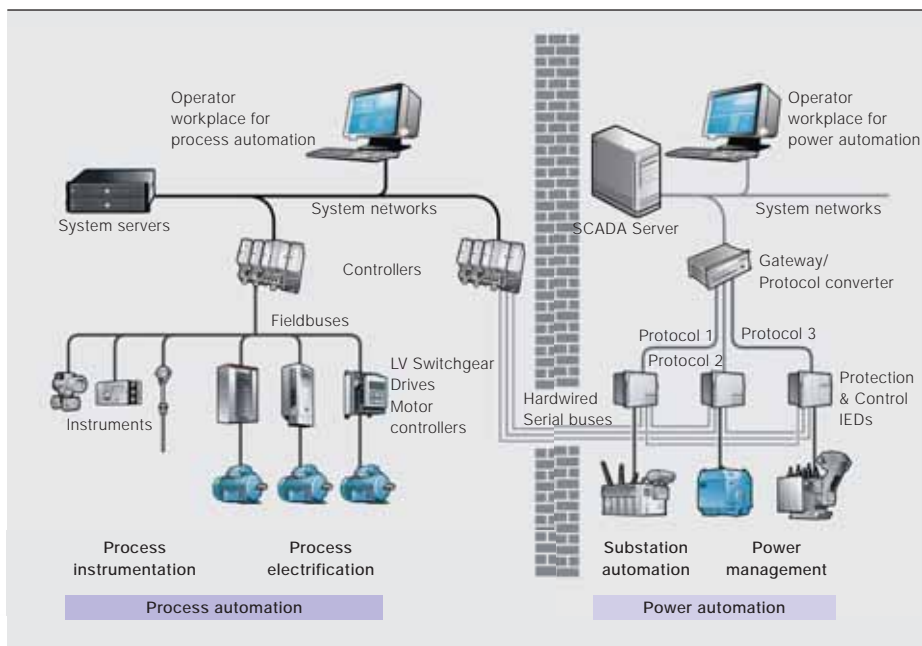
IEC 61850 integration in System 800xA

The combination of ABB's Extended Automation System 800xA with IEC 61850 not only addresses the above-mentioned end-user demands, but it also gives greater synergy and flexibility to fully integrated plant operations.

Introduced in December 2003, System 800xA provides a scalable solution that extends traditional process control by incorporating: safety; discrete logic and sequence control; production management; information management; smart instrumentation; asset management; and document management. Based on Aspect Object technology, System 800xA is capable of adopting data models from different disciplines and making them available in a harmonized way through a singular virtual database environment.

The integration of IEC 61850 into System 800xA supports both generic object oriented substation events (GOOSE) and manufacturing message specification (MMS) protocol options described in the

1 Traditional process control systems do not offer built-in support for proprietary communication protocols and data models



standard. GOOSE communication is directly connected to the AC 800M controller (one of many from the System 800xA family of controllers) via a communication interface so that the data becomes available in the controller application. This so-called horizontal integration¹ enables the AC 800M controller to communicate with all other IEDs on the same IEC 61850 network in real time → 2. Moreover, the AC 800M controller acts like an IED on the IEC 61850 network, and can therefore be involved in load shedding or other power management applications.

MMS communication is used for the vertical integration of IEC 61850. Via an OPC² interface, System 800xA has direct access to all IED data such as current and voltage measurements, status, interlocking, time-stamped alarms and events. The system can also send open and close commands to IEDs. Logical nodes (LNs) of IEDs are modeled as Aspect Objects in System 800xA and therefore all system features, such as freely configurable graphics, faceplates, alarms and event lists, and historian capabilities are available for IED data.

To engineer IEC 61850 integration, System 800xA uses the information contained in the substation configuration description (SCD) file, which describes the complete substation configuration. System 800xA processes the extensible markup language (XML) based substa-

tion configuration file to create all data items for vertical integration as well as the connections for horizontal communication. Separate gateway configuration or additional project-specific software interfaces become obsolete.

To be more specific, System 800xA seamlessly integrates IEC 61850, delivering the features and benefits requested by end users, such as:

- Reduced cost of ownership through fewer components and spare parts, and less system administration.
- Greater flexibility as integration is much less complicated than before and the interfaces adapt easier to changes.
- Centralized data recording, including the plant-wide sequence of events and a harmonized interface to enterprise level systems.
- A complete view of electrical system data, especially to process operators so they can make educated decisions.
- Improved operator effectiveness with one user interface that can consistently present plant-wide data, enable data access and display operating procedures.

Because of its flexibility, System 800xA allows the configuration of individual workplaces for both electrical and process operators so that they can retain the graphical displays and workflows familiar to them while operating in a single environment. Maintenance and asset optimi-

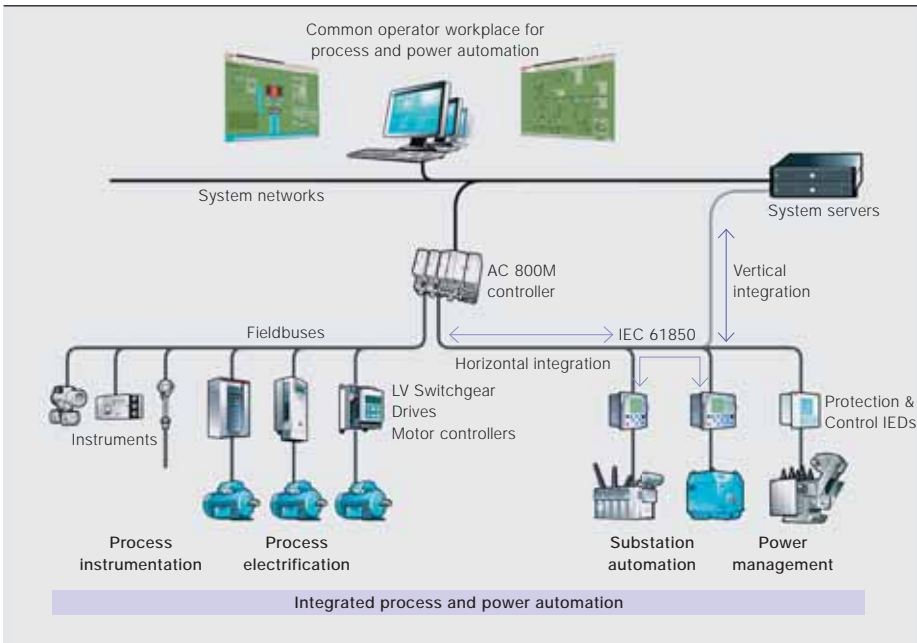
zation workflows can be harmonized once IED data is available in System 800xA, allowing instrument maintenance engineers and those servicing electrical devices to work from the system's common maintenance workplace. System 800xA's maintenance structure gives an overview of all plant assets in a single display. Conditions can be monitored, and diagnostics and maintenance related alarms for electrical devices and process instruments are presented in practically the same fashion. For further in-depth analysis, additional IED data points can be subscribed to or disturbance records can be uploaded. Access-right settings ensure that only authorized people are allowed to perform such detailed analysis.

As the ultimate step, System 800xA's Asset Optimization functionality can be integrated with a computerized maintenance management system (CMMS) so that work order handling is automatically treated the same for both electrical and process equipment. This eliminates the need for separate working procedures or the adaption of different systems to the CMMS.

The Flåsjö facility is one of the first hydro power plants to utilize a combination of IEC 61850 and System 800xA for process and substation automation.

The possibility of electrical integration presented by ABB's System 800xA in combination with IEC 61850 has been keenly observed by industries other than power distribution. The Oil & Gas and Power Generation industries in particular have been evaluating these new opportunities and some have even taken the first steps toward the implementation of such a system.

2 Communication with all other IEDs on the same IEC 61850 network is possible in real time



3 The Flåsjö hydro power plant

Upstream, Flåsjö is the first of E.ON's hydropower plants on the 350-kilometer long river Ljungan. The Ljungan runs to the northeast of Helagsfjället and flows into the Gulf of Bothnia just south of Sundsvall. The power plant was built in 1975 and has a maximum waterfall of 46 meters and a flow through the turbine of 60 m³ per second. The Flåsjö plant produces about 73 GWh with an installed capacity of 24 MW. The plant is unmanned, and controlled and monitored from E.ON Vattenkraft's control center in Sundsvall. Communications between the power plant in Flåsjö and the control center in Sundsvall is via satellite transmission.

E.ON integrates substation and process automation

E.ON Vattenkraft, a subsidiary of E.ON Sverige, is the third largest hydroelectric power producer in Sweden. In a typical year it produces about 8 TWh from 77 hydro power plants, from Kristianstad in the south to Lycksele in the north. Most of these plants were built between the 1950s and 1970s using what is now considered legacy technology. Up to 2015, E.ON plans to invest SEK 6 billion (\$763 million) in safety, renewal and productivity improvements in installed power plants. All of E.ON's hydro power plants are usually operated remotely from the central control center in Sundsvall, and are visited only for maintenance reasons.

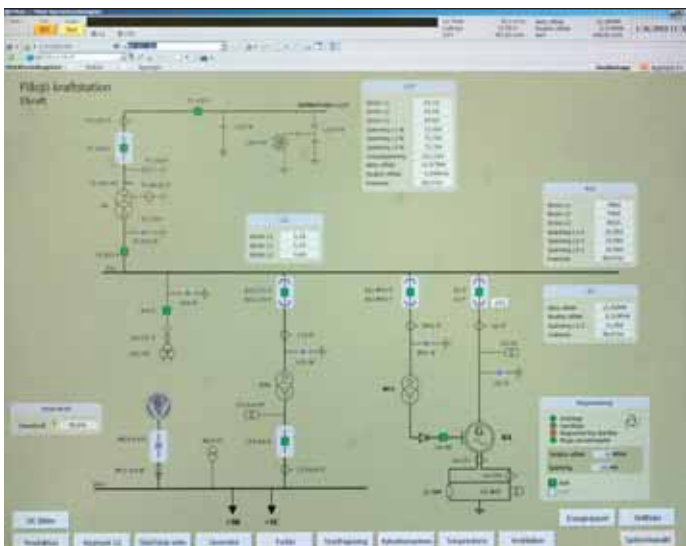
One of these, the Flåsjö hydro power plant, was the first upstream plant installed on the river Ljungan in northern Sweden → 3. Since 2009, it holds the distinction of being one of the first hydro power plants in the world to utilize a combination of IEC 61850 and System 800xA for both process and substation automation.

In the installation at Flåsjö, the original relay-based system was replaced by one System 800xA together with an AC 800M controller. Process control handles applications such as turbine control, vibration protection and synchronization. Process electrification and control of auxiliaries and pumps are done using Profibus communication with ABB's modular low-voltage switchgear MNS.

For substation automation, the IEDs are the most critical devices in the plant in that they provide protection, control and monitoring of generators and lines from the outgoing high-voltage substation. Three native IEC 61850 compliant ABB Relion® IEDs are integrated with System 800xA, two redundant REG670 IEDs are used for generator protection and one REL670 for protection of the outgoing 130kV line. All the IEDs are integrated with the AC 800M controller using IEC 61850-defined GOOSE. This enables the AC 800M controller to function not only as the process controller, but also to act as an IED on the IEC 61850 network, communicating horizontally with all other IEDs as well as with the control center via satellite communication. Important data from the IEDs include measurements such as power, reactive power, voltages and currents, together with breaker and disconnecter statuses → 4. This data is displayed at the local System 800xA operator workplace and the control center in Sundsvall some 260 km away from where the system is usually monitored and controlled → 5. In addition, alarms and events from the combined process and substation automation system are also transmitted to Sundsvall, providing operators with valuable information about the plant. At the control center, the operators monitor and control the plant using an ABB Network Management System. They also have remote access to the System 800xA operator workplace, providing a redundant connection to the control system.

The use of IEC 61850 with a single control system provided E.ON with the means to investigate the benefits of using the standard for standardized system integration, application building, installation and testing.

4 IED data include power, reactive power, voltage and current measurements



5 The control center in Sundsvall from which all of E.ON's hydropower plants in Sweden are controlled and monitored



Main benefits

The use of IEC 61850 with a single control system in the Flåsjö hydro power plant was a pilot installation for E.ON. It provided the means from which the company could investigate the benefits of using the renowned global standard for substation automation not only as a communication protocol for devices, but also for standardized system integration, application building, installation and testing. The success of this pilot project is very important to E.ON because it will influence the upgrade of the substation and process control systems in other hydro power plants.

Assar Svensson worked on technology assessment and plant design for the power plant in Flåsjö and is now involved in the majority of E.ON Vattenkraft's upgrades and modernizations → 6. Of the renewal plans for the hydropower plants, he says, "this is an extensive conversion job we have ahead of us. We're therefore looking for standardized solutions in accordance with IEC 61850. Thus far, it only concerns relay protection." For E.ON, IEC 61850 will provide new opportunities to increase availability and simplify engineering. Several standardized components provide the capability to build plants in a more structured manner. "We want to be able to receive deliveries in which all components can be tested together prior to initiating operations." Another important reason for a more standardized structure for the control systems is that all E.ON Vattenkraft facilities in Sweden are controlled from a single control center. Svensson says that

when so many power plants are controlled from one location, it's very important that there is a standard on which everything is based.

From an E.ON point of view, there are many benefits of using IEC 61850 and System 800xA:

- Complete system configuration is more efficient and safer because standardized solutions for IED configuration, substation automation design and control system programming are used.
- The testing of protection, control and monitoring functions can be carried out before installation begins, and this helps to minimize the downtime needed for installation and commissioning.
- IEC 61850 is standard for Ethernet-based communication solutions and that means reduced wiring, which in turn leads to shorter installation time and reduced sources of errors during operations.
- With improved access to electrical and process data from the entire plant, the focus is shifted from troubleshooting to more preventive maintenance. The system itself can indicate when a component needs servicing or replacing.
- A common event list for both the process and electrical monitoring makes it easier to monitor errors and draft maintenance plans.

These benefits are such that according to Assar Svensson, E.ON will continue to ask for IEC 61850 in its specifications:

6 Assar Svensson is involved in many of E.ON Vattenkraft's upgrades and modernizations



"I now have major expectations regarding our supplier's ability to give us additional capabilities to standardize and simplify construction of electrical and control systems for hydropower plants. With the installation in Flåsjö, we have hopefully just opened the door to the future."

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Footnotes

- 1 Horizontal integration can also replace the hardwiring traditionally used for interlocking signals.
- 2 Object linking and embedding (OLE) for process control