Priority Action Plan (PAP) – 13

PAP 13 – Harmonizing of IEEE C37.118 with IEC 61850 and Precision Time Synchronization

Nashville, TN - March 30, 2011

Gerald (Jerry) FitzPatrick, NIST
Ken Martin, EPG
Ron Farquharson, EnerNex
Meeting Agenda

• Introductions – Jerry FitzPatrick
• NIST Remarks
• Background and Overview of the PAP effort
• Review of Previous Meeting Notes
• Update on IEC 61850-90-5
• SDO Reports:
  – IEEE H7 - C37.238
  – IEEE H11 and HTF3 – Ken Martin
  – IEC WG10 – Ken Martin
  – NASPI
• NIST Contractor (ESTA/Quanta) – Yi Hu
• SGiP standing committee liaison status
• New items, actions and next meeting
PAP Leadership and Coordination

**PAP Leadership:**
- NIST Lead: Jerry FitzPatrick, fitzpa@nist.gov
- PAP-13: Technical Champion: Ron Farquharson, EnerNex, ron@enernex.com

**SDO and Stakeholder Co-Leads:**
- IEEE PSRC H11 Committee Chair: Ken Martin kemartin8421@comcast.net.
- IEEE PSRC H7 Committee Chair: Galina Antinova galina.antinova@ge.com
- IEC TC57 WG10 (IEC 61850): Christoph Brunner, Convenor christoph.brunner@it4power.com, Herb Falk, herb@sisconet.com
- UCAIug: Mark Adamiak, TC Chair, mark.adamiak@ge.com
- NASPI: Allison Silverstein, allisonsilverstein@mac.com
- NASPI: Vahid Madani, VxM6@pge.com
- IEEE Power Systems Relay Committee, Communications Subcommittee: Veselin Skendzic, Veselin_Skendzic@selinc.com
- IEC TC57 WG19: Paul Skare Paul.Skare@siemens.com

**Other Coordination:**
- Other related IEEE and IEC standards activities (eg IEEE 2030)
- Other PAPs
- DEWGs – Domain Expert Working Groups
- SGAC – Smart Grid Architecture Committee
- SGCSWG – Smart Grid Cyber Security Working Group
- SGTCC – Smart Grid Test and Certification Committee
PAP 13 OVERVIEW
(HARMONIZING OF IEEE C37.118 WITH IEC 61850 AND PRECISION TIME SYNCHRONIZATION)

- IEEE C37.118-2005 is the current world wide standard for synchrophasor data. This standard is being updated and will be published in two parts (118.1 – Measurement and 118.2 – Data Transfer) with the intent of creating a harmonized standard between 118.2 and IEC 61850.

- IEC 61850-90-5 will provide important enhancements in communicating phasor data while still addressing the core data transfer requirements identified in C37.118.

- Precision time synchronization is key to many Smart Grid applications. IEEE 1588 (Ver 2.0) has been identified as the network based application to achieve this objective. However a profile (IEEE C37.238 ) for the application of IEEE 1588 to power applications is needed.
Requirements – Key Role for the PAP

Written requirements
– Functional requirements
  • Based on business cases
  • Use case traceability
– Non-Functional requirements
  • Performance requirements
  • Regulatory and other “soft” requirements
  • Testing and certification requirements
  • Cyber security requirements
  • Architectural requirements

• Utilize a standards analysis criteria when standards work is “handed off” back to team
Life of a PAP

1. PAP initiation (Nov 2009 – SGIP Meeting)
2. SSO / SDOs identified
3. Requirements Handoff
4. Standards Hand-back
5. SGIP Governing Board / SGIP Decision
6. Close the PAP
# PAP-13 Deliverables

<table>
<thead>
<tr>
<th>S</th>
<th>D#</th>
<th>Deliverable</th>
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<tbody>
<tr>
<td>✓</td>
<td>D1</td>
<td>Harmonization use cases and requirements</td>
</tr>
<tr>
<td>✓</td>
<td>D2</td>
<td>C37.118 Enhancement (gaps) List</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>IEC 61850-90-5 Mapping document</td>
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<tr>
<td>✓</td>
<td>D4</td>
<td>1588 Time Sync Demo</td>
</tr>
<tr>
<td></td>
<td>D5</td>
<td>1588 Power Profile is IEEE PC37.238</td>
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<tr>
<td></td>
<td>D6</td>
<td>Amendments to IEC 61850 documents</td>
</tr>
<tr>
<td></td>
<td>D7</td>
<td>Amendments to IEEE C37.118 document(s)</td>
</tr>
<tr>
<td></td>
<td>D8</td>
<td>Guideline for Harmonizing C37.118-2005 with IEC 61850</td>
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</tbody>
</table>
IEC WORKING GROUP 10 UPDATE ON IEC 61850-09-5

Ken Martin
PROJECT TIMELINE: SIMPLIFIED + NIST/SGIP

2005
IEEE C37.118 Published

2009
IEEE Request IEC for Dual Logo
IEEE & IEC start JTF to develop IEC 61850-90-5

2010
NIST SGIP PAP-13
NIST recommends IEC 61850 for Adoption
1st DC of IEC 61850-90-5 balloted

2011
2nd DC of IEC 61850-90-5 to be balloted.
PAP-13 & SGIP Committee Reviews
IEC TR 61850-90-5 publication

2012
SGIP GB Approval & Recommendation to NIST
Addition of IEC 61850-90-5 and IEEE C37.238 to NIST Standards Framework Document

IEEE PC37.238, IEEE C37.118.1, C37.118.2 submitted to IEEE SA

SGiP
IEC 61850-90-5 Technical Report – (Synchrophasor Data Mapping to 61850)

- 61850 is the IEC standard for communication between IEDs
- New development for synchrophasors using 61850 standard
- Significant additions
  - Draws on wide range of use cases, analysis to protection
  - Adds routability to sampled values (using UDP, called R-SV)
  - Modeling is extended to the PDC function
  - Substation configuration language (SCL) is likewise extended
  - Uses MMXU logical node for basic measurements (I, V, P, Q, F, etc.)
  - Use Sequence components
  - A new security method for multicast encryption

- Security in Multicast - Allows key management based upon “stream”, allows PMU/PDC to act as own Key manager
- Gives preference to multicast UDP - Applications can perform time alignment function
  - C 37.118 Does not require time alignment for PDC
WHY IEC 61850-90-5?

- Part of broad scope, world-wide electric power interoperability effort for devices & systems:
  - Industry consensus object modeling for power system devices
  - Self-Description and Structured meta Data
  - Publish/subscribe services
  - Fast data services for protection and control (eg tripping over the LAN)
  - Transmitting Waveform Samples in Real-Time
  - LAN-Based Time Synchronization
  - Cyber security (IEC 62351)
  - Substation Configuration Language
  - Automated system engineering tools and processes
  - Testing, verification, and quality assurance processes

- Easier to support and maintain by end user
  - PMU models and functions are integrated with the rest of the substation
  - System functions configured by 61850 automated processes – reduced manual configuration
  - Consistent with other 61850 substation LAN support and devices
  - Leverages available 61850 tools and processes
PMU/PDC Architecture

(Mix of Protocols)

Source: SISCO

IEC 61850-90-5

IEEE C37.118

Real-time Data Analysis

Off Line Analysis

Regional

National
PEER-TO-PEER COMMUNICATIONS

GOOSE SERVICES MODELS

• Generic Object-Oriented Substation Event (GOOSE)
  – Fast and reliable distribution of data
  – Send to multiple subscribed peers
  – Data set interrogation services

• Generic Substation State Event (GSSE)
  – Sends fixed set of status outputs
  – Also fast, reliable and multicast
PEER-TO-PEER COMMUNICATIONS

SAMPLED VALUES ON THE LAN

- Takes decentralization one step further
- Separates sampling physically from
  - Measurement
  - Metering
  - Calculation
- Synchronizing breaker closure over LAN
- More flexibility in measurement
  - Any device may measure any circuit
  - “Smart” CTs and PTs
- No measurements yet of performance
- Estimates indicate it will require Gigabit Ethernet for large-scale deployment
RELATIONSHIP OF DOCUMENTS

IEEE C37.118
Published

IEEE C37.118.2
(packet format streaming)

IEEE C37.118.1
(measurement specification)

IEC TR 61850-90-5

Use Cases

SCL Enhancements
IEC 61850-6 (SCL - for: C37.118, PDC, 90-5 configuration)

Security Enhancements
IEC 62351-6 GOOSE and SV Security

Multicast Key Distribution
IEC 61850-8-1
IEC 62351-9 Key Management

Routing
IEC 61850-9-2
Multicast Path Creation
Quality of Service and Priority

IEC 61850-8-1 GOOSE
(Events)

IEC 61850-9-2 Sampled Values (streaming)

IEC 61850-6 (SCL - configuration)

IEC 62351-6 GOOSE and SV Security

IEC 61850-6 (SCL - configuration)

NASPI/NASPINet Requirements and Use Cases
SGIP PAP-13 Requirements and Use Cases

Source: Herb Falk Update on IEC 61850-90-5 March 2011
**Migration from C37.118 to 61850 Laid Out**

<table>
<thead>
<tr>
<th>C37.118</th>
<th>61850</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current State + Error Corrections</strong></td>
<td><strong>C37.118 Initial Migration</strong></td>
</tr>
<tr>
<td>Enable/Disable data frames</td>
<td>+ SCL CID file</td>
</tr>
<tr>
<td>Header exchange</td>
<td>+ SCL CID File (description fields) for C37.118 have header information</td>
</tr>
<tr>
<td>CFG-1 Exchange</td>
<td>+ SCL ICD File</td>
</tr>
<tr>
<td>CFG-2 Exchange</td>
<td>+ SCL CID File</td>
</tr>
<tr>
<td>Extended Frame</td>
<td>No migration indicated</td>
</tr>
<tr>
<td>Data Frame</td>
<td>No change</td>
</tr>
</tbody>
</table>

*Source: Herb Falk Update on IEC 61850-90-5 March 2011*
## IEC 61850-90-5 Use Cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Minimum Rates</th>
<th>Allowed Comm Latency</th>
<th>Allowed timing error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchrocheck</td>
<td>4/second</td>
<td>0.1 second</td>
<td>0.05 ms</td>
</tr>
<tr>
<td>Adaptive Relaying</td>
<td>10/second</td>
<td>0.05 second</td>
<td>0.05 ms</td>
</tr>
<tr>
<td>Out-of-Step</td>
<td>10/second</td>
<td>50 – 500 ms</td>
<td>0.05 ms</td>
</tr>
<tr>
<td>Local Oscillation</td>
<td>50/second</td>
<td>5 seconds</td>
<td>0.05 ms</td>
</tr>
<tr>
<td>Current State Estimation</td>
<td>10/second – 1/minute</td>
<td>5 seconds</td>
<td>0.05 ms</td>
</tr>
<tr>
<td>Predictive Dynamics</td>
<td>25/second</td>
<td>20 ms</td>
<td>0.05 ms</td>
</tr>
</tbody>
</table>

Source: Herb Falk Update on IEC 61850-90-5
March 2011
Use Cases – IEC 61850-90-5 (Draft TR)

- Direct connection with tunnelling or USV service
- The gateway approach
- Wide Area Applications Utilizing Synchrophasors
- Synchro-check
- Adaptive relaying
- Out-of-step (OOS) protection
- Situational awareness
- State Estimation and on-line security assessment
- Archive data (event & continuous)
- Wide Area Controls
IEC 61850-90-5 OUTLOOK

• First complete draft in August 2010
• Meeting at end of February to resolve current draft
• Publication in August 2011
• Use of 61850 requires sending & receiving 61850 compatible equipment
• Measuring type equipment could be available 6-24 months after publication
• Software type processing equipment (PDCs, etc.) could be available 3-6 months after publication
IEC 61850 UPDATE

Christoph Brunner

Christoph.brunner@it4power.com
NEW PARTS

• Domain specific object models
  – IEC 61850-7-4, Ed 2: Basic communication structure – Compatible logical node classes and data object classes
  – IEC 61850-7-410: Hydroelectric power plants – Communication for monitoring and control
  – IEC 61850-7-420: Communications Systems for Distributed Energy Resources (DER)
MAPPINGS FOR GATEWAYS

• IEC 61850-80-1 – Guideline to exchange information from a CDC based data model using IEC 60870-5-101 / -104
• IEEE 1815.1 – Exchanging Information between networks Implementing IEC 61850 and IEEE 1815 (DNP3),
  – Intended to become a IEC dual logo standard (IEC 61850-80-2)
WG10 TECHNICAL REPORTS

- IEC 61850-90-1: Using IEC 61850 for communication between substations (published)
- IEC 61850-90-2: Using IEC 61850 for communication between substations and control center
- IEC 61850-90-3: Using IEC 61850 for condition monitoring
- IEC 61850-90-4: Network engineering guidelines
- IEC 61850-90-5: Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118
PAP-13 Standards Group Reports

- IEC WG10 – Ken Martin (provided above)
- IEEE H7 - C37.238
- IEEE H11 and HTF3 – Ken Martin
- NASPI
USE OF IEEE 1588 PTP IN POWER SYSTEMS, STANDARD IEEE C37.238

- IEEE 1588 (IEEE C 37.238) describes a Precision Time Protocol for transferring precise time over Ethernet
  - It includes many parameters that need to be mapped to specific applications
- New IEEE C37.238 describes mappings for power systems applications
- First ballot in 2010 and comments have been resolved
- First recirculation is complete (closed on Feb 17th)
  - 59 comments being resolved
- Anticipate next recirculation mid to end of March
- Expect to submit to IEEE SA by May 2011
- Expect approval in June 2011 and publication by July 2011
- Fully compliant clocks could be available 3-6 months after
- Compliant PMUs could be available within 1-2 years
NASPI – PSTT Fast Track Items

• Certification of PMUs and Testing / NIST Testbed
  – Stenbakken / Hu

• PMU-PDC/PDC-PDC Communication Methods
  – Huang & Quanta

• Phasor Data Concentrator Requirements
  – Weekes & Quanta

• Phasor Data Concentrator Testing and Calibration Standard
  – Kezunovic
IEEE Std PC37.238
- Standard is under development so reviews are considered “detailed preliminary” as part of the on-going liaison efforts
- Reviews underway by the CSWG & SGAC
- Related standard review for IEEE 1588

IEC 61850-90-5 DTR
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- Reviews underway by the CSWG & SGAC
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