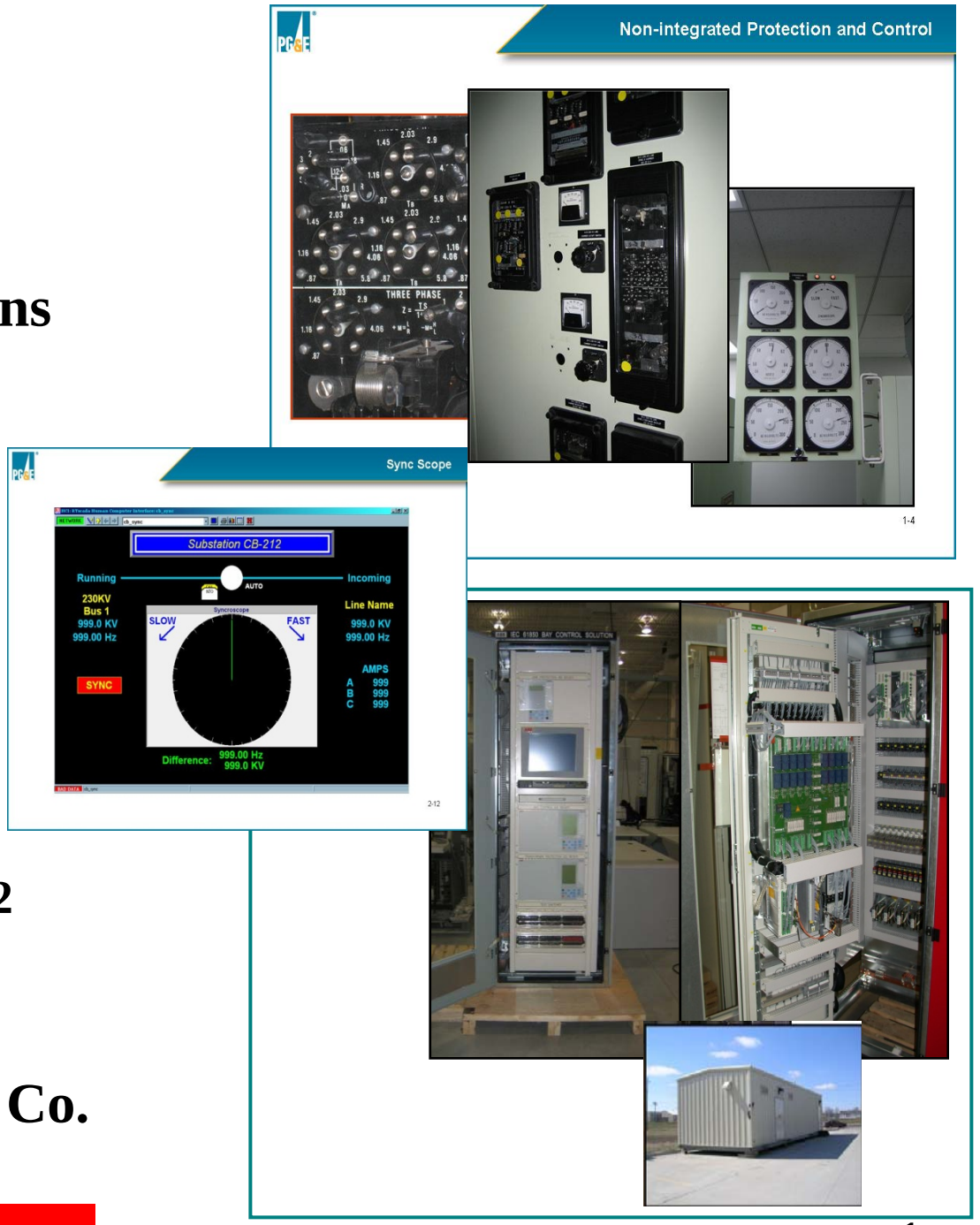
NASPI Tutorial
on
IEC 61850 Introductions



Tuesday October 16, 2012

Vahid Madani
Pacific Gas and Electric Co.

Tutorial Objective

- Benefits and Impact of IEC 61850
- Understanding of technology behind IEC 61850
- Life cycle impact of IEC 61850
- Integration with other standards and interoperability
- Installation examples - North America and Internationally
- Key deployment success factors and deployment roadmaps

Tutorial Overview and Outline

- Tutorial objectives and brief history of IEC 61850 – **Madani / Farquharson**
- IEC 61850 benefits and overview of NIST standardization process – **Adamiak / Farquharson**
- Insight in IEC 61850 - What is it? – **Mackiewicz / Falk**
  a) What is IEC 61850 and Its Relationship to other IEC Standards
  b) Impact of IEC 61850 on the Engineering Processes of SCADA, Automation, Protection
  c) IEC 61850 Profiles
  d) IEC 61850 Modeling
     i. Device and Object Models
     ii. Service/Behavior Models
  e) Substation Configuration Language
- Q & A Session – **Novosel**

Break - 15 Minutes

- IEC 61850 Applications with real-life examples, Recent Industry Activities **Brunner / Madani**
- IEC 61850-90-5, including interaction with IEEE 37.118 **M. Adamiak**
- Brief overview of IEEE 1588 test results – Concept and practical examples and lessons learned - **Rahmatian / Adamiak**
- Interoperability issues, tests, and practical examples - **Madani / Rahmatian**
- Q&A session – **Novosel**

Two clarification type qualification questions from each presenter immediately after the presentation
Additional questions will be deferred to the panel session.

Why IEC 61850?
Harmonization, Standardization, Ease of Use

National Origin??

Communication Networks and Systems in Substations

IEC 61850

Global Driver

- Necessity to simplify & standardize substation design, construction, commissioning, operation and maintenance

Driven By

- Utilities through UCA & IEC standard committees

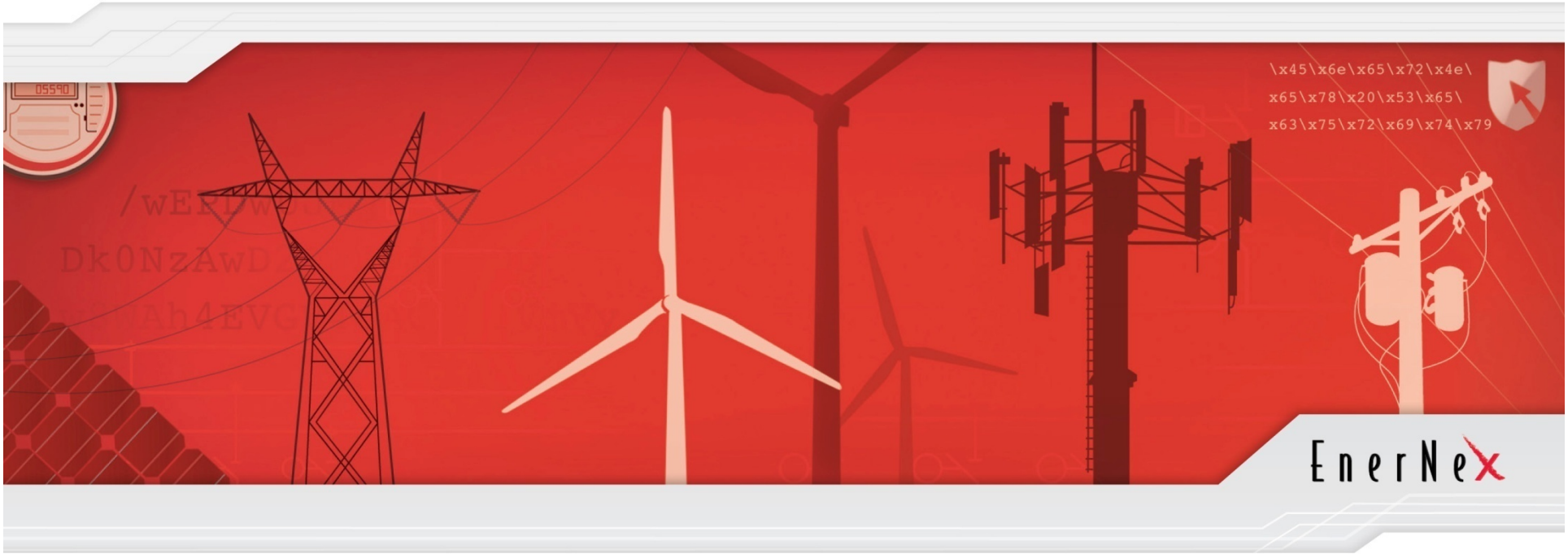
IEC 61850 - Communication networks and systems in substations

Why it is real:

- Driven by Utilities to meet a need
- Finally see the "Promised LAN" (…and we don't anticipate taking 40 years to get there…)
- It works and is in the market (after many years)
- Fits and supports today's Power System Technical and business drivers – Makes a business case
- Networking dominates the utility landscape
- Time for paradigm Shift
  - ✓ If you are not on-board, you will be soon
  - ✓ Start Developing the foundations & standards for application in your company
    - » Timing is right
    - » Better get involved sooner

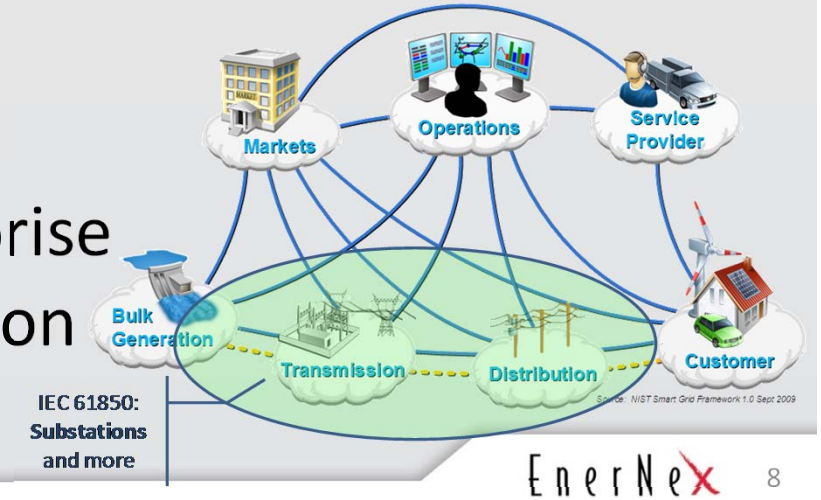
Origin and History of IEC 61850

Ron Farquharson,
Principal Consultant, EnerNex

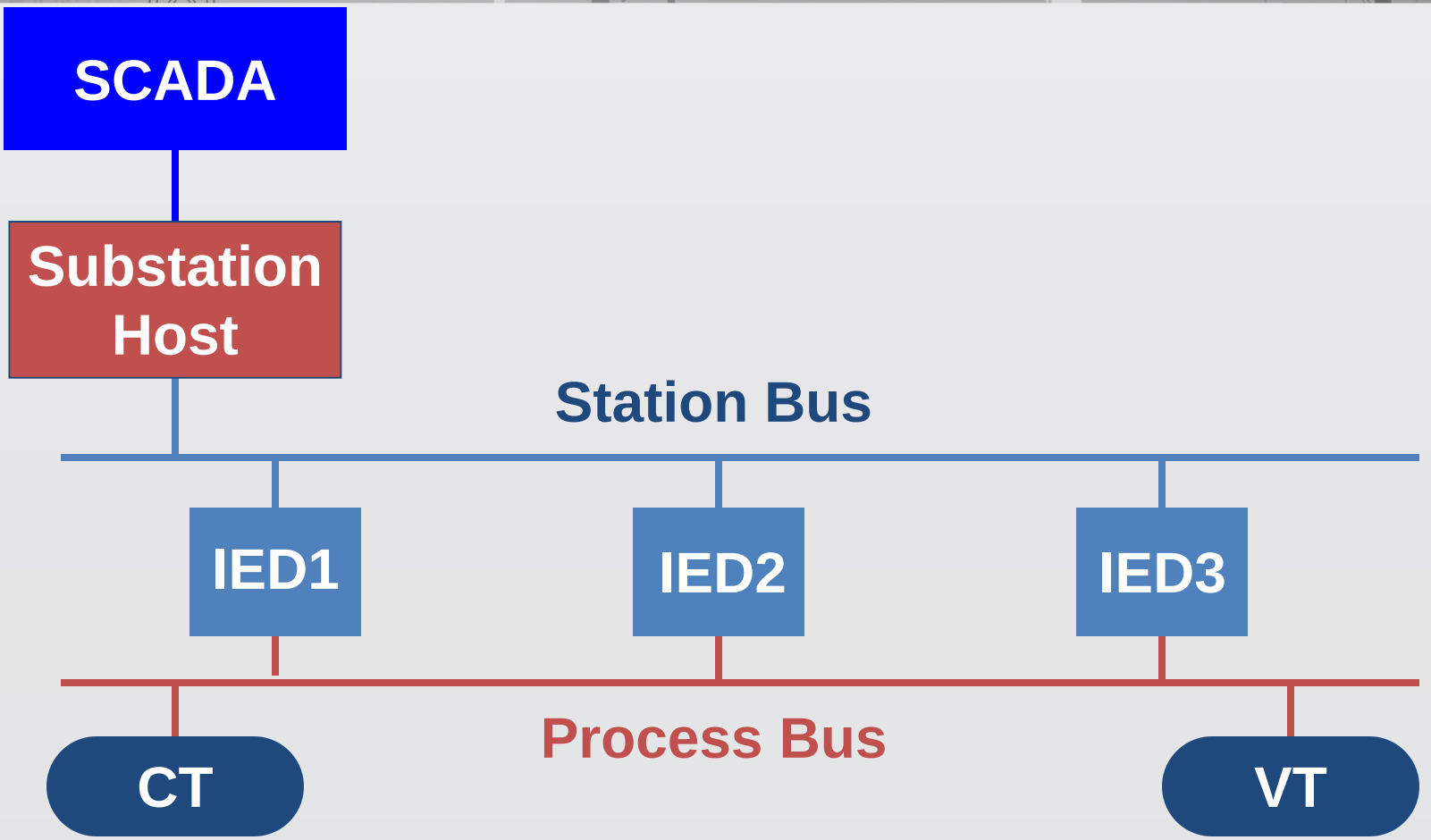


IEC 61850's role in the "Big Picture"

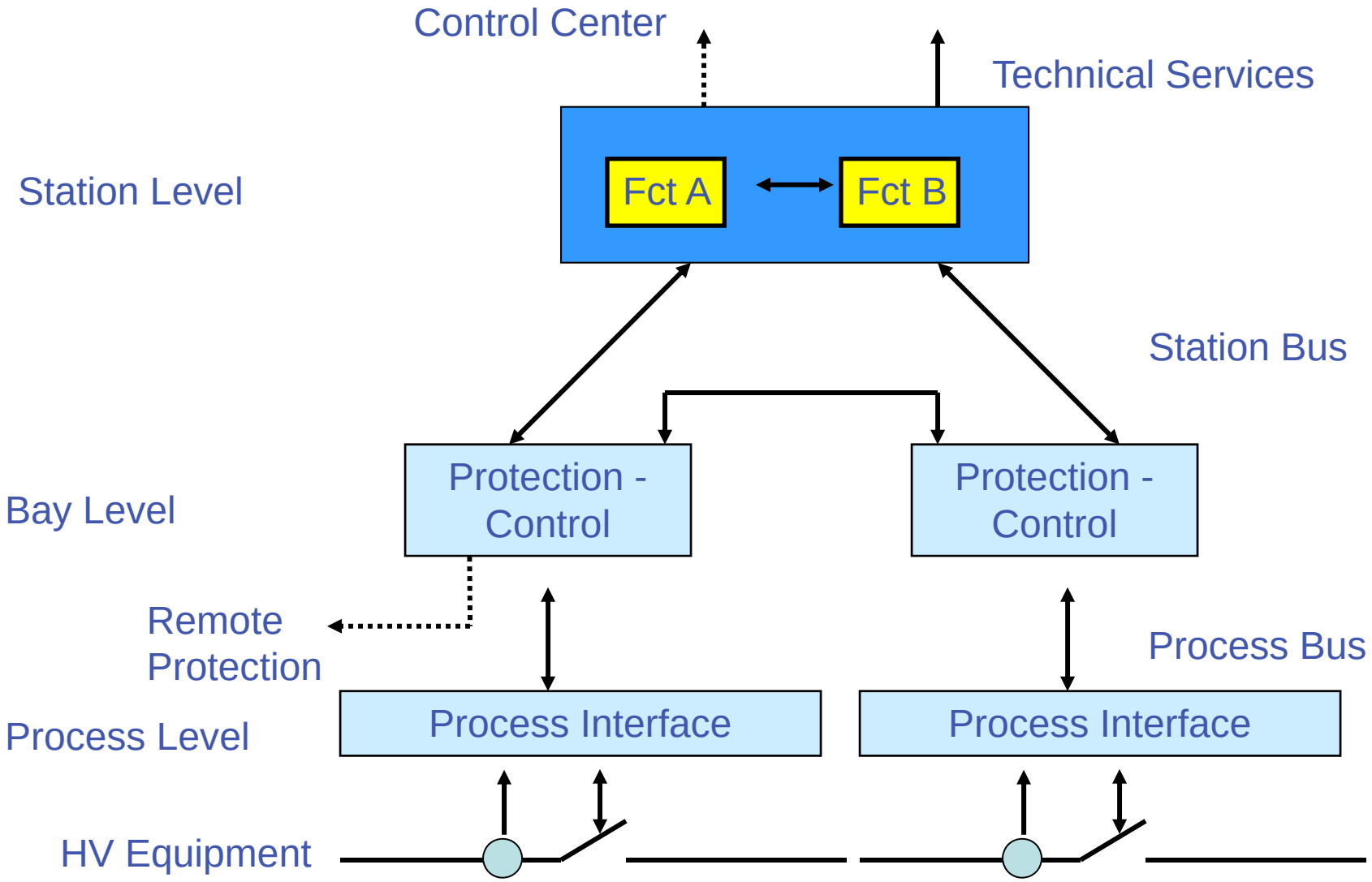
- Identified in the first batch of interoperability standards key to Smart Grid deployment by NIST
- Initial focus was substation automation (Edition 1)
- Scope is now expanded to address many of the automation systems utilized in the electric utility transmission and distribution domains
- Supports traditional protection and control functions while enabling new advanced capabilities
- Future integration with enterprise applications using CIM (Common Information Model)



IEC 61850 Architecture

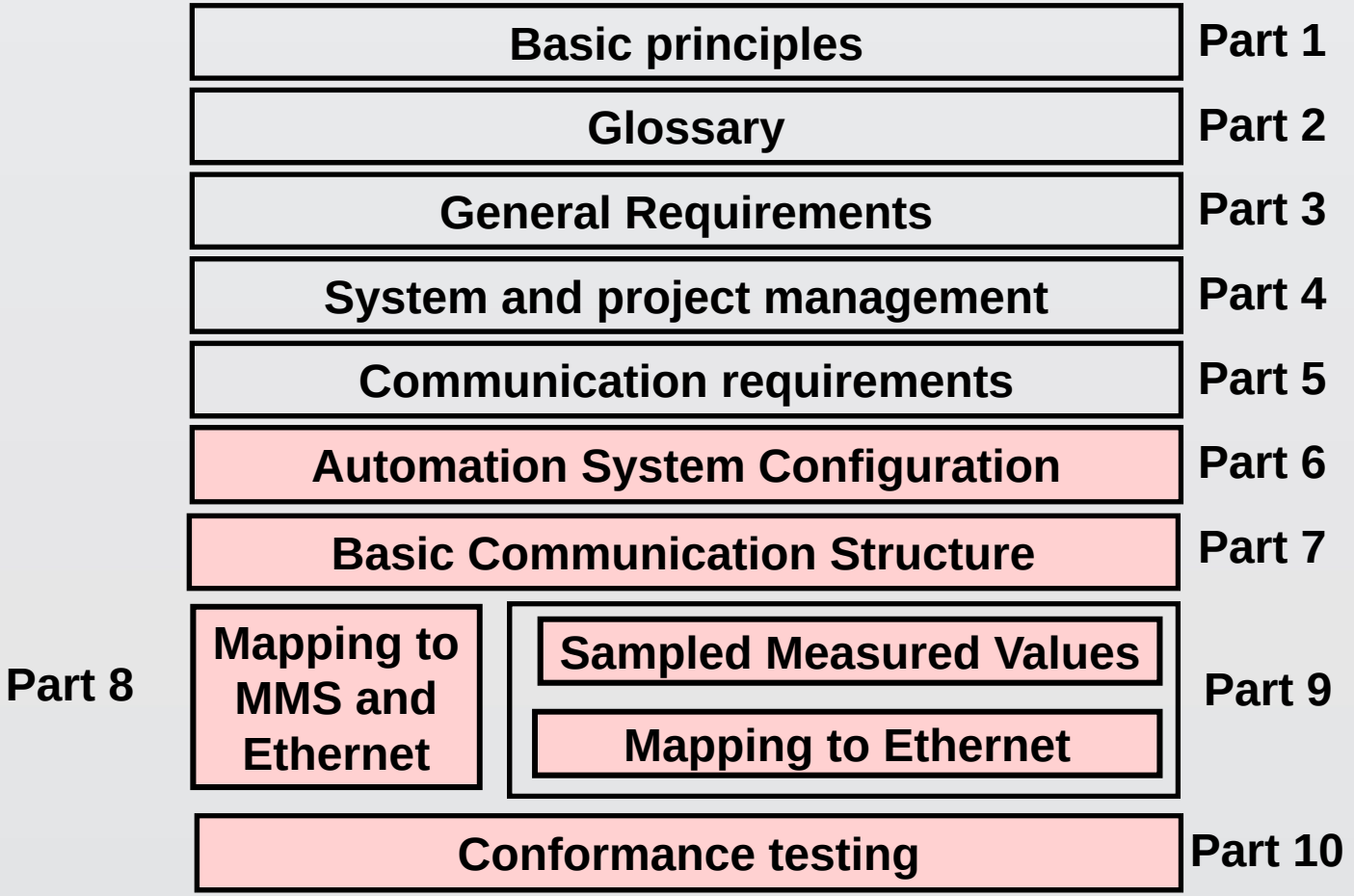


IEC61850 Interface Model

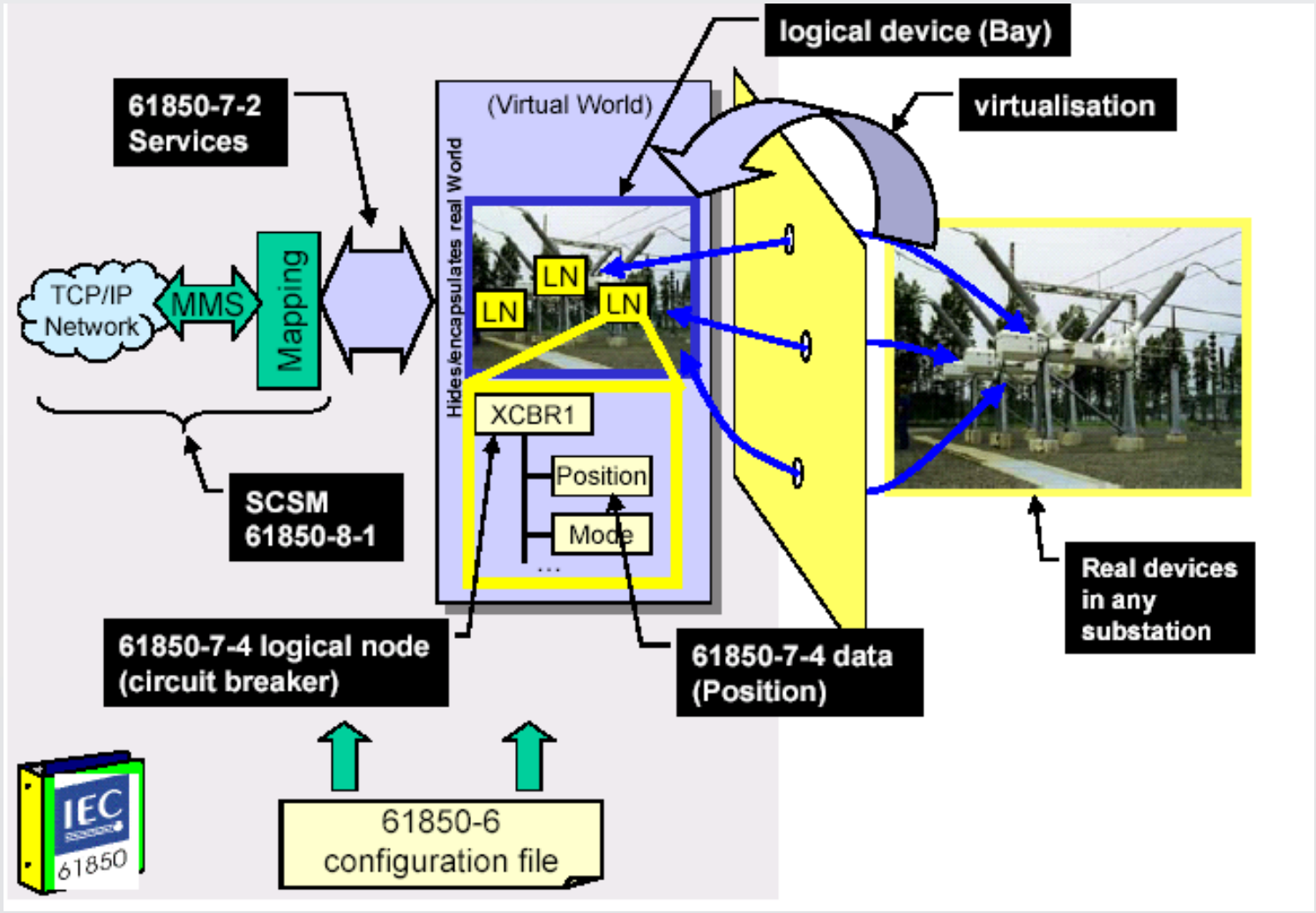


IEC 61850

Document Set

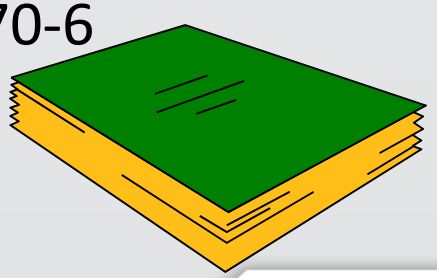


Object Modeling: Visualize a Substation



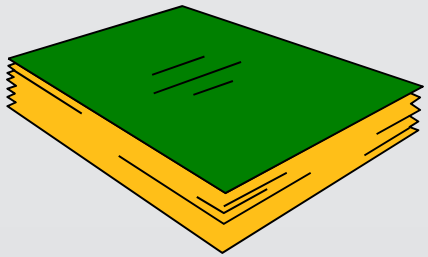
Origin and History - 1

- Sponsored by Electrical Power Research Institute (EPRI)
- Early work by GE, KEMA, others
- EPRI RP3599 became UCA 1.0 in 1990 - no TCP/IP
- Many pilot projects, no consensus
- American Electric Power initiative brought focus
- UCA 2.0 became an International Standard - IEEE TR-1550 (1999)
- UCA 2.0 became the core technology in IEC 61850 released as Edition 1 in 2003
- EPRI considered that UCA included the popular Inter-Control-Center Protocol (ICCP) a separate standard: Telecontrol Application Service Element (TASE.2), IEC 60870-6

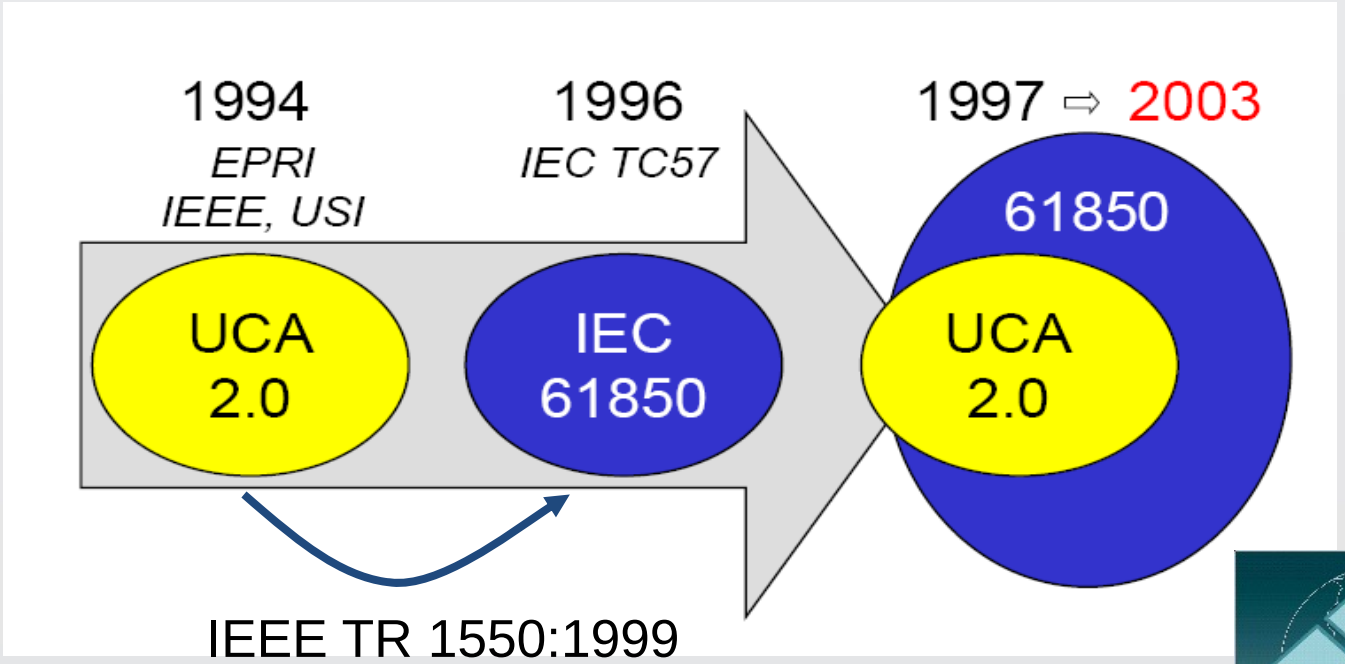


Origin and History - 2

- UCA International Users Group founded in 2003
- IEC 61850 Edition 2 – releases started in 2010
- New technical reports for synchrophasor data, condition monitoring, communications outside the substation (other stations, control centers etc)
- New standards for DER, hydro, wind, distribution automation, electric vehicle charging
- Standards for mapping to other protocols:
  - IEC 60870-5-104
  - IEEE 1815 – 2010 (DNP3) - pending
- Cyber security addressed by IEC 62351

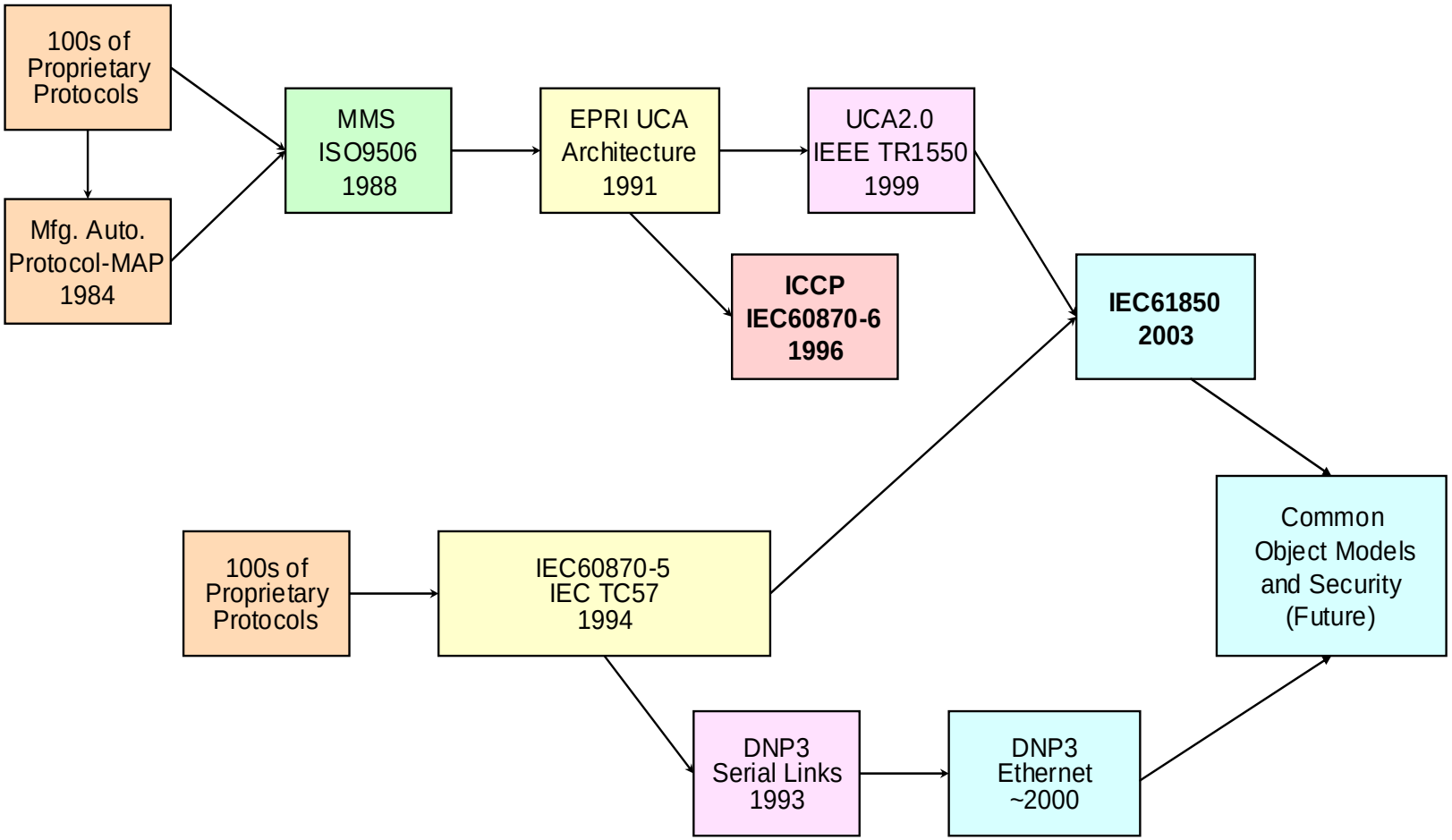


Origin and History - 3



"UCA & 61850 for Dummies." – Douglas Proudfoot

Origin and History - 4

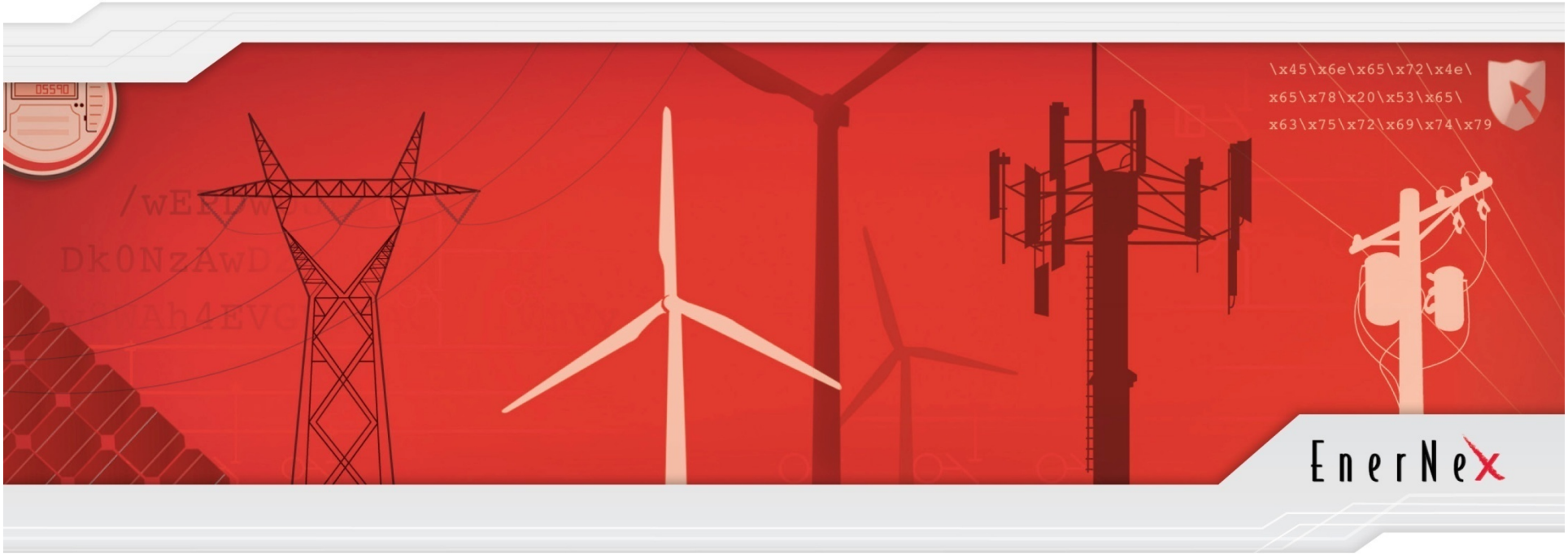


UCA International User's Group (UCAIug)

- Founded in 2003
- Key Committees:
  - Technical Oversight Committee
  - CIMug (CIM Sub Committee)
  - IEC61850ug (IEC61850 Sub Committee)
  - OSGug (Open Smart Grid Sub Committee)
  - Harmonization Sub Committee
  - Technical Publications Sub Committee
  - Testing Sub Committee

Rationale and Benefits for IEC 61850 and NIST Catalog of Standards

Ron Farquharson,
Principal Consultant, EnerNex



Example Benefits by Stakeholder

- **Utility Decision Maker**
  - Lower capital costs
  - Improved engineering efficiency
  - Benefits of data modeling extend into the utility enterprise
- **Utility Engineer**
  - New tools and options for designing systems to meet the evolving requirements of a smart grid world
  - Process improvements
- **Regulator**
  - High benefit-cost ratio (BCR)
- **Vendor**
  - Narrower focus on product communication features - more focus on innovation, features, benefits, cost

So Why all the Excitement?

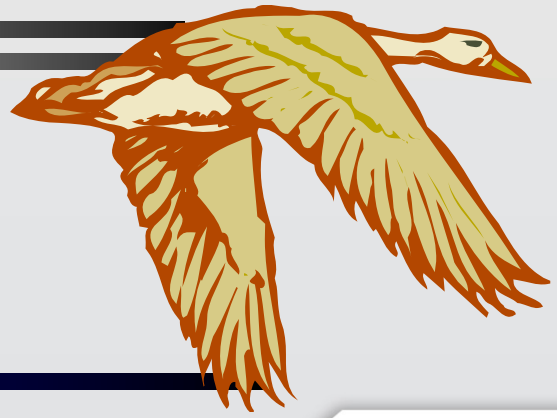
- **Part of a broad scope, world-wide electric power interoperability effort for devices & systems:**
  - Industry consensus object models for power system devices
  - Self-description and structured meta data
  - Publish/subscribe services
  - Fast data services for protection/control (eg tripping over LAN)
  - Transmitting waveform (synchrophasor) samples in real-time

So Why all the Excitement?

- **Part of a broad scope, world-wide electric power interoperability effort for devices & systems (cont'd):**
  - LAN-Based Time Synchronization
  - Cyber security (IEC 62351)
  - Substation Configuration Language
  - Support for automated system engineering tools and processes
  - Testing, verification, and quality assurance processes

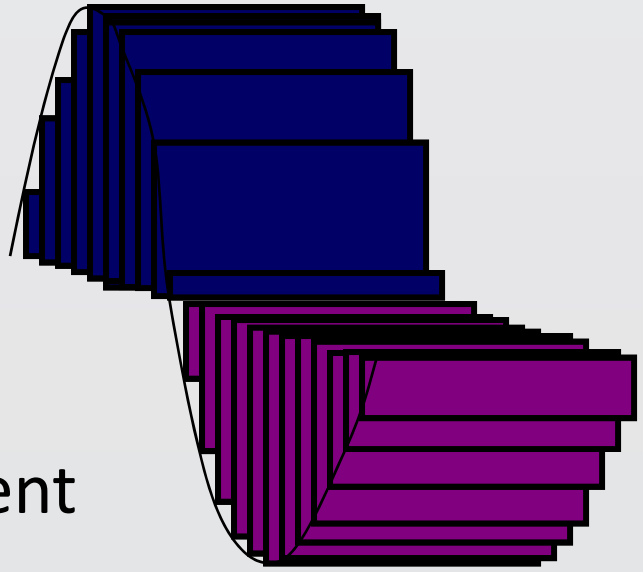
Fast Peer-to-Peer Communication

- Generic Object-Oriented Substation Event (GOOSE)
- Intended to replace relay-to-relay wiring
- Each device multi-casts (one to many) a selected set of data
- Assumes the message will not get through
- Retransmits immediately, exponential back-off
- Periodic retransmission



Sampled Values on the LAN

- Enables a single measurement and sharing with multiple devices and applications
- Separates sampling physically from:
  - Measurement
  - Metering
  - Calculation
- More flexibility in measurement
  - Any device may measure any circuit
- Used for synchrophasor measurement (TR 61850-90-5)
- Gigabit Ethernet will likely be required



What are the Benefits of IEC 61850?

- GOOSE (high performance) messaging for inter-relay communications can reduce hard wiring and/or enable functions not possible with hard wires. Saves $$ in engineering, wiring and maintenance.
- Enhanced communications services enable self-describing devices and automatic object discovery. Saves $$ in configuration, testing, commissioning and maintenance.
- Sampled measured value messaging enables sharing of transducer (CT/PT) signals. Saves $$ by reducing equipment, wiring and connection costs
- Comprehensive cyber security solution (IEC 62351)

Contributions: Mark Adamiak, GE

What are the Benefits of IEC 61850?

- Standardized configuration file formats enables exchange of device configuration and auto-configuration capabilities. Supports a range of tools. Saves $$ in design, specification, configuration, testing, commissioning and maintenance.
- Industry standard object naming conventions with power system context eliminates device dependencies and tag mapping. Saves $$ in configuration, testing, commissioning and maintenance.
- Significant potential in process improvement!!

Excerpts from a Recent Post by a Large and Respected IOU…… (edited)

- (They are in the process of adopting IEC 61850 for their next generation substation automation systems)
- Successful implementation of “IEC 61850” will result in measurable engineering, operations and maintenance benefits through cost reduction, reliability and safety.
- The primary benefits arise the use of an open system such as the IEC 61850 standard for substation communications and include:
  - Cost Savings due to process improvement
  - Enhanced Security
  - Configuration Management (auto-configuration)
  - Interoperability – including future integration with distribution automation and field area networks.

PAP-13 SGIP Activities - 1

- IEEE Std C37.238-2011 – now in the Catalog of Standards
  - Full document set completed and posted on CoS TWiki
  - Successful reviews by the CSWG and SGAC
  - IEEE Std C37.238-2011 approved for Catalog of Standards – October 18, 2011
  - Moving forward:
    - T & D DEWG to address time synchronization compatibility issues that were identified as part of our PAP13 work.
    - Need to address (per the CSWG review) cyber security deficiencies with the existing IEEE 1588 standard.

PAP-13 SGIP Activities - 2

- IEC TR 61850-90-5 – now in the Catalog of Standards:
  - Full document set completed and posted on CoS TWiki
  - Successful reviews by the CSWG and SGAC
  - IEC TR 61850-90-5 approved for Catalog of Standards – September 14, 2012
  - Moving forward:
    - Technical Report means that the content is gradually adopted into the next editions of the various parts of IEC 61850.
    - A task group is developing an Implementation Guide to address (e.g.) mapping between IEEE C37.118.2 and IEC 61850.
    - IEEE PSRC meeting has formed a new Task Force to determine whether a formal IEEE standard should be developed for the Implementation Agreement

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