DOE/OE Transmission Reliability Program

Synchrophasor Standards Development & Support

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June 27-28, 2013

Washington, DC

CERTS

Consortium for Electric Reliability Technology Solutions

Introduction

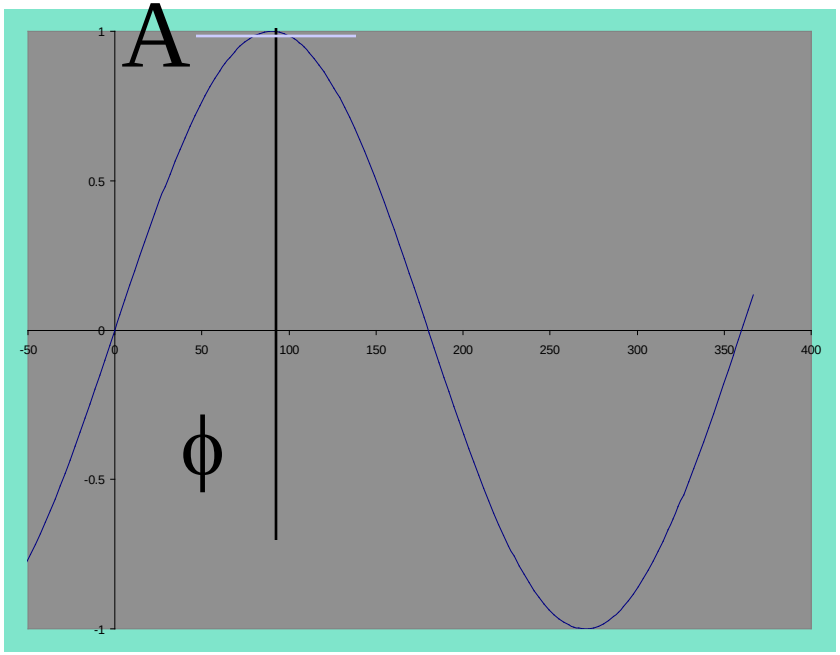
- Synchrophasor measurement systems widely deployed
- Enable a new generation of power system monitor & control capability
  - Improved power system analysis & system models
  - Wide area, high-resolution visibility
  - Basis for a new generation of controls
- Research challenge – standards to enable interoperability
  - Measurement performance
  - Communications
- Research focus – facilitate development, testing, and validation of standards to promote interoperability

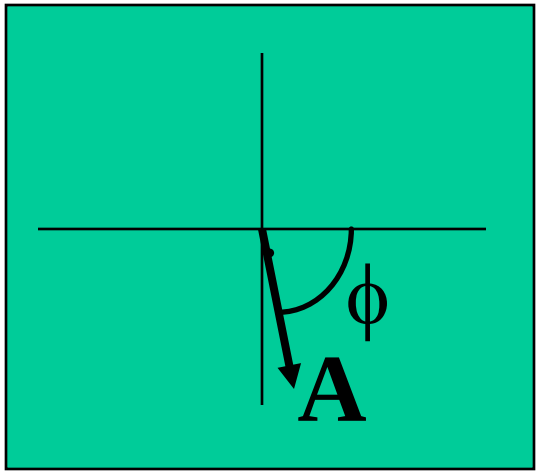
Basic phasor concept well known

A phasor is the complex form of the AC waveform

$\sqrt{2}\, A \cos(2 \pi \omega_0 t + \phi)$

$A\, e^{j\phi}$

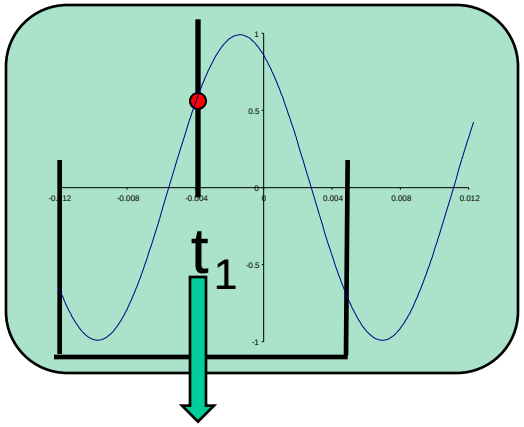




Synchrophasor value estimated from waveform depends on method

- Given waveform, what is the phasor?
  - There is no phasor in waveform
  - We cannot measure an instantaneous phasor
- Observe waveform over interval
  - The instantaneous phasor value at t_1 is estimated over an interval around t_1
- Estimate depends on sampling, window, algorithm, etc.
- **Standards assure common measurement**

Sample the given waveform:

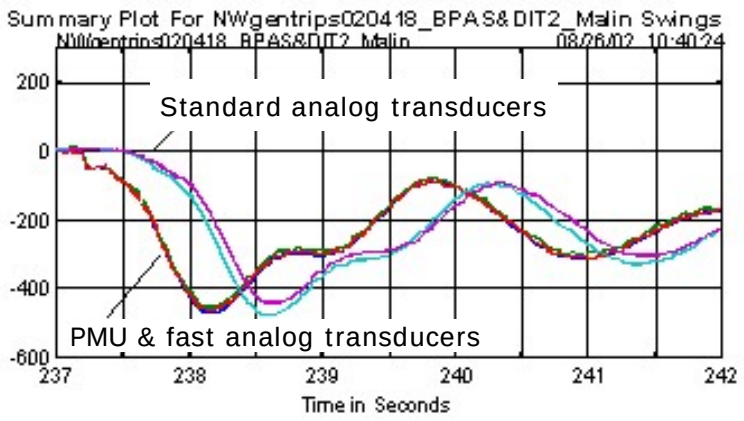


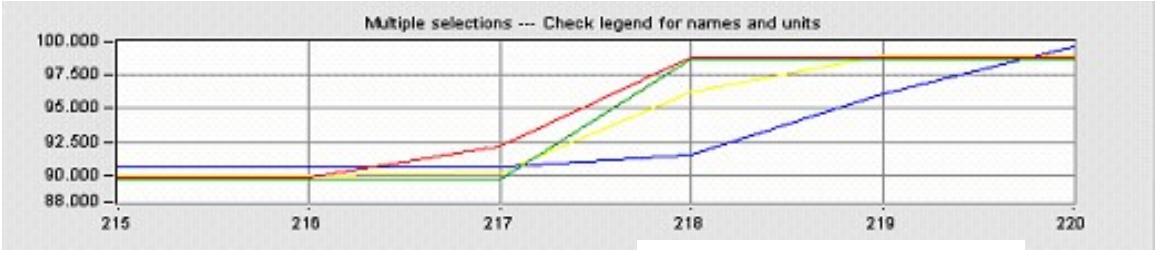
Estimate the phasor over interval: $\boldsymbol{X}(t_1) = (X_m/\sqrt{2})e^{j\varphi}$

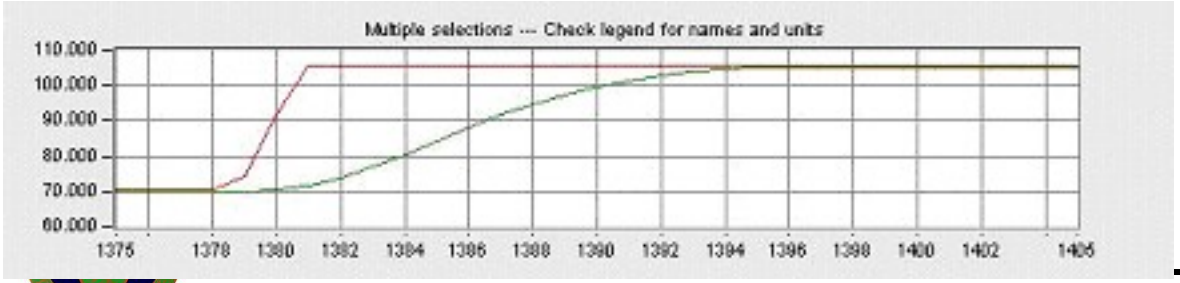
Need for standards

Standards assure comparability

- Apparent response depends on:
  - Technology
  - Timetag options
  - Measurement window
  - Filtering







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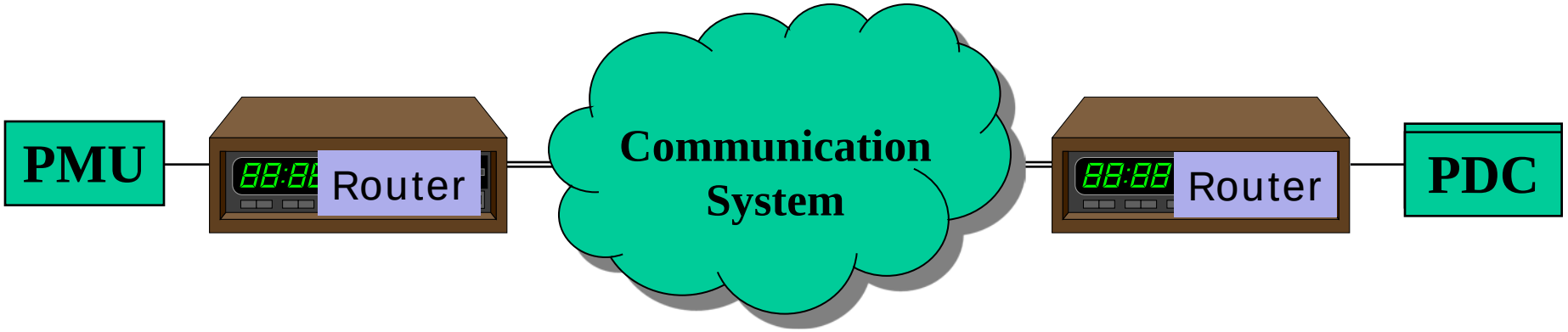
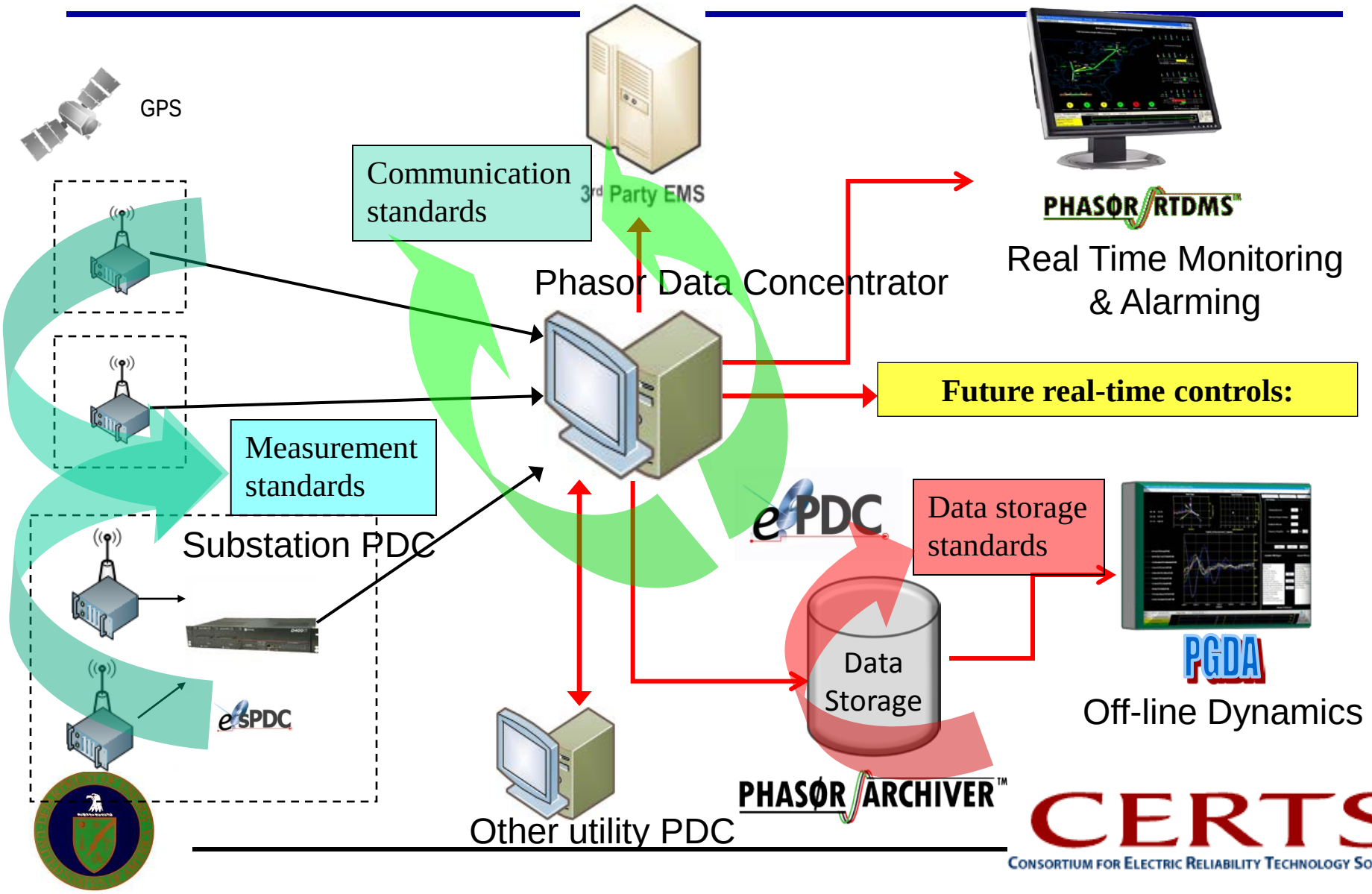
Synchrophasor communications

- Interface connection & protocol
- Communication system (WAN)
- Messaging and contents
- End-to-end compatibility
- Standards assure common interfaces and protocols



Standards in Measurement Systems



Research need & project objective

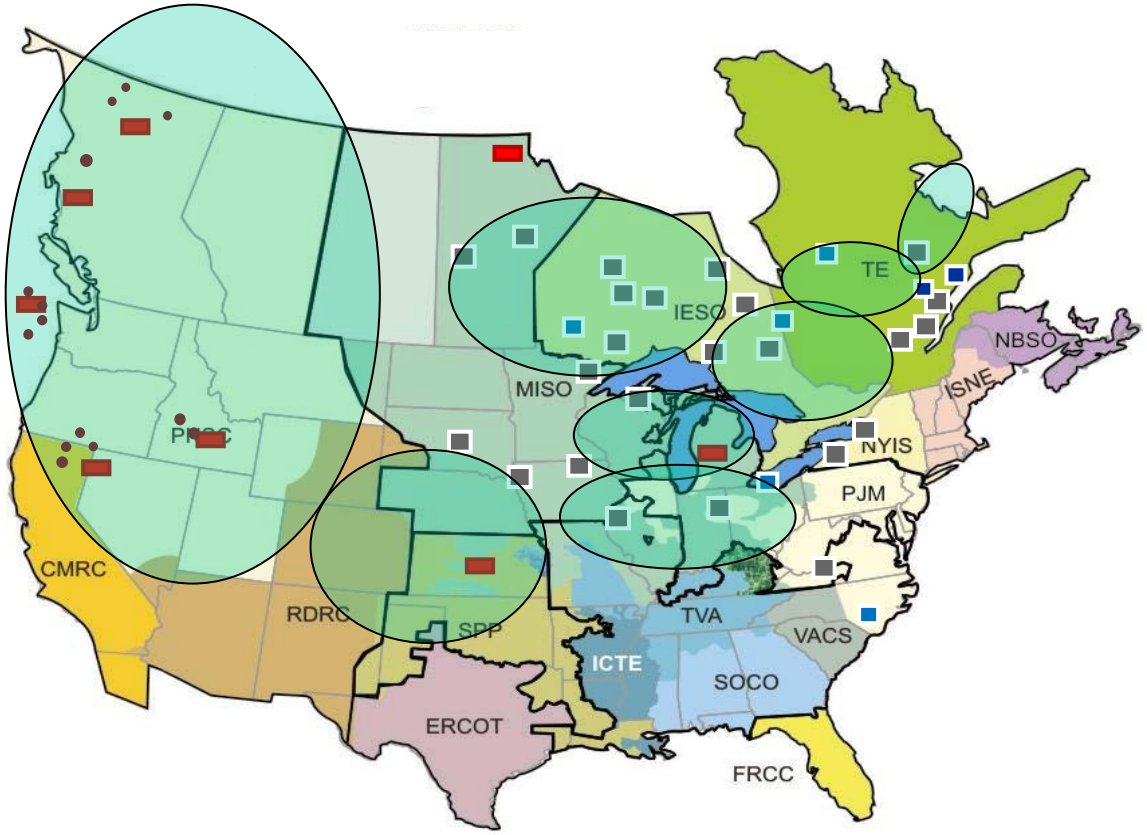
- Extensive development of synchrophasor systems
  - Technology requires many systems for operation
  - Measurement technology new and developing
- Project objective
  - Develop & harmonize IEEE & IEC synchrophasor standards
    - Measurements, communications, & data storage
  - Support continuing technology development
    - Assess implementation issues for standards updates
    - Guides for synchrophasor applications
    - Provide standard & guide interpretations
    - Disseminate information about standards & guides

Project Impacts

- SGIG Project grants $308 million (+50% cofunding)
- About 1000 PMUs installed across N. America

Internationally:

- Brazil
- W. Europe
- India
- China
- Russia
- Australia
- Others too



All use or refer to the C37.118 standards

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Synchrophasor Standards & Guides

- **C37.118.1-2011 – Measurement requirements**
  - Synchrophasor measurement including frequency and rate of change of frequency
- **C37.118.2-2011 – Synchrophasor communications**
  - Extension of the original synchrophasor standard (2005)
- **IEC 61850-90-5 – Phasor measurement communications**
  - Technical Report that adds wide-area capability for phasors
- **C37.242-2013 – Guide for PMU utilization**
  - Installation, testing, synchronization & measurement error issues
- **C37.244-2013 – Guide for PDC**
  - Definitions and functions used in PDC units

Current status

- Communication standards done
  - C37.118.2 widely used, no problems reported
  - IEC 61850-90-5 some implementation, details under development
- Measurement standard C37.118.1 amendment
- Standard for PDC initiated in May 2013
  - Anticipate completion in 2016
- Joint IEEE-IEC standard development initiated
  - IEC wants measurement standard
  - Joint development starting with C37.118.1 facilitates compatibility
  - New standard IEC/IEEE 60255-118-1

C37.118.1 amendment

- Synchrophasor technology under development
  - Standard is defining the technology as it develops
  - C37.118.1 included the first formal definition for dynamic phasors and mathematical definitions for Frequency & rate-of-change of frequency (ROCOF) as related to synchrophasors
- Immediate issues being resolved
  - Ramp test exclusion lengthened for M class filters
  - ROCOF limits relaxed or suspended
  - Filtering for M class improved for OOB & other tests
  - Modulation types separately tested for better evaluation
  - Reference frequency estimation method improved
- Expect to complete this amendment by end of 2013

ICAP - SCASC

- IEEE Conformity Assessment Program (ICAP)
- ICAP Synchrophasor Conformity Assessment Steering Committee (SCASC)
  - Under development for last year
  - Officially launches June 2013
  - Development of testing & certification program for PMUs
- Test labs may use different methods & get different results
- Programs assure labs get same results
- PMUs get certification to assure users

Other accomplishments for 2012-3

- New guides and standard updates previously described
- Each IEEE Working Group completed an IEEE paper on the respective standard
- Presentations on synchrophasors & standards:
  - Tutorial at CBIP in Delhi, India
  - Overview at Phadke-Thorpe Symposium, Reston, VA
  - 2 panels & 1 tutorial for IEEE General Meeting 2013 Vancouver, BC
  - Workshop at NCEPU in Bejing, China
- Standards harmonization discussion with China synchrophasor group

Risk Factors

- The C37.118.1 standard is leading technology development
  - Requirements may exceed current technology
- Applications should dictate requirements
  - Here requirements anticipate applications
  - Not enough applications with specific requirements
- Development of divergent standards
  - C37.118 popular, 61850 widely used for other applications
- Proprietary methods outside of standards
  - Gives vendors marketing edge
  - Creates problems for users

Follow-on for 2014

- Continue information exchange
  - Presentations at meetings, workshops, conferences, etc.
  - Solicit information from projects, technical development, other standards
- Continue standards development
  - Joint IEC/IEEE measurement standard
  - PDC standard
- Develop guides for understanding standards
  - Propose a workshop for vendors on the measurement standard
- Develop links between applications & synchrophasor performance

Questions?