DOE Update

Applications and Analysis Tools for Grid Monitoring

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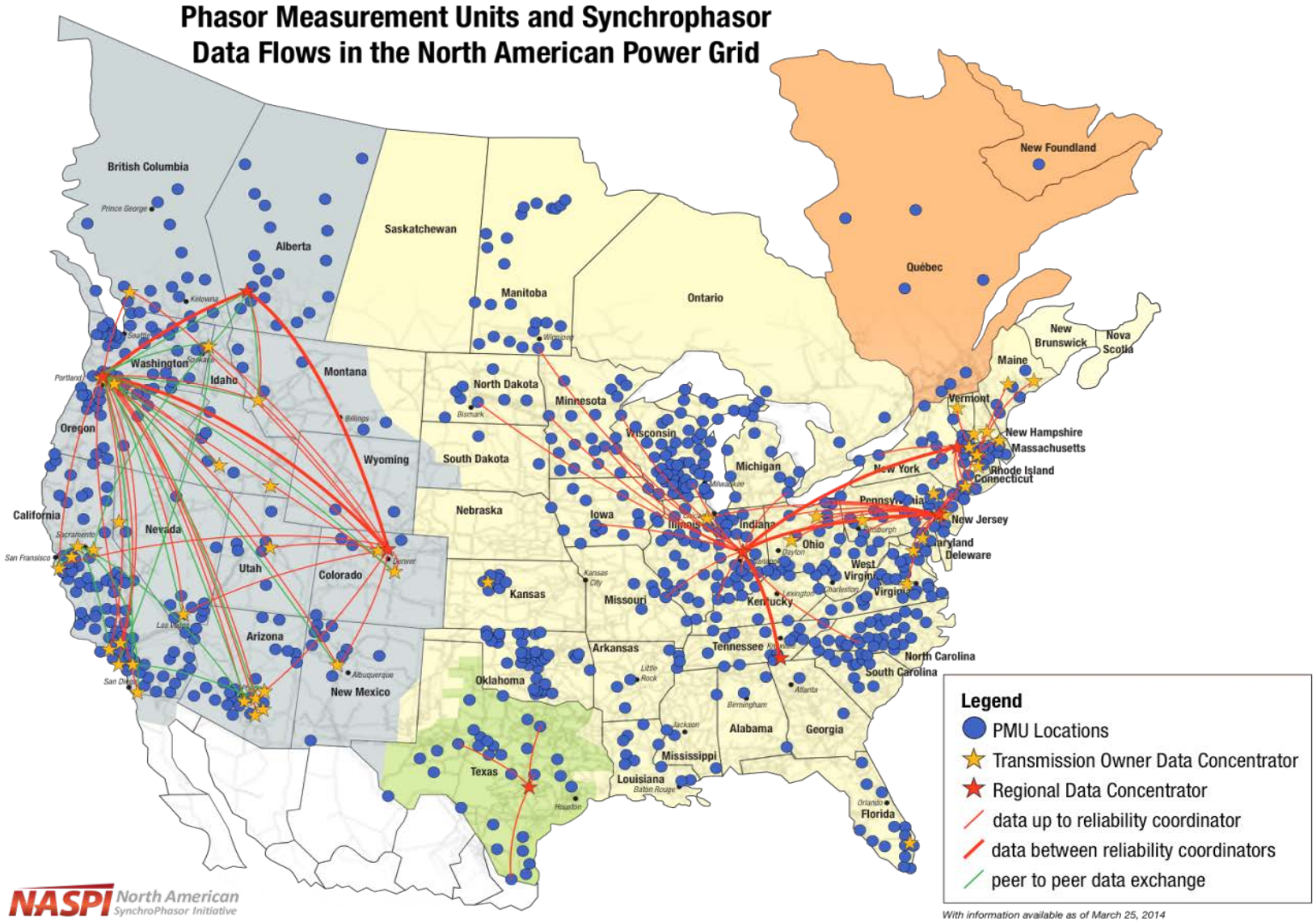
Transmission Reliability Program Advances Applications of Grid Measurements

- Sponsors deployment and application development for Phasor Measurement Units (PMU)
  - Led Recovery Act deployment of PMUs – from ~ 200 in 2009 to over 2,000 today
  - Funds North American Synchrophasor Initiative in partnership with Electric Power Research Institute
  - Awarded over $12.5 million (plus 50% cost share) for PMU application development and deployment for system operations in 2014
  - Plans to award (with 50% cost share) for PMU application development targeted to system owners in 2016
- Supports university R&D
  - Co-sponsor with NSF the Center for Ultra-wide-area Resilient Electric Energy Transmission at the University of Tennessee, Knoxville
  - Plans for a university grant solicitation in FY 2016

Deployment of a Continental PMU Network



Pre-Commercial PMU Applications Projects

Applicant	Utility Engagement	Synchrophasor Enabled Functionality	Data	Open Framework
Quanta Technology, LLC	• NYPA	Direct Non-Iterative State Estimator	Data conditioning	Open structure
Electric Power Group, LLC	• SCE • ERCOT • Dominion Virginia	Phasor Simulator for Operator Training	Supplement proprietary event data	Use of standard protocols
Burns & McDonnell Engineering Company, Inc.	• Southern Company	Real-time stability monitoring and analysis	Archival database, real-time data pre-processing (detect and process bad/missing data)	GPA's openPDC, openHistorian
Hawaiian Electric Company	• HECO	Real-time operational awareness for variable generation; measurement/modeling of DG and microgrid impacts on operations, restoration, and contingency capabilities	Data management and analysis capability, integrate SCADA and non-SCADA data streams	Common data analysis platform
Peak Reliability	• BPA • CAISO • Idaho Power • SDGE • SCE	Extensive functionality including real-time voltage stability assessment, linear state estimation, cascading propagation prediction, phase angle separation, rate of change baselining and monitoring, decision support for operators, closed loop controls, and generator load model enhancement and validation	Manage and improve data quality (validity and availability), assessment of data quality impact on tool performance	GPA – Interoperability, integrated security, common configuration interface, common analytics interface
Grid Protection Alliance, Inc.	• Dominion Virginia • Oklahoma Gas and Electric Company • SPP • NorthWestern Energy • BPA	Oscillation detection, mode damping monitoring, wide-area VAR control, automated PMU calibration, line parameter estimation, and synchronous machine parameter estimation	Bad data detection, data smoothing and conditioning	Open and Extensible Control and Analytics (openECA) Platform

Engineering Education Program Awards

$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

Synchrophasor Implementation Opportunities and Challenges

Opportunities

- 13 transmission owners committed to install and use applications from the FOA 970 projects as production systems
- TR FY16 FOA focusing on expanding application areas for PMUs
- Active engagement of technical support through NASPI and NIST

Challenges

- Need to deliver near-term value of PMUs to asset owners
- Continued lack of acceptance of PMU data for real-time operations
- Proven, vendor-supported production-grade applications
- Access to synchrophasor and supporting data for R&D

Applications for Wide Area Monitoring, Analysis and Control

Monitoring	Analysis	Control
• Frequency • Voltage • Oscillation Detection • Wide-area Visualization • Operator Decision Support • State estimation (hybrid or linear state estimation / state measurements) • Renewables Integration	• Post Event Analysis • Model Validation • State Estimation	• Adaptive Islanding • Adaptive Relaying • Power System Stabilizing / Power Oscillation Dampers • Black-Start Restoration • Automated Remedial Action Schemes

For More Information

Transmission Reliability Program	http://energy.gov/oe/services/technology-development/transmission-reliability
NASPI Technical Reports • Visualization • Model validation • Renewables integration	http://energy.gov/oe/downloads/north-american-synchrophasor-initiative-naspi-technical-reports
NASPI Workshop Reports	https://www.naspi.org/techworkshops
Smart Grid Investment Grant Program	www.smartgrid.gov
ARRA SGIG Synchrophasor Final Report	http://www.energy.gov/oe/downloads/advancement-synchrophasor-technology-projects-funded-american-recovery-and-reinvestment

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