Quanta Technology

Quanta Technology, headquartered in Raleigh, NC and a division of Quanta Services (NYSE: PWR), is an expertise-based independent consulting company providing business and technical expertise to energy and utility companies. We offer a full-range of technical and analytical services related to electrical transmission and distribution systems. Through the collaborative and integrated efforts of its associated and specialized operating companies, Quanta Technology is uniquely qualified to provide comprehensive infrastructure services including strategy, planning, design, engineering, program management, procurement, construction and maintenance on a project or turnkey basis.

This document contains a summary of qualifications for Quanta Technology to assist electric utilities and owners of electrical delivery facilities (transmission, substations, distribution and industrial) with issues related to infrastructure maintenance, engineering, and planning standards and guidelines. These services include:

- Standards and guidelines development and review
- Project and facilities design criteria (including arc flash analysis)
- Equipment failure and system event investigation and forensics
- Lifetime extension and maintenance optimization
- System studies and analysis
- Resource planning
- Portfolio optimization
- Economic analysis
- Feeder analysis
- Expert witness and regulatory support
- Training

This qualification document contains information about Quanta Technology, a summary of related projects previously performed by Quanta Technology staff and associates, and the credentials of key personnel.
IEC 61850
Quanta Technology's industry experts have participated in the development of the IEC 61850 protocol since its inception in 1995, and through its absorption of EPRI UCA in 2000 to yield the single international multivendor standard for substation protection and data integration. IEC 61850 is a compendium of definitions of communications services and objects at several layers of the OSI 7-layer communications stack.

The specific services of IEC 61850 should be mapped to application needs in order to design practical substation protection and control systems, with assessment of products, tools, risks and risk mitigation strategies for each facet of the deployment.

The most widely recognized IEC 61850 services are:

- **GOOSE Messaging** – Publisher-subscriber service for transfer of status, control, and analog information among peer servers (interacting IEDs) at millisecond speeds equaling or exceeding the speed of the dedicated point-to-point wiring that GOOSE aims to replace.

- **Information and Control Object Exchanges** – Substation specific messages passed between servers (IEDs) and clients (substation host computers or concentrators) for operational and non-operational data – local HMI, SCADA and EMS, and operations support.

- **Sampled Values or Process Bus Messaging** – For bringing switchyard power system data (such as voltage and current waveforms from VTs and CTs) from switchyard data collecting and apparatus control units (merging units) to IEDs in the control building on optical fibers that replace conventional switchyard wiring. This technology has triggered industry attention with the recent introduction of the first products from major vendors.

- **A Host of Other Services** – Device configuration and parameter settings, file transfer for non-operational data, time synchronization, etc.

Tools for automated configuration of networked devices from multiple vendors, based on IEC 61850-6 substation configuration language (SCL), are just emerging from multiple vendors. As the industry absorbs these developments, the standards writing teams continue with new features and services including objects for new applications (hydro power plants, distributed energy resources) and new communications applications reaching outside the substation to control centers and to other substations for teleprotection applications.

Each of these services and applications has specific purposes, risks and benefits, and the risks evolve as vendors continue product development. A Quanta Technology IEC 61850 strategy project maps these factors to the needs and circumstances of the utility, weighing alternatives and risks in the process.
Offerings in the Area of IEC 61850

Training
As a starting point for utilities seeking to engage with IEC 61850, Quanta Technology conducts customized on-site seminars to explain the features, services, applications, risks and industry experience. Common training topics are:

- Basic IEC 61850
- Ethernet communications network design
- Tools and applications with:
  - GOOSE messages
  - Process bus
  - MMS mapping
- Testing
- How to build a business case for IEC 61850
- Hands-on training on selected equipment and tools

Roadmap for Implementation of IEC 61850
Quanta Technology has assisted utilities defining a technical roadmap for implementing IEC 61850. Some or all of the following planning steps are normally included in such a roadmap:

- Needs Analysis: The planning of a roadmap starts with the needs analysis. Quanta Technology organizes on-site information gathering and discussion seminars. The needs analysis is made by developing surveys and interviewing stakeholders to identify needs, requirements and use cases tailored to the utility.

- Definition of Functional Requirements: The results of the survey, interviews and group discussions will be used to identify drivers and functional requirements for implementing advanced, IEC 61850 based protection and automation architecture and applications. This may include applications of the complete IEC 61850 protocol services suite, or for particular services of interest like sampled values/process bus with optical fiber for switchyard to control house communications.

- Development of Business Case: In order to define a business case for a IEC 61850 based solution, the Quanta Technology team will use cost factors for equipment purchase, systems engineering and installation for the proposed architecture, organizational support requirements, installation lifetime, regulatory impacts, hard and soft cost benefits of new functions, and any other identified cost benefits versus costs of continuing with pre-project approaches.

- Development of a Training Facility: The adoption of IEC 61850 in the utility depends on a high level on acceptance by the stakeholders such as system engineers, and relay and field technicians. Experience has shown that a training facility for IEC 61850 is of paramount importance. The training facility is a test bed for development and fine tuning of applications and user interfaces before implementation in the field.

Pilot Projects & Implementation Support
Once technical plans and high level specifications are adopted, the implementation phase is started. Quanta Technology brings experience in dealing with vendors and new products, as well as manpower to reduce the workload of a fully burdened utility team while maintaining collaboration and utility awareness. Implementation activities by Quanta Technology engineers include development of detailed specifications and requests for proposals. Quanta Technology supports or leads a process of objective proposal assessment and vendor selection. Quanta personnel can serve as owner’s engineers who oversee suppliers and installations. The Quanta team has experience with development or review of test plans and results for new equipment and system designs for substation protection and control. Quanta team members with utility experience can develop operating, maintenance, and test plans including documentation for regulatory compliance.
The implementation or a pilot project typically includes the following steps:

- Defining functional requirements
- Request for Information (RFI)
- Selection of qualified suppliers
- Request for Proposal (RFP)
- Evaluation of proposals
- Planning and supervision of factory acceptance test
- Planning and supervision of site acceptance test
- Commissioning assistance

**Testing of New Equipment & Applications**

As part of an implementation project or a roadmap development, there may be a need to evaluate and test the new IEC 61850 equipment and applications. This evaluation and tests can be provided by the Quanta Technology Real-Time Digital Simulation (RTDS™) test facility with IEC 61850 and PMU test capabilities. Our experts support test activities, such as:

- Test plan development
- Test set-up
- Conducting test
- Reviewing of test results
- Detailed test reports
Publications on IEC 61850

- Comparison of IEC 61850 GOOSE messages and control wiring between protection relays (Juergen Holbach, Thierry Dufaure)
- Building the Business Case for IEC 61850 (Solveig Ward, Bas Kruimer)
- In-Service Challenges of Protection Systems Based on IEC 61850 GOOSE Message Exchanges (Eric Udren, Juergen Holbach)
- Wide-Area Ethernet Network Configuration for System Protection Messaging (Eric Udren, Craig Hammond, Jun Wen)
- Status on the First IEC 61850-Based Protection and Control, Multi-Vendor Project in the United States (Juergen Holbach and others)
- System-Wide Replacement Strategy for Substation Protection and Automation Systems (Eric Udren, Paul Myrda)
- IEC 61850/GOOSE Messaging Project (Juergen Holbach, North Carolina State University)

Membership in Standards Bodies Related to IEC 61850

- Member of IEC TC57 WG10: Solveig Ward, Eric Udren, Farnoosh Rahmatian
- Member of UCA International Users' Group Testing Subcommittee (IEC 61850 test procedures): Eric Udren
- Power System Relaying Committee – Relaying Channels Subcommittee which oversees much of the IEC 61850 related standards and guide development in IEEE: Eric Udren
- WG H12 developing paper on use of Ethernet for IEC 61850 and other P&C uses: Eric Udren
- Member of IEC TR 61850-90-5 for synchrophasor communication. Farnoosh Rahmatian, Eric Udren
- Member of TC 57 WG 17 during the development of DER part of the standard: Farid Katiraei
- Member of IEEE 1547.7 & 1547.8 on DER interconnection and protection standards. Writing group lead for Modeling and Data requirements: Farid Katiraei
- Solveig Ward was on the Task Force and contributed to the Technical Report IEC 61850-90-1TR "Substation to substation communication" completed in 2010
- NERC System Protection and Control Subcommittee (SPCS) : Eric Udren
- NERC Protection System Maintenance Standard Drafting Team developing NERC Standard PRC-005-2: Eric Udren
- IEEE-PSRC H5 Common Data Format for IED Configuration Data: Juergen Holbach (Chair)
- Member, Chair of the proceeding IEEE-PSRC C1 that produced a report for Cyber Security Considerations for Protective Relaying IEC 61850 cyber security requirements are considered in this guide
- IEEE-PSRC C4: IEEE PC37.244 Draft Guide for Phasor 1 Data Concentrator Requirements for 2 Power System Protection, Control and 3 Monitoring: Solveig Ward (Member and Chair of the System protection Subcommittee, C). IEC 61850-90-5 is considered in this guide
Selected Project Experience

The following is a selected list of relevant projects and industry activities that members of the Quanta team have participated in recent years. Brief project descriptions are provided below and detailed descriptions are available upon request.

**New York Power Authority- St. Lawrence Substation (2009)**

**Northeast Utilities (NU) (2009) IEC 61850 Implementation Support**

Quanta Technology supported Northeast Utilities Service Company (NU) in implementing the IEC 61850 communications protocol as an integral part of new protection and control system design. Quanta experts served the NU development team in a technical advisory role:

1. Reviewed the overall NU implementation strategy to help identify potential pitfalls and improvement opportunities, assess potential risks in the use of various IEC 61850 protocol services and tools, and develop risk mitigation plans.
2. Reviewed and provided suggestions for the IEC 61850 Substation Simulator.
3. Supported the evaluation of the RFP responses and vendor selection.
4. Supported development of Protection and Control logic for IEC 61850 implementation including, for example, distributed control logic associated with GOOSE messaging, maintenance and testability features, monitoring features for maintenance reduction, or other support and review steps agreed by NU and Quanta Technology teams.
5. Supported development of system testing specifications, including test plans and acceptance criteria for communications conformance testing, system or functional type testing, factory testing, and field and site acceptance testing.
6. Supported development of system configuration management, design documentation, database management, and system change control processes.

**Southern California Edison Company (2009-2012) Feasibility Study – Process Bus & Optical Sensors**

SCE and Quanta experts held discussions with managers from SCE Protection and Automation, Substation Engineering, and Advanced Technology (R&D) departments on a project to investigate the technical features, architecture, products, and the business case for using IEC 61850 communications between the control house relays and IEDs and switchyard-mounted signal and control multiplexers called Merging Units (MUs). SCE managers expanded the scope to include an optical sensor track and an in-depth business case study.

**Joulz, Holland (2011) Assessment of IEC 61850 System Engineering Process & Training**

Advanced Substation Automation engineering and IEC 61850 training for Joulz SA Engineers in Baden, CH. Quanta has organized the training and will also handle the hotel cost.


National Grid UK requested Quanta Technology and University of Manchester to quote a project in which the IEC 61850 based substation automation architecture for the different types of substations of NGC-UK would be developed for the future. This work resulted in a number of scenarios for different practical solutions depending on the substation. A project-specific system design and specification for a selected substation was written and the substation system realized by end 2014.
A Con Ed engineering team is developing specifications for a replacement protection and control system for the East 13th Street (Manhattan) Substation based on IEC 61850 communications and integration. They plan to engage Eric Udren and Quanta experts on review of their specifications, with special concern for 61850 engineering tools. Tasks are vendor proposal evaluation, P&C design review, GOOSE documentation, Ethernet network testing methods, and FAT review.

TVA 500KV Bradley Substation: First IEC 61850 based PAC multivendor project in the United States (2005)
Organized IEC 61850 Interoperability demonstration during Western Protection Relay Conference 2005 in Spokane WA.

PG&E and NGrid IEC 61850 project (2010-ongoing)

Triangle Microworks (2014-ongoing) Tool Development Support

North Carolina State University Cooperation with Quanta Technology: Test the GOOSE performance from different IED's under different stress conditions (ongoing)


HEP Croatia (2010)
Key Personnel

The Quanta Technology T&D system protection, control and communications team consists of world-class experts in the area of substation and feeder automation, protection and control, communications systems, power system operation and engineering, system enterprise integration and other disciplines that are key to the success of an IEC 61850 project. Brief biographies of key team members are provided below. Quanta Technology also has additional team members and resources available to support projects as needed.

Juergen Holbach, Senior Director

Juergen H. Holbach, PhD, Senior Director, Automation & Testing, has more than 17 years of experience in design and application of protective relaying. He led the development project for the second generation of numerical line differential relays for a German relay manufacturer. As an application expert for transmission protection he was responsible for approval test of transmission relays with utility customer around the world. Since 2000 he works in the U.S. as a product manager for protection relays. Juergen was one of the lead engineers on the first IEC 61850 based Protection and Control, Multi-Vendor Project in the United States (500KV Bradley Station-TVA).

Juergen contributed to several working groups in CIGRE as well as in IEEE-PSRC and is the chairman of the working group H5 “Common format for IED configuration data”. He is also member of the IEEE-PSRC subcommittees “Relay Practices” and “Relay Communication”. He published over a dozen papers at the major relay conferences in North America and is member of the Georgia Tech Protective Relaying Conference Planning Committee. Juergen holds several patents in the area of protection relaying.

Prior to joining Quanta Technology, he was Product Lifecycle Manager at Siemens Energy Inc. in Wendell North Carolina. He was born in Germany and graduated from the University of Berlin with a PhD in Electrical Engineering. He joined the Siemens AG in 1992 as a development engineer in Berlin Germany. In 1994 he moved to the product management group for protection relays in Nuremberg Germany. In 2000 he joint Siemens Power and Distribution in Wendell, NC as a product manager for transmission relays.

Eric Udren, Executive Advisor

Eric A. Udren, Executive Advisor, Automation & Testing, Quanta Technology Expert, has 42 years of experience leading design and application of protective relaying systems, substation control, wide-area monitoring and control systems, and communications systems. His areas of expertise are protective relaying and substation control, IEC 61850 power system communications and modeling protocol, remedial action scheme design, protection system maintenance and condition monitoring, NERC PRC reliability standards, communications systems and Ethernet networking for substation and power system control, and Wide-Area Monitoring, Protection, Automation and Control (WAMPAC).

Eric has over 40 years’ experience in the electric power industry and is an IEC 61850 architect. Prior to joining Quanta Technology, he was Senior Principle Consultant with KEMA T&D Consulting and Manager of Project Management with ABB/Westinghouse Relay Division. Mr. Udren is an IEEE Fellow and Chair of numerous IEEE committees and working groups. In addition, he has authored over 80 papers and chapters of books including IEEE Prize Paper, Walter A. Elmore Best Paper Award, chapters in 2012 PAC World Conference book, Westinghouse Applied Protective Relaying book, and two papers in IEEE Press Book on Relaying.
Solveig Ward, MSEE, Executive Advisor

Solveig Ward, MSEE, IEEE Fellow, Executive Advisor, Protection, Automation and Testing, has over 37 years’ experience working in a variety of managerial, product management and marketing roles in the protective relaying and relaying communications area. Combining relay expertise with communications knowledge, she provides leadership in the area of communications systems for power system protection and control including IEC 61850, wide area protection, cyber security and integration issues.

Solveig is an application expert in current differential and pilot relaying. During her time with ABB, she was a product manager for line differential relays (pilot wire, phase comparison and current differential) and was involved in developing a new current differential relay. At RFL, she continued in this line of business, being project manager for a new current differential relay and communications product. She has written and presented many papers in relation to pilot relaying, current differential relaying, and associated communications, both digital and analog. She has also written application guides for settings of current differential relaying and wrote and presented a paper on this topic, as well as application guides for settings and coordination of pilot distance protection.

Farid Katiraei, PhD, Senior Director

Dr. Farid Katiraei, PhD, Senior Director, Renewables, Emerging Technologies & Microgrids, Executive Advisor & Director, Quanta Technology Expert, has more than 7 years of design, modeling and implementation of power electronic apparatus for power system applications; dynamic system analysis and testing of emerging technologies and architectures for medium- and low-voltage distribution systems based on Mini-grid, Microgrid and Smart Grid approaches.

Prior to joining Quanta, Dr. Katiraei has been with Natural Resources Canada Energy Research Center (CANMETEnergy) in Varennes-Québec and CYME International where he has been involved in control and protection system design, grid interconnection, transient modeling, field testing, utility impact assessment of distributed and renewable energy resources and management of several pilot demonstration projects in the aforementioned areas.

Farid received his PhD degree in electrical engineering from University of Toronto (Toronto, Canada) in 2005. He is an active member of IEEE, an active participant in several working groups and committees, and an accomplished author of several journal papers, conference publications and technical articles.

Yi Hu, PhD MSEE, Executive Advisor

Dr. Yi Hu, IEEE Fellow, Director, Wide-Area Monitoring, Protection and Control, Quanta Technology Expert, has over 24 years of experience working with electric utilities and vendors. He has developed a number of concepts and methods to improve power system operation, protection and control and consulted for many customers.

He had successfully led the development of Wide-Area Monitoring, Protection and Control business since joining Quanta Technology. Dr. Hu has led the Quanta Technology team to win several major WAMPAC projects in the U.S. and Internationally, such as U.S. DOE/NETL NASPInet Specification project, Brazil ONS PMU Certification project.

Prior to joining Quanta Technology, Dr. Hu was a Principal Consultant of KEMA T&D Consulting in US. He has also held various senior engineering positions while with TEKELEC, ABB and NARI. His work had earned him industry recognition and reputation and currently is an IEEE Senior Member. He presently holds 13 US and multiple international patents. Yi had published multiple technical papers and articles in Refereed Journals and Conference Proceedings in various areas of power system analysis, protection, automation and control.

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