# Global Synchronized Phasor Measurement Standards

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Pacific Gas and Electric Company

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# Phasor Measurement System

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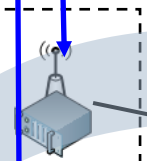
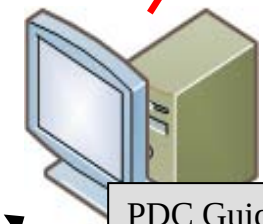
Timing standards
IEEE 1588 PTP
C37.238 Profile

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

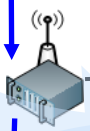

Real Time Monitoring & Alarming



Phasor Data Concentrator



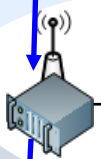
Installation, calibration, test guide PC37.242

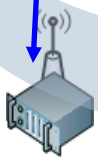


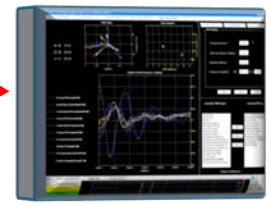
**Future real-time control and protection**

PDC Guide – Requirements, System Communications, Testing (PSTT, IEEE C4)

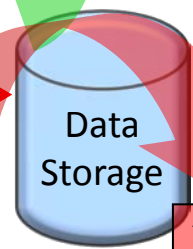
Substation PDC







Off-line Dynamics Analysis




Measurement standards
IEEE C37.118.1
IEEE 60255-37-118-1 (prospective)

Other utility PDC

Data storage standards
IEEE C37.111 COMTRADE
PSRC H8 Schema
IEEE C37.232 File Naming

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# Brief History of related Standards & Guides

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## 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

- Split into measurement (118.1) & transport (118.2) for coordination with IEC
- Dynamic response & frequency requirements, communication improvements

## IEEE 1588 timing profile C37.232 & COMTRADE schema in 2008

## Synchrophasor transport 61850-90-5 tech report started in 2009

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

## PDC Guide started in 2010

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# Synchrophasor Measurement Std – IEEE C37.118.1

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
- Fast-response P class & high accuracy M class measurements
- Adds requirements for frequency measurements

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

Specifies conditions or tests for measurement evaluation

Provides evaluation error limits

Adds annex with sample algorithms

- Supports requirements 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 formulae, tests, & algorithms complete

Expected to go to IEEE ballot in March/April 2011

Final approval in June & publication in July, 2011

Several current PMU equipment should meet C37.118.1 requirements

- To be confirmed by test
- Small measurement differences with C37.118-2005 compliant equipment
- A crossover list could be prepared so users can note differences

Joint IEEE-IEC synchrophasor measurement standard project based on C37.118.1 is likely to start in May 2011

- IEC 60255-37-118-1 from TC 95
- IEEE and IEC working towards minimum or no differences.

# Synchrophasor Data Transfer Standard – IEEE C37.118.2

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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 as appropriate for selected protocol layers

Extended 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 backward compatible with C37.118-2005

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# IEEE C37.118.2 Outlook

Most development is complete

Expected to go to IEEE ballot in March/April 2011

Publication in July 2011

Current C37.118-2005 compliant equipment will most likely meet 37.118.2 requirements, with the exception of the added features

Even though C37.118.2 addresses a number of gaps in C37.118-2005, other improvements are expected to be captured in IEC 61850-90-5

# IEC 61850-90-5 for Synchrophasors

61850 is the IEC standard for functional modeling and communication protocol services among IEDs

New synchrophasor transport service builds wide area capability on existing 61850-8-1 GOOSE and -9-2 sampled values services

Significant additions:

- Draws on wide range of use cases
- 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 PMU
- New security method for multicast encryption – built into data packets

Security in Multicast - Allows key management based upon “stream”, allows PMU/PDC to act as its own Key manager

Gives preference to multicast UDP - Applications can perform time alignment function

# IEC 61850-90-5 outlook

First complete draft in August 2010

Last meeting at end of February 2011 to edit current draft

Publication in August 2011

IEC 61850-90-5 draft calls for IEDs to include security in packets

Adoption depends on user advantages

# IEC 61850-90-5 Advantages

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Leverages world-wide effort in advanced power systems communications including:

- Interoperability of devices and systems
- Standardized modeling and services
- 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

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# Guide for Synchronization, Testing, Calibration and Installation of PMUs IEEE PC37.242

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

Final ballot expected by December 2011

Guide approved by January 2012

Help users with interoperability testing and installations, starting January 2012

# PDC Guide – NASPI-PSTT

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

| | First draft | PSTT review calls | Revised Draft | Available for IEEE |
|---|---|---|---|---|
| PDC Functional Requirements Guide | 1/2011 | 1/2011 | 3/2011 | 5/2011 |
| Synchrophasor System Communications Guide | 2/2011 | 2/2011 | 4/2011 | 5/2011 |
| PDC Test Guide | 3/2011 | 4/2011 | 5/2011 | 5/2011 |

# PDC Functional Requirements Guide

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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

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## 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

# PDC Testing Guide

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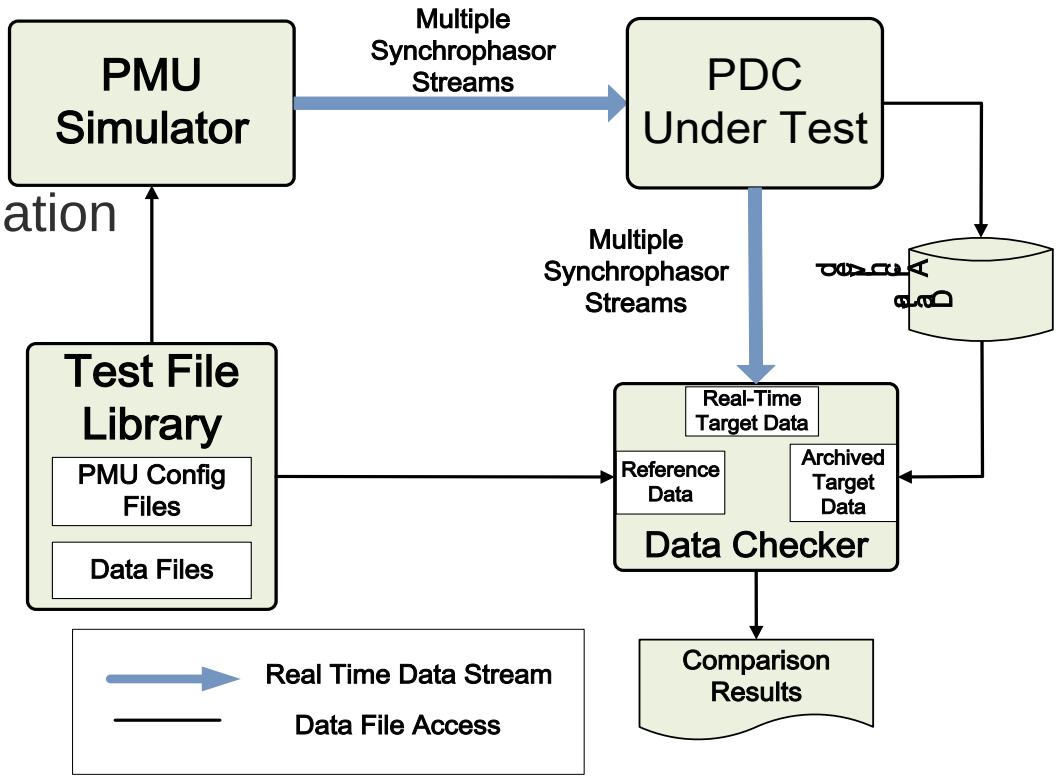
Driven by PDC Functional Requirements and Synchrophasor System Communication Requirements

First draft focus on test techniques to verify core Functional Requirements

- Merging time-aligned data
- Timing measurements
- Capacity limitations/ determination
- Performance measurements
  - latencies
  - Data quality
  - Impact of filtering
  - Impact of data volume (both input and output)

**PDC Tester Schematic**



# PDC Guide Outlook

NIST supported Draft PSTT PDC Guides available in May 2011

Supports both IEEE C37.118.2 and IEC 61850-90-5

Hand-off to IEEE (PSRC C4) on PDC Guide for fast track development – May 2011

Publication in May 2012

Compliant PDCs and Systems could be available beginning of 2012

# Use of IEEE 1588 PTP in Power Systems, Standard IEEE C37.238

IEEE 1588 describes a Precision Time Protocol for transferring precise time over Ethernet

- Includes parameters that need to be mapped to specific applications
- Achieves timing precision suitable for PMU clock inputs
- Wide area timing reference gives redundancy for GPS satellite timing

New IEEE C37.238 describes mappings for power systems applications

Balloted in 2010 and comments are being resolved

Final ballot expected in early 2011

Standard approved by June 2011

Fully compliant clocks could be available 3-6 months after publication

Compliant PMUs could be available shortly after publication

# Questions?

Thank You