Smart substation in smart grid

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The world has gone digital and that includes the electricity industry. It is hard to remember the time when relays were simple electromechanical devices without firmware, communications interfaces or multifunctionality. Providing electricity has always been challenging, but new technologies increased the complexity of that challenge when moving from the 20th century to the 21st century. The industry had to bridge the gap between aging analog devices and digital technologies.

Today, there is not a single component in a substation that has not been enhanced, enriched or augmented by some form of embedded digital technology, making them operate better at higher ratings with more reliability than ever before. However, the challenge now is integrating all of these elements into a totally digital substation and making it work in a demanding environment.

With IoT, people can check the security of their homes from hundreds of miles, or kilometers, away. Home thermostats can be adjusted from any location by pulling up an app on a smartphone. Luggage can be tracked with another app when the airline says it cannot locate a missing suitcase. Cars even e-mail their owners when they need maintenance. And IoT has taken this connectivity to a level of being able to add sensors on people and monitor them with wired workout clothes and devices like a Fitbit fitness tracker.

Long before there was a smart grid, the electric power industry had a stratagem of an all-knowing grid with technology-enabled substations networked into a communicating transmission and distribution grid. The nomenclature may have been different, but the idea had smart grid written all over it; the technology just needed time to develop. The industry deployed supervisory control and data acquisition (SCADA) and then remote terminal units (RTUs) were introduced. These were followed by the introduction of micro-processor-based relays for control and protection systems.

Technology moved forward and communications interfaces were integrated directly into the microprocessor-based relays. Advancements in the microprocessor"s firmware and software brought about multifunctional microprocessor-based relays that communicated directly with RTUs and gateways.

All of these innovations ramped up the complicatedness, but they also increased system performance enormously. During about the same time frame, vendors began incorporating intelligent electronic device (IED) technology into the electrical apparatus and components found throughout the substation, including the switchyard. As a result, the industry experienced a transformation more far-reaching than any in the past. Not only was the industry exploiting digital technology, but it was setting the stage for incorporating IoT technology into the grid.

Digital technologies are driving the evolution of digital substations. This FOCS is smaller than conventional current transformers. It also provides direct digital measurements and doesn"t use copper cable to take data

into the control building.

At best, communications between the different manufacturers" schemes was piecemeal and fragmented. One might say they were mutually incompatible and kept that way with an assortment of nonstandard messaging protocols. It was the technological equivalent to the Tower of Babel. Luckily, it did not take a rocket scientist to see the problem proprietary systems caused. As a result, open standards became the solution.

In 1995, the International Electrotechnical Commission (IEC) began working on IEC 61850, a communications standard published in 2003 for electrical substation automation systems. Today, this document has many parts that relate to data modeling, reporting schemes, fast event transfers, setting groups, sample date transfer, commands and data storage that create a uniform basis for the protection, control and communications of substations. A short time after IEC 61850 was accepted, IEC 61850-9-1 (a point-to-point unidirectional process bus) was introduced.

By 2005, the world"s first IEC 61850-based substation was commissioned in Switzerland. It was the Winznauschachen substation owned by Swiss distribution network operator Atel Versorgungs AG, part of the Aare-Tessin AG Group, an independent power producer. The Swiss substation was transformed into a substation with an IEC 61850-based protection and control system that included several IEDs to improve control and feedback.

More than 100 substations were installed worldwide by 2007, all claiming to be operating with IEC 61850-based equipment, but utilities had a new concern. Industry-wise, IEC 61850 had been developed, but no one had tested the interchangeability of intelligent devices from multiple manufacturers. But what happens if you mix and match components and systems from different suppliers?

This was the question Comisi?n Federal de Electricidad (CFE) in Mexico wanted answered. Suppliers had been diligent about getting their equipment certified to be in compliance with IEC 61850, but none of the manufacturers were working together for group certification.