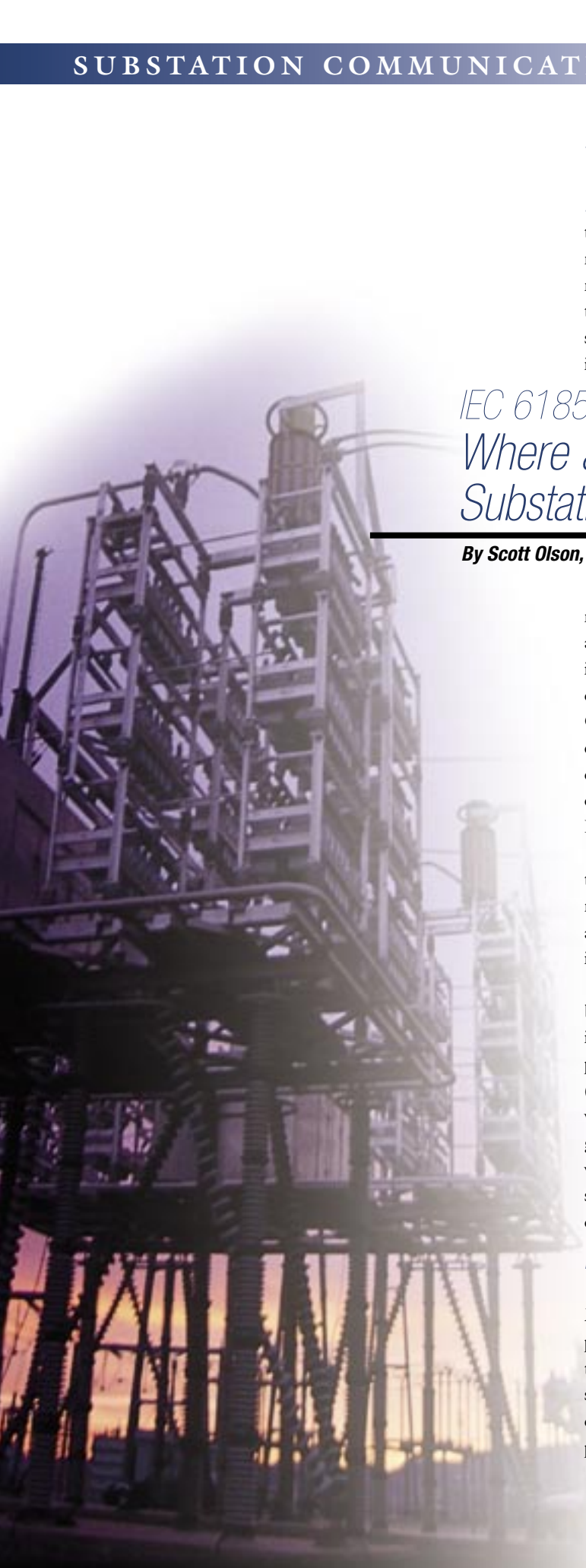
PennWell

UTILITY Automation & Engineering T&D

CYBERSECURITY for Critical Utility Applications

IEC 61850: Where are We Headed with Substation Communications?

Vol10, No4, May/June 2005
www.utility-automation.com



For years, the power utility industry has struggled with standardization of communications in the substation environment. When substation automation was initially considered, the biggest hurdle was the integration of different vendors and equipment all using different protocols. A standard protocol to meet the needs of information flow was necessary. Although different organizations have made strides to fill this requirement with their preferred solutions, a new generation of communication protocol is moving into the market. And just who is this rising star? IEC 61850.

IEC 61850: Where are We Headed with Substation Communications?

By Scott Olson, POWER Engineers Inc.

As the leading international standard for substation communications and the successor to UCA (which European vendors and utilities have embraced), IEC 61850 is aiming to fill this seat in the United States as well. The IEC 61850 series of standards offers many of the same functions and features as the Utility Communications Architecture (UCA), but with some distinct enhancements. Similar features include Ethernet-based, standard object-oriented data naming and structures, automated point configuration and retrieval, and IED-to-IED communications. Enhancements include those listed in the table on the following page.

The standard not only defines communication, but also qualitative properties of engineering tools, measures for quality management, and configuration management. Having been officially approved in the standardization process, vendors, consumers and industry professionals are now asking, "Where are we headed?"

Over the last decade, in the struggle for standardization, DNP has been the de facto standard. While DNP has been successful in providing open, standards-based interoperability between substation computers, remote terminal units (RTUs), intelligent electronic devices (IEDs) and master stations, today's technology has surpassed the networking that DNP was originally based on. As information technology becomes more advanced, standards-based, networked technologies via Ethernet are becoming the preferred solution. Object-oriented, self-describing languages will help make substation integration less cumbersome, and that's the goal of IEC 61850.

History

Early on, substation communications were all but non-existent. Most IEDs that had communication capabilities used proprietary protocols that made it difficult to move data from the IEDs to the RTU to the SCADA system. Also, it was nearly impossible to share data between IEDs. To fill this gap, data concentrators were developed that utilized different protocols on separate RS232 ports to poll data from substation IEDs. These legacy protocols,

in general, tended to be simple protocols that were designed to be byte efficient.

Communications protocols such as PG&E 2179, Modbus and DNP became industry standards. These were tag-based protocols, where users accessed data by specifying a tag number or index number. The result was a reliable network architecture, but the effort required to sort out all the different protocols and data made these protocols needlessly complex.

This complexity, however, did not keep DNP or Modbus from becoming widely accepted protocols for substation networks. Driven by user demands for intercommunications between IEDs, these protocols provided the logical initial solutions for open protocols. With the global move to Ethernet, the industry became interested in network solutions, and, as a result, DNP and Modbus quickly adapted to the TCP/IP format.

In the meantime, EPRI and others were developing UCA—widely considered the grandfather of IEC 61850— as the future utility communications protocol. UCA has been tested and run through several pilot projects to confirm that an object-orientated, self-describing protocol can be used reliably over Ethernet. These tests have proven successful and have attracted a lot of interest, but there has been little action in the market. As need dictated, the shift to Ethernet was obtained, but an object-oriented protocol for DNP or Modbus was unachievable. To basically packetize the serial protocol in an Ethernet fashion certainly serves the purpose, but is not a true solution to a robust Ethernet protocol.

IEC 61850 appears to be the solution. With IEC 61850, you actually reference data by specifying its power system tag. In other words, there is a common naming convention for all the points that are in a device. If you want a voltage, there is only one way to name a voltage. What this does from a SCADA perspective is remove systems that are built around a mapping process of taking arcane tag numbers and mapping them into power system functions. There are significant advantages to users, as they don't have to manually map tag numbers to power system functions. It's inherent in the device.

Given this better functionality, and the recognition that IEC 61850 is a true, high-speed, robust, interoperable protocol, migration to IEC 61850 as an industry standard seems inevitable. Most importantly, IEC 61850 is a published standard. The users have something to specify, and the vendors have something to test against. The time it will take the industry to get there is another story. Slowly but surely, the utility community will see that IEC 61850 is available, it's supported, it's easy to use, and it can be a useful product in their process.

Figure 1

IEC 61850 vs. UCA: Notable Differences

IEC 61850	*TR 1550 (UCA)*
XML Based Config language	*No config language*
Comprehensive, modular info models	*Information models*
Prioritized Ethernet; preferred GOOSE messages	*No priorities*
Flexible IEC-GOOSE supports exchange of any data	*UCA GOOSE supports fixed number of digitals*
Sample value transmission of CT/VT	*No sample value transmission*
Info models and comm. Services independent of protocol	*Mapping to MMS*
Enhanced security control model	*Restricted control model*

Migration

Migration doesn't happen overnight, but it is happening all the same. Confidence and maturity are great enablers. If you look historically, after being harmonized from UCA, IEC 61850 addressed European requirements, while from IEC 60870-5, DNP became the North American standard. Concurrently, these two new protocols—IEC 61850 and DNP—had taken different directions. There was a split where DNP was recognized as the North American version, and IEC 61850 was used by the rest of the world. When it came time to actually take the work from the UCA effort and try to make it a U.S. standard, industry professionals didn't want this split to continue. So, UCA was submitted as input to the IEC working groups that were responsible for this new IEC 61850.

Then, just as UCA came in and was accepted, it was harmonized into IEC 61850. This instability ultimately has created less confidence in IEC 61850. Just as UCA was recognized as an interoperable, simple-to-use, robust protocol, it was replaced. Inevitably, users react accordingly: "We thought we had a standard; now it's turned into another. Will it change again?" "Let's wait until it matures a bit." "Let's wait until the product is out there." "Let's wait until other people use it, and it's vendor-supported."

Utilities are conservative by nature, driven by budgets that, when upgrading or implementing new technology, mandate proven solutions. Solutions can be driven by the industry, by requirements, and by needs, but until standardized and supported, conservative utilities shy away.

So, is IEC 61850 for real? Most European utilities are already starting to specify IEC 61850. There are a number of projects under

Reprinted with revisions to format, from the May/June 2005 edition of **UTILITY AUTOMATION & ENGINEERING/T&D**

way—some of which have already been commissioned. The same is happening in Mexico. China, too, is in the process of standardizing on IEC 61850 for substation automation. Its use in North America is a bit behind because of the strength of DNP 3 in this market. Regardless, it is inevitable; the amount of equipment that is going to become available worldwide supports the standard and most importantly the extremely significant benefit that you have with IEC 61850 using standardized object name, self describing devices, and standardized configuration language. These kind of user benefits can't be denied.

The Future

Habit, fear, instability and lack of confidence are the roadblocks to change. Change is never easy, but when utilities recognize that simple integration, speed, robustness and interoperability are valuable in their practices, change becomes inevitable. Requirements, needs and vendor support are the motivators. When a protocol becomes a part of a utility's business practice and their standards process, it is very hard to change. It can take years for this migration to occur. The community must believe the standard is here and available, products need to be developed around that standard, and the standard needs to be supported. IEC 61850 appears to provide the solutions to effect change.

No matter the roadblocks, when it comes down to how much effort it takes to commission substations with IEC 61850 technology vs. other protocols, there is little question. Cost over time for maintenance makes IEC 61850 a clear choice. The effort required to change equipment is drastically reduced because of the protocol's object-oriented, self-describing nature. If you look at doing equipment replacements over time and through incremental improvement, the cost is much lower and the integration efforts are simpler. This is a significant benefit to users considering their cost, over time, to maintain the systems. The costs for keeping current is drastically reduced as well.

IEC 61850 is the future of substation automation networking. It is feature-rich with capabilities optimized for Ethernet-based systems. IEC 61850 reduces setup and configuration, it standardizes functions, and has greater performance overall. «

Scott Olson is a project manager for the SCADA department for POWER Engineers, a 600-person consulting engineering firm specializing in energy, facilities and communications. With his 15 years of experience, he has gained an in-depth knowledge of the energy industry with a strong focus in SCADA, energy management and utility automation. He is instrumental in providing energy and facilities clients with innovative solutions.

Contact Information:
POWER Engineers
Automation
1295 S. Eagle Flight Way
Boise, ID 83709
Phone: 208-685-6355
Fax: 208-378-0025
Email: automation@powereng.com
www.powereng.com