DEPARTMENT OF ENERGY - A SYNCHROPHASOR PARTNER
A HISTORY OF SUCCESS

Phil Overholt
It Started with a Novel Concept…and Flourished

“A New Measurement Technique…”

“Workshop on Real-Time Control…”


Western Interconnection Blackout Eastern Interconnection Phasor Project Eastern Interconnection Blackout

“Workshop on Real-Time Control And Operation Of Electric Power Systems”

Proceedings

1983

“PMU Pioneers Event”

2002 2003 2007 2009

ARRA

NASPI

Reliability monitoring has a new paradigm
A NEW MEASUREMENT TECHNIQUE FOR TRACKING VOLTAGE PHASOR LOCAL SYSTEM FREQUENCY, AND RATE OF CHANGE OF FREQUENCY
A.G. Phadke Fellow, IEEE VPI & SU Blacksburg, VA, J.S. Thorp Senior Member, IEEE Cornell University Ithaca, NY,
M.G. Adamiak Member, IEEE AEP Serv. Corp. New York, NY
May 1983

REAL TIME VOLTAGE-PHASOR MEASUREMENTS FOR STATIC STATE ESTIMATION
J.S. Thorp, Senior Member IEEE Cornell University Ithaca, NY, A.G. Phadke, Fellow IEEE Virginia Polytechnic Institute & State University, Blacksburg, VA, K.J. Karimi, Student Member IEEE Cornell University Ithaca, NY
Nov 1985

STATE ESTIMATION WITH PHASOR MEASUREMENTS
A.G. Phadke, Fellow, IEEE Virginia Polytechnic Institute & State University, Blacksburg, VA, J.S. Thorp, Senior Member, IEEE Cornell University, Ithaca, NY, K.J. Karimi, Student Member, IEEE, Cornell University, Ithaca, NY
Feb 1986

The DOE Wide Area Measurement System (WAMS) Project – Demonstration of Dynamic Information Technology for the Future Power System
W.A. Mittelstadt (BPA), J.F. Hauer (PNL), P.E. Krause (WAPA), R.E. Wilson (WAPA), P. N. Overholt (DOE)
D.T. Rizy (ORNL)
Nov 1995
Actual System Performance - unstable system behavior observed

Model Simulation - predicted stable system performance

August 10, 1996

August 14, 2003
Honored at the NASPI Working Group Meeting
Long Beach, California
May 9, 2007

Arun Phadke  Jim Thorp  Bharat Bhargava  Ken Martin
Jay Murphy  Bill Mittelstadt  Mark Adamiak  John Hauer  Ed Schweitzer
SynchroPhasor Awards

Advanced Research Projects

$4.3M awarded to 4 projects in August 2009

• Regents of University of California
  SynchroPhasor-based Adaptive Relaying (PG&E, SCE)

• Virginia Polytechnic Institute and State University
  Implement SynchroPhasor-based Three-Phase Tracking State Estimator for Unbalanced Conditions and Adaptive Relaying (Dominion VA Power)

• Georgia Tech Research Corporation
  Real-Time Implementation of the Distributed Dynamic State Estimation for On-line Generator Parameter Identification and Wide-Area Transient Stability Analysis (NYPA, Virgin Islands WAPA)

• Electric Power Research Institute
  Wide-area, Real-time Visualization of Frequency, Voltage and Current Contours for Security Monitoring, on-line Identification of Major Events and Event “instant” Replay (TVA)

Engineering Education Program

$1.4M awarded to 7 projects in May 2013

• Washington State University
  A Collaborative Educational Program on Synchrophasor Applications for Smart Electric Grid

• North Carolina State University
  Development of a Multi-User Network Testbed for Wide-Area Monitoring and Control of Power Systems Using Distributed Synchrophasors

• Illinois Institute of Technology (IIT)
  IIT-Industry Collaboration: Synchrophasor Engineering Research and Training

• University of Wyoming
  Advancing Synchrophasor Applications and Training through Academic-Industry Collaborations

• Virginia Polytechnic Institute and State University
  Data Mining and Playback of Hybrid Synchrophasor Data for Research and Education

• Texas Tech University
  Collaborative Industry-Academic Synchrophasor Engineering Program

• Clemson University
  Clemson University’s Synchrophasor Engineering Education Program
<table>
<thead>
<tr>
<th>Project Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Transmission Company, LLC (PMU)</td>
<td>$2.7*</td>
</tr>
<tr>
<td>American Transmission Company, LLC (SCADA)</td>
<td>22.9</td>
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<tr>
<td>Duke Energy Carolinas, LLC</td>
<td>7.8</td>
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<tr>
<td>Entergy Services, Inc.</td>
<td>9.2</td>
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<td>Midwest Energy, Inc.</td>
<td>1.4</td>
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<td>Midwest ISO, Inc. – 17 trans owner partners</td>
<td>34.5</td>
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<td>ISO New England, Inc. – 7</td>
<td>18.1</td>
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<td>New York ISO, Inc. - 8</td>
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<td>PJM Interconnection, LLC – 12</td>
<td>27.8</td>
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<tr>
<td>Western Electricity Coordinating Council – 18</td>
<td>107.8</td>
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</tbody>
</table>

* Total Project Cost - Millions

307.9
DOE and NERC are working together closely with industry to enable wide area time-synchronized measurements that will enhance the reliability of the electric power grid through improved situational awareness and other applications.