Synchrophasor Standards and Guides

PSTT and IEEE PSRC

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Presentation

- Standards & guides related to synchrophasors
- Addressing interoperability issues
- Development outlook
Phasor Measurement System

GPS

Timing standards
IEEE 1588
C37.238*

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

3rd Party EMS

Real Time Monitoring & Alarming

Phasor Data Concentrator

Future real-time controls:
PDC Guide – Requirements, System Communications, Testing (PSTT, IEEE WG C4)

Substation PDC

Measurement standards
C37.118.1*

Installation, calibration, test guide;
C37.242*

Other utility PDC

Data Storage

Off-line Dynamics Analysis

Data storage standards
IEEE C37.111
COMTRADE

* Not yet released
Brief History of Synchrophasor related Standards & Guides

- IEEE 1344 synchrophasor standard in 1995
  - Time sync defined by sample timing
  - No measurement requirements

- IEEE C37.118-2005 in 2005
  - Total Vector Error (TVE) method for measurement qualification
  - Requirements for steady-state performance
  - Extended data communication profile

- Revision of C37.118 started in 2008
  - Dynamic & frequency requirements, communication improvements

- 1588 timing profile & COMTRADE profile in 2008

- Synchrophasor additions to 61850 started in 2009

- PSTT Testing, Calibration, and Installation guides in 2008 – IEEE PC37.242 started in 2010

- PDC Guide started in 2009 by NASPI / PSTT
  - Expected Completion April 2011
    - Plans are in place to generate IEEE Guide
IEEE standard PC37.118.1 covers measurement of and requirements for synchrophasors, frequency, & rate of change of frequency (ROCOF)
- Adds dynamic measurement requirements to present steady-state
- Adds requirements for frequency measurements

Specifies an measurement evaluation method (TVE, FR, & RFE)

Specifies conditions or tests for measurement evaluation

Provides evaluation error limits

Adds annex with sample algorithms
- Supports requirement development & aids user implementation

PMUs that meet the Standard should provide comparable measurements under most power system operating conditions
IEEE C37.118.1 Outlook

- All development of formulas, tests, & algorithms complete
- Expected to go to IEEE ballot in March 2011
- Final approval in June & publication in July, 2011

- Most current PMU equipment will meet 37.118.1 requirements
  - To be confirmed by test
  - Small measurement differences with C37.118-2005 compliant equipment
  - A crossover list should be prepared so users can note differences

- Fully compliant PMUs expected within 6 months of final approval

- A joint IEEE-IEC synchrophasor measurement standard based on IEEE C37.118.1 is proposed - IEC 95-277
Synchrophasor Data Transfer Standard
IEEE C37.118.2

- Covers the communication of phasor measurements
  - Describes simple and compact messaging structure and contents
  - Includes a simple command-response for essential parameters
  - Can use any communication protocol or hardware

- Standard practice is established by industry
  - Common mapping onto IP protocol, Ethernet, RS232, other protocols
  - Security can be applied appropriate to selected protocol

- Improved configuration message added: Flexible naming; Extended scaling parameters; Additional data (e.g. geographic location)

- Time Quality for measurements added

- Improved data modification flagging

- All changes fully backward compatible with C37.118-2005
IEEE C37.118.2 Outlook

- Most development is complete
- Expected to go to IEEE ballot in March 2011
- Publication in July 2011

- All current C37.118-2005 compliant equipment will meet 37.118.2 requirements
  - -2005 equipment interoperable without new features
- Fully compliant PMUs could be available 6-12 months after publication
IEEE C37.118 Published

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

IEEE splits C37.118 into C37.118.1 C37.118.2 SGIP PAP-13

NIST recommends IEC 61850 for Adoption

1st DC of IEC 61850-90-5 balloted

2nd DC of IEC 61850-90-5 to be balloted.

IEC TR 61850-90-5 publication

IEEE C37.242 To be Completed

IEEE C37.118.1 C37.118.2 complete

IEEE PDC Guide To be Completed

IEEE PSRC WG C-4
IEC 61850 Synchrophasor -90-5

- 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
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
- Adoption depends on user advantages
- 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 61850-90-5 Advantages

- Leverages world-wide interoperability effort of devices and systems in power systems communications including:
  - Hierarchical Object model structure allows one time modeling for enterprise applications
  - Standardized modeling and services
    - Implication of a growing pain – Benefits outweigh the upfront work
  - Established high speed data services for protection and control
  - 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 and system functions configured by 61850 automated processes – reduced manual configuration
  - Consistent with other 61850 substation IED communications stacks and services
  - Leverages available 61850 tools and processes
Guide for Synchronization, Testing, Calibration and Installation of PMUs IEEE C37.242*

- IEEE Guide is a combination of NASPI PSTT documents
  - Test and calibration for laboratory and field applications: Updated to comply with 37.118 improvements
  - Installation of PMU devices based on application requirements and typical bus configurations
  - Techniques focusing on the overall accuracy and availability of the time synchronization system
  - System testing and calibration

- Started in 2010 on the fast track
- Initial ballots May & September 2011
- Final release expected by December 2011
- Help users with interoperability testing and installations, starting January 2012

* Not yet released
PSTT PDC Guide

- NIST supported PSTT work on Fast Track
  - PDC Functional Requirements Guide
  - Synchrophasor System Communications Guide
  - PDC Test Guide
- Support both IEEE C37.118.2 and IEC 61850-90-5
  - Concurrent identification of gaps and solutions to improve standards near completion

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PDC Functional Requirements Guide

- Identified major PDC functional requirements
  - Time alignment:
    - Wait Time
    - Buffer Time
    - Data Processing Time
  - Data re-sampling and filtering issues and impact on accuracy
  - Data validation
- Non-core functions in Appendices:
  - Data storage
  - Event detection
  - Gateway
- *PSTT Review Meetings on 1/21/2011 and 1/28/2011*
Identified Major Communication Needs of Synchrophasor Systems

- Data Flow Management
  - Late, lost, and missing data
  - Data quality marking

- System Configuration Management
  - Addition / removal of devices / signals
  - Automatic Reconnection
  - Hierarchical Configuration
  - Addition of Application functions

Further coordination with Data Network Management (DNMTT)
Driven by PDC Functional Requirements and Synchrophasor System Communication Requirements

- First draft focus on test techniques to verify core Functional Requirements
  - Merging time-aligned data
  - Timing measurements
  - Capacity limitations/determination
  - Comparative measurements (using a reference PDC)
    - Timing
    - Data quality
    - Impact of filtering
    - Impact of data volume (both input and output)

- Final document includes Synchrophasor Communication Req.
PDC Guide Outlook

- Publication of NIST supported PSTT PDC Guides in May 2011
- Available to vendors and users
- Support both IEEE C37.118.2 and IEC 61850-90-5

- Hand-off to IEEE (PSRC WG C4) - PDC Guide for fast track development – Starts May 2011
- Initial balloting – January 2012
- Publication in May 2012
- Compliant PDCs and Systems could be available beginning of 2012
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

Balloted in 2010 and comments have been resolved
Final ballot expected by end of February 2011
Standard approved by June 2011
Fully compliant clocks could be available 3-6 months after publication
Compliant PMUs could be available within 1-2 years
Technical Presentations on Thursday

IEC 61850-90-5 Basics -- what’s new, what does it mean for future systems and devices, what does it mean for legacy systems and devices?

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Questions and Discussion??

A quick look at 90-5