PAP13 - Accelerated Synchrophasor Standards Development

Jerry FitzPatrick, NIST
Ron Farquharson, EnerNex

Performance & Standards Task Team

June 5, 2012
Denver, CO
Support various SGIP Domain Expert Working Groups (DEWGs), Committees and Priority Action Plans (PAPs) to coordinate accelerated work by standard development organizations

Publish Framework and Roadmap for Smart Grid Interoperability Standards – Release 2.0 (released on February 28th)

For Synchrophasor data, develop standards and guidelines for interoperation between IEC 61850 / IEEE Std C37.118.1 & .2 / IEEE 1588 devices (IEEE Std C37.238) and systems

Key SGIP activities related to Synchrophasor data – PAP13, T&D DEWG, CSWG, SGAC

Jerry FitzPatrick, NIST – Program Lead – T&D DEWG, PAP 8, 12,13,14

Catalog of Standards (CoS):

- PAP process including consensus and documentation
- SGIP Governing Board vote
- SGIP Plenary vote
SGIP Organization

Governing Board  SGIP Officers  NIST

SGIP Administrator

Standing Committees & Working Groups

- Test & Certification Committee (SGTCC)
- Architecture Committee (SGAC)
- Cyber Security Working Group (CSWG)
- Implementation Methods Committee (SGIMM)

Coordination Functions

- Program Mgmt Office (PMO)
- Comm. Marketing Education (CME)
- Bylaws & Operating Procedures (BOP)
- Business Sustainment Plan (BSP)
- International Task Force (ITF)

SGIP Membership

Priority Action Plan Teams (now at 20 Teams)

- PAP 1
- PAP 2
- PAP 3
- PAP 4
- PAP 5
- PAP ...

Domain Expert Working Groups

- BnP
- H2G
- B2G
- I2G
- PEV2G
- DRGS
NIST Smart Grid Framework – 2.0 (NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0)

- Draft released for public comment October 25, 2011
- Comment period ended November 25, 2011
- Publication is set for Feb 27, 2012
  - Extensive public input and review
  - > 240 comments addressed
- Chapter 4 now has:
  - 34 “Identified Standards”
    - All 34 standards moving to CoS
  - 62 “Additional Standards”
- Companion Cyber Security Strategy
- 20 Priority Action Plan Projects have/are filling key gaps
PAP13: Overview

- IEEE C37.118-2005 has been the current world wide standard for synchrophasor data. This standard is now updated and 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 61850-90-5.

- IEC 61850-90-5 has now been published to 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 C37.238-2011 has now been published as the Power Profile for IEEE 1588 (Ver 2.0) which is identified as the network based application to achieve this objective.
PAP-13 SGIP Activities

- **IEEE Std C37.238-2011** – now in the Catalog of Standards
  - Full document set completed and posted on CoS TWiki page
  - Successful reviews by the CSWG and SGAC
  - IEEE Std C37.238-2011 – both GB and SGIP votes were successful – October 18
  - IEEE Std C37.238-2011 approved for Catalog of Standards – October 18

- **IEC 61850-90-5** – steps toward the Catalog of Standards:
  - ¾ documents completed and posted on CoS TWiki page
  - Successful reviews by the CSWG and SGAC
  - In the midst of the PAPWG Consensus process, voting until COB Friday
  - Final document – PAPWG Summary
  - PMO presentation to the GB
  - GB vote in July at the SGIP F2F in Portland
  - SGIP votes
  - CoS and PAP13 Closes
Overall Catalog of Standards (CoS) Process Flow (2011-07-01)

Identify Standards

PAP Proposal Process → PAP Lifecycle Process → Standards Review Process

Priority Action Plans (PAPs)

Consensus Processes

Consensus Process → Consensus Vote Process

Vote Package Finalization Process → Standards Vote Process

Existing Standards

Identified Standard → Existing Standard to CoS Process → Standards Review Process

Catalog of Standards (CoS)

Interoperability Knowledge Base (IKB) - TWiki

Slide 6
High Level Summary –
Catalog of Standards Process (CoS)

SGIP Working Groups
- Standards Information Form
- Development Process Statement
- Criteria and Analysis Report
- CSWG assessment
- SGAC assessment

SGIP Priority Action Plans (PAPs)
- Standards Information Form
- Development Process Statement
- PAP WG Assessment
- CSWG Assessment
- SGAC Assessment
- PMO Assessment

Defined separately in the SGIP PAP Process

SGIP Governing Board provides a recommendation

SGIP Acceptance (75% or greater rule)

SGIP Catalog of Standards
Steps to Interoperability and Industry Adoption for IEC 61850-90-5

- Implementation agreements and guides
- Good documentation and training courses
- Wide adoption of the existing generation standard
- Strong support of a user group technical issue, application note and marketing team
- Industry standard mapping specification between the existing and new (61850-90-5) standard
- Testing and certification function with independent testing to an established test plan and procedure
- Frequent (yearly) updates to the capabilities of the standard
IEC 61850-90-5 Technical Report – (Synchrophasor Data mapping to 61850)

- 61850 is the IEC standard for communication between IEDs
- Benefits associated with IEC 61850 itself
- 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
  - C37.118 Does not require time alignment for PDC
Why IEC 61850 and 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 = NASPInet
  - 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
Back Up Material
Priority Action Plans (PAP) – June 2012

0. Meter Upgradability
1. Use of IP in the Smart Grid
2. Wireless Guidelines
3. Pricing Model
4. Scheduling
5. Meter Profiles & Upgrade Std.
6. Common Semantic Model (CIM)
7. Storage Interconnect
8. CIM Distribution Models and Harmonization
9. Standard DR Signals
10. Energy Usage to Customer
11. Common Data Models for Electric Transportation
12. DNP3 to IEC 61850 Mapping
13. SynchroPhasor Data Harmonization (C37.118 to IEC 61850) and Time Synchronization
15. Harmonize Power Line Carrier Standards
16. Wind Plant Communications
17. Facility Smart Grid information
18. SEP 1.x to 2.0 upgrade and coexistence guideline and best practices introduction
19. Wholesale DR
20. Green Button
Phasor Measurement System

Timing standards
IEEE 1588 or C37.238

Communication standards
IEEE C37.118.2
IEC 61850-90-5
ICCP

Measurement standards
C37.118.1

Installation, calibration, test guide
C37.242*

Substation PDC

Phasor Data Concentrator

PDC Guide – Requirements, System Communications, Testing
IEEE C37.244 *

Data storage standards
IEEE C37.111
COMTRADE

Other utility PDC

Real Time Monitoring & Alarming

Future real-time controls

Off-line Dynamics Analysis

* Not yet released
Use of IEC 61850 modeling and services (e.g. GOOSE and SV) for synchrophasor communications; includes 8 primary use cases, security and profile mappings
TR is now released by the IEC
Use of 61850-90-5 requires sending & receiving 61850 compliance
Measuring type equipment and Software type processing equipment (PDCs, etc.) will be available in 2012
H/W and S/W suppliers implementing
Implementation guide under development
SGIP Catalog of Standards submission is pending
Reviews by SGIP Cyber Security Working Group (CSWG)
Review by the SGIP Smart Grid Architecture Committee (SGAC)
# 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>
<tr>
<td>Others…</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key IEC 61850 Services - Enhanced

• New - R-GOOSE (for Routed GOOSE)
  • For routing of Event Data
• New - R-SV (for Routed Sample Values)
  • For routing Periodic Data
IEEE Std C37.238-2011

- The power profile for the use of Precision Time Protocol - PTP (IEEE 1588 Ver. 2) for transferring precise time over Ethernet
- Standard was published in July 2011
- Standard was recommended to the SGIP GB for CoS in November and successfully voted by the SGIP plenary in December 2011. It is now in the SGIP CoS.
- Focus for the IEEE WG H7 / C7 now is a white paper to summarize the standard and provide implementation guidance.
- Current standard deprecates wireless physical infrastructures due to determinism requirements
- WG H7 / C7 is in contact with WG developing 801.AS – wireless profile for IEEE Std 1588 Ver.2.
IEEE C37.118.1 is Released in 2011

- Measurement of and requirements for synchrophasors, frequency, & rate of change of frequency
- All development of formulas, tests, & algorithms complete
- Current PMU equipment compliance with 37.118.1 requirements
  - Added new requirements, such as “M” and “P” class, dynamic and frequency measurements
- Compliant PMUs are being released
- Planning a joint IEEE-IEC synchrophasor measurement standard based on IEEE C37.118.1 - IEC 95-277
IEEE C37.118.2 is Released in 2011

- Covers the communication of phasor measurements, but does not define an actual protocol

  *All current C37.118-2005 compliant equipment meet 37.118.2 requirements. New features in 37.118.2 are optional.*

- IEC 61850-90-5 addresses new communication requirements to take advantage of IEC 61850 environment
Reference Contacts

- **IEEE C37.118**
  - Ken Martin - martin@electricpowergroup.com

- **IEEE C37.242**
  - Farnoosh Rahmatian - FRahmatian@Quanta-Technology.com
  - Paul Myrda - pmyrda@epri.com

- **IEEE C37.244**
  - Galina Antonova - galina.s.antonova@ca.abb.com
  - Vasudev Gharpure - VGharpure@Quanta-Technology.com

- **IEC 61850**
  - Alex Apostolov - alex.apostolov@omicron.at
  - Christoph Brunner - Christoph.Brunner@it4power.com
  - Herb Faulk - herb@sisconet.com

- **PSTT Material**
  - Vahid Madani – vxm6@pge.com
  - Damir Novosel - DNovosel@Quanta-Technology.com

- **SGIP (i.e: PAP 13)**
  - Ron Farquharson - Ron@ENERNEX.COM
TWiki is a “brand” of Wiki – wiki:
- A wiki (pronounced /ˈwɪki/ WIK-ee) is a website that allows the easy creation and editing of any number of interlinked web pages via a web browser using a simplified markup language or a WYSIWYG text editor.

SGIP / NIST TWiki has major sections for:
- SGIP Overview and Introduction:
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIP
- Priority Action Plans
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PriorityActionPlans
- Working Groups and Committees
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIPWorkingGroupsAndCommittees
- Interoperability Knowledge Base
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/InteroperabilityKnowledgeBase