19th Annual PQSynergy™
International Conference and Exhibition 2019

KEYNOTE ADDRESS

IEC 61850 Digital Communication Standard for Substation: History, Overview, and Future

James Mater
General Manager
Smart Grid, Quality Logic Inc., USA
(Presented by Terence Chandler)

QualityLogic

James is a member of the Gridwise Architecture Council, as well as Chair Emeritus, Smart Grid NW and Chair, OpenADR MWG.

INTRODUCTION TO IEC 61850: STRUCTURE AND INTEROPERABILITY

PREPARED BY MR. JAMES MATER

QualityLogic

PRESENTED BY TERRY CHANDLER

POWER QUALITY THAILAND LTD

PQSYNERGY 2019 BANGKOK, THAILAND

MARCH 2019

TOPICS

- Background
- Structure and Functions
- Information Model
- Communications
- Testing and Certification
- Interoperability Challenges

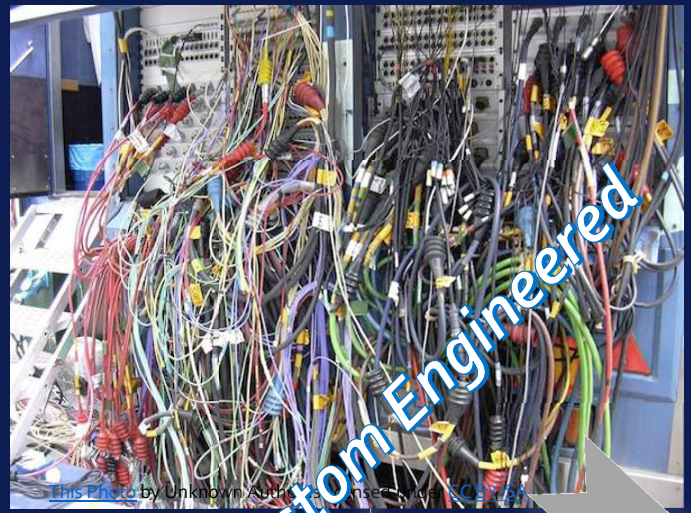
IEC 61850 HISTORY

- Started 1989 by EPRI USA: 6 Volume report 1991
- IEC Started Work in 1995 to become IEC 61850 Edition 1
- Edition 1 was focused on Substation Automation
- Edition 2 added Distributed Energy Resources (DER)
- Formal title: "*IEC 61850 Ed 2 Communication Networks and Systems for Power Utility Automation*"

IEC 61850 PURPOSE AND GOALS

QualityLogic

SUBSTATION DESIGN AND CONSTRUCTION

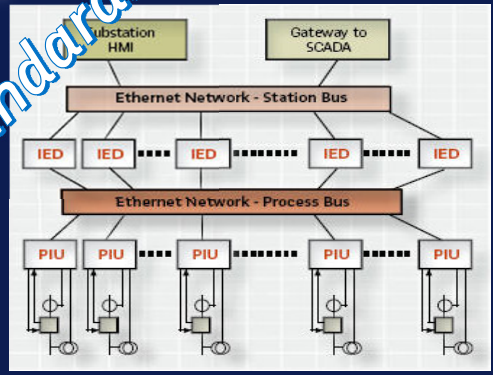


Custom Engineered

herbfalkmi@gmail.com

- Standardization of…
  - Information Model
  - Functionality
  - Communications
  - Substation Design
  - Substation Configuration

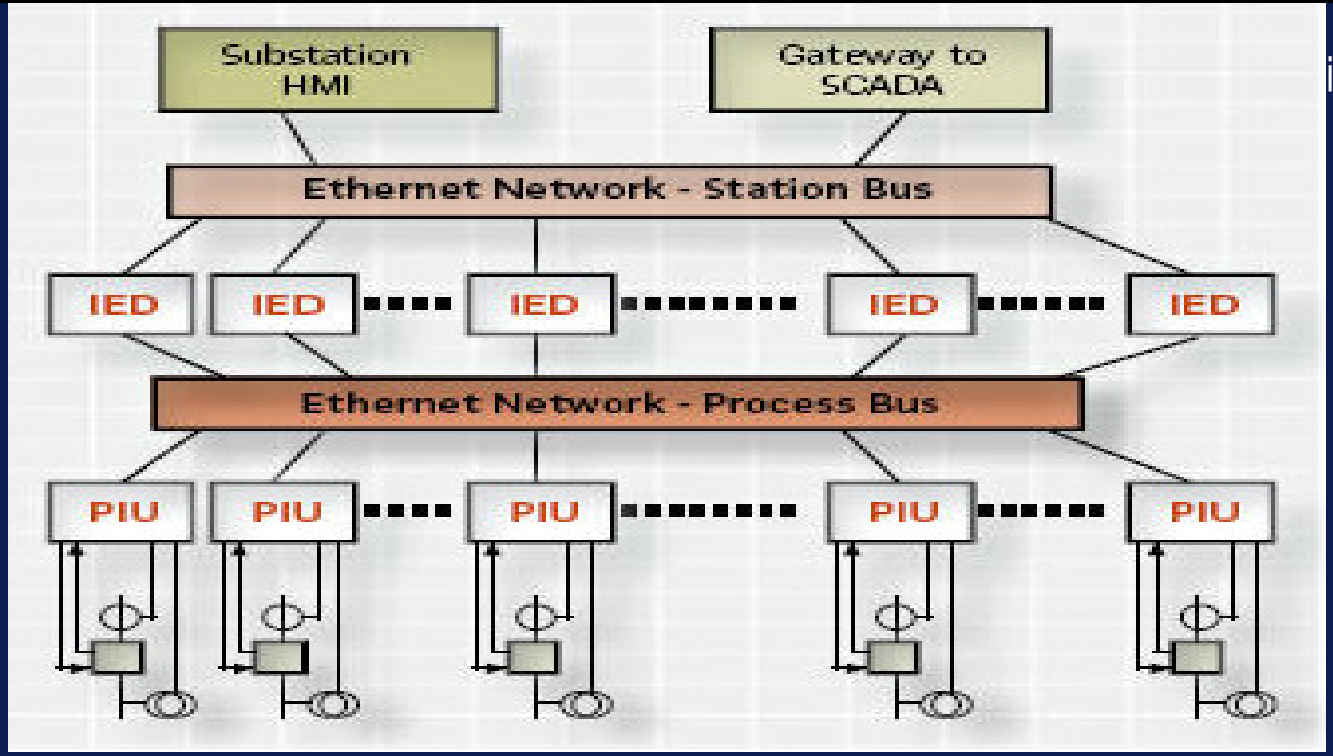
Standardized



IEC 61850 BENEFITS

- Multivendor, interoperable solutions
- Reduce/eliminate vendor lock-in
- Simplified wiring reducing costs
- Improved security/integrity
- Fewer communications protocols
- Flexible programmable protection schemes
- Communication network speeds in lieu of numerous hard-wired connections
- Access to better and faster grid information
- Reduced construction, commissioning and O&M time and costs

IEC 61850 STRUCTURE



- Station bus Ethernet for Human Machine Interface (HMI) to Intelligent Electronic Device (IED)
- Process bus for very fast monitoring and control functions at the Process Interface Unit (PIU) –
- fast protocol Generic Object Oriented Substation Event (GOOSE)

IEC 61850 STRUCTURE

- IEC 61850 includes 10 Parts
  - -1 Introduction and Overview
  - -2 Glossary
  - -3 General Requirements
  - -4 System and Project Management
  - -5 Communications Requirements for functions and device models
  - -6 Configuration description language
  - -7-1 Basic communication structure for substation and feeder equipment
  - -7-2 Abstract Communication Service Interface (ACSI)
  - -7-3 Common data classes
  - -7-4 Compatible logical node classes and data classes
  - -8 Specific communication service mapping within substation
  - -9 Specific communication service mapping for transmission of sampled values
  - -10 Conformance testing

IEC 61850 STRUCTURE

- Core Substation Automation Functions
  - Monitoring
  - Protection
  - Control
  - Reporting

IEC 61850 STRUCTURE : MONITORING

- Monitoring Functions
  - Reporting (buffered and un-buffered)
    - PQ data
    - Energy data
    - Relay data
  - Earth fault
  - Over current

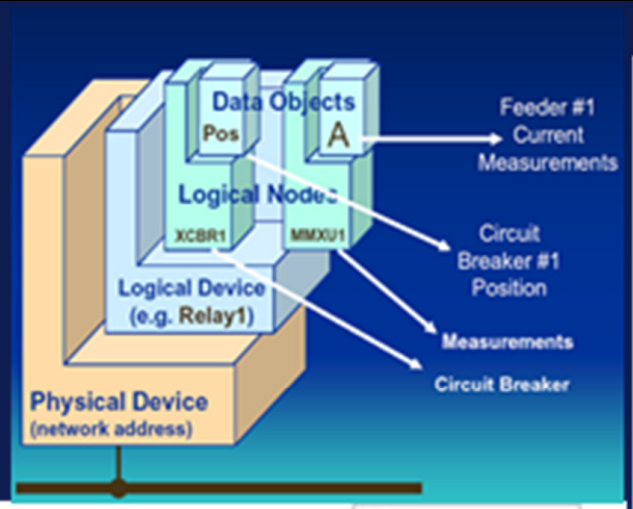
IEC 61850 STRUCTURE : PROTECTION

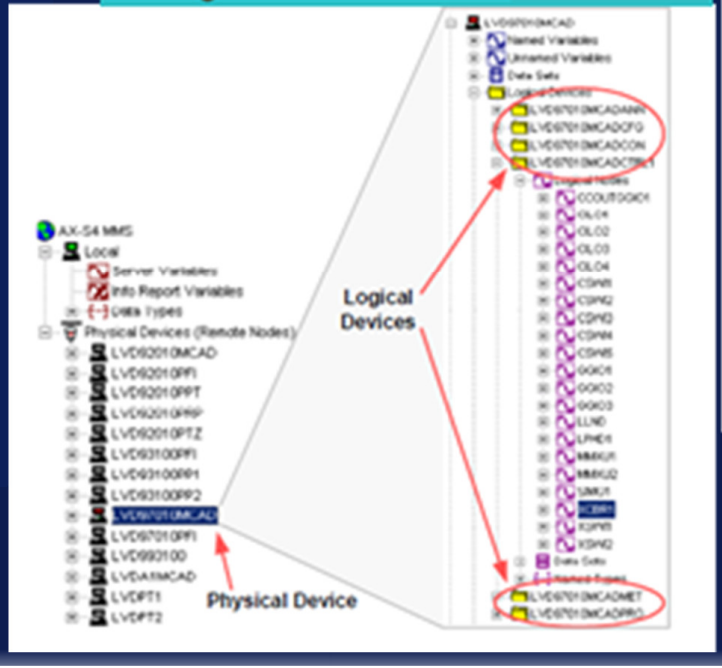
- Protection Functions
  - Earth fault
  - Over current
  - Distance

IEC 61850 STRUCTURE: CONTROL

- Control Functions
  - Open/close circuit breakers
  - Change settings
  - Control Isolators, Earth Switch, etc
  - Online/Offline
  - Change configurations

IEC 61850 INFORMATION MODEL





Discrete Points

Analog Points

IEC 61850 INFORMATION MODEL

QualityLogic

Information Model consists of:

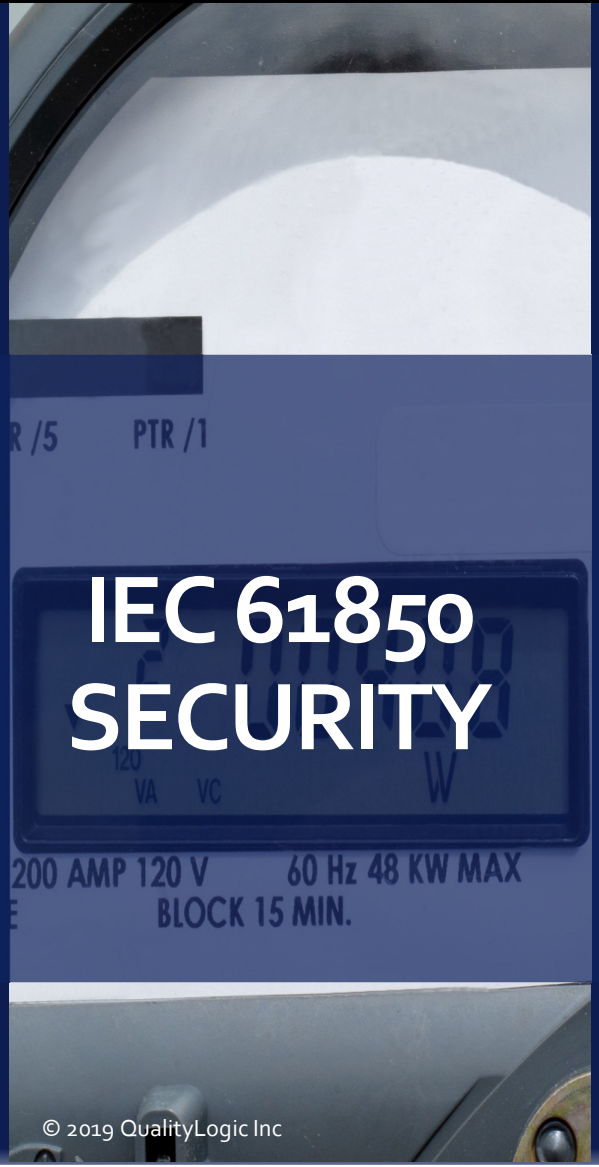
- Standard data types: common digital formats such as Boolean, integer, and floating point.
- Common attributes: predefined common attributes that can be reused by many different objects, such as the quality attribute.
- Common data classes (CDCs): predefined groupings building on the standard data types and predefined common attributes, such as the single point status (SPS), the measured value (MV), and the controllable double point (DPC.
- Data objects (DO): predefined names of objects associated with one or more logical nodes. Their type or format is defined by one of the CDCs.
- Logical nodes (LN): predefined groupings of data objects that serve specific functions and can be used as "bricks" to build the complete device.
- Logical devices (LD): the device model composed of the relevant logical nodes for providing the information needed for a particular device. For instance, a circuit breaker could be composed of the logical nodes: XCBR, XSWI, CPOW, CSWI, and SMIG.

IEC 61850 COMMUNICATIONS

- IEC 61850-1 defines communication services :
  - Retrieving the self-description of a device,
  - Fast and reliable peer-to-peer exchange of status information (tripping or blocking of functions or devices),
  - Reporting of any set of data (data attributes),
  - Sequence of Event (SoE) – cyclic and event triggered,
  - Logging and retrieving of any set of data (data attributes)
  - Substitution,
  - Handling and setting of parameter setting groups,
  - Transmission of sampled values from sensors,
  - Time synchronization,
  - File transfer,
  - Control devices (operate service),
  - Online configuration.

QualityLogic

- IEC 61850-8-1 communication protocols :
  - Generic Object Oriented Substation Event (GOOSE)
    - Multicast publish/subscribe protocol
    - Runs over Ethernet
  - Manufacturing Message Specification (MMS ISO 9506)
    - Client/server protocol
    - Uses the Abstract communication service interface (ACSI)
    - Runs over TCP/IP and Ethernet

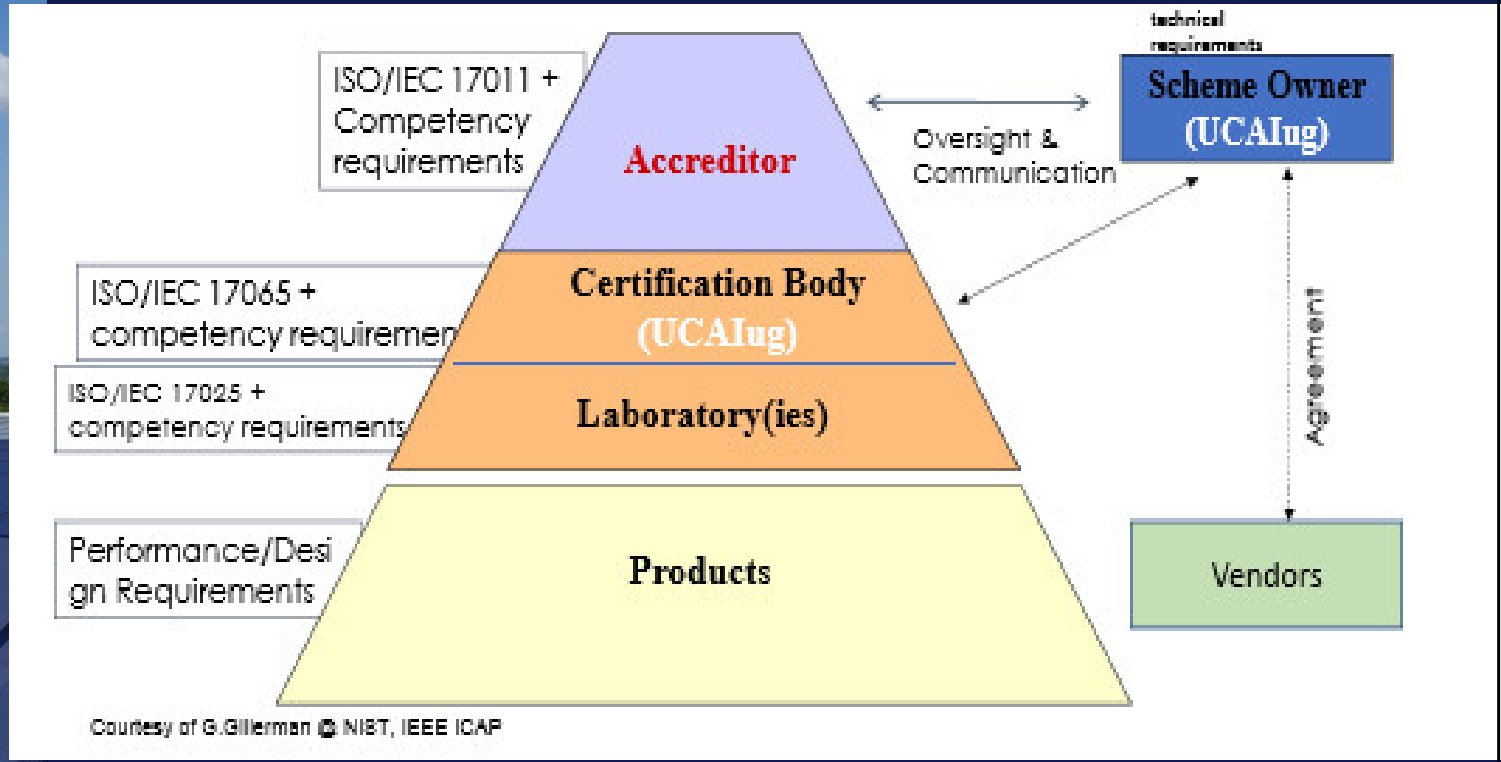


IEC 61850 SECURITY

- MMS protocol supports authentication using certificates
- TLS support defined by IEC 62351-3
- GOOSE – state and sequence numbers
- Routable GOOSE - authentication
- Role Based Access Control (RBAC) - spec being defined

IEC 61850 TESTING AND CERTIFICATION

- New UCAIug Conformity Assessment Certification Scheme – 2019



IEC 61850 TEST AND CERTIFICATION

QualityLogic

- UCAIug is responsible for the certification program for IEC 61850 worldwide.
  - Develops and maintains the test specification
  - Approves test labs
  - Maintains database of certified products
  - Manages the overall program
- IEC 61850 Edition 1 certification will terminate December 31, 2020 (current proposal)

IEC 61850 CHALLENGES

- Standard complexity and evolution
  - Intentionally complicated to enable wide applications
  - Creates interoperability challenges
  - Standard evolving – slowly due to IEC process
- Interoperability Challenges
  - Certification requirements minimal – do not insure interoperability (certified to not not conform!)
  - Multiple certification centers and multiple test tools creates opportunities for incompatible certifications from different labs
  - Lack of application profiles and associated certifications

QualityLogic

- Test Tools for IEC 61850, IEEE 2030.5, OpenADR
- Training/support services
- Customized test tools for protocols commission testing

TERRY CHANDLER

Terryc@powerquality.co.th

JAMES MATER

jmater@qualitylogic.com

www.qualitylogic.com

WWW.powerquality.co.th