An Update on the North American SynchroPhasor Initiative

Alison Silverstein
NASPI Project Manager
NERC Board of Trustees
May 5, 2015

Overview

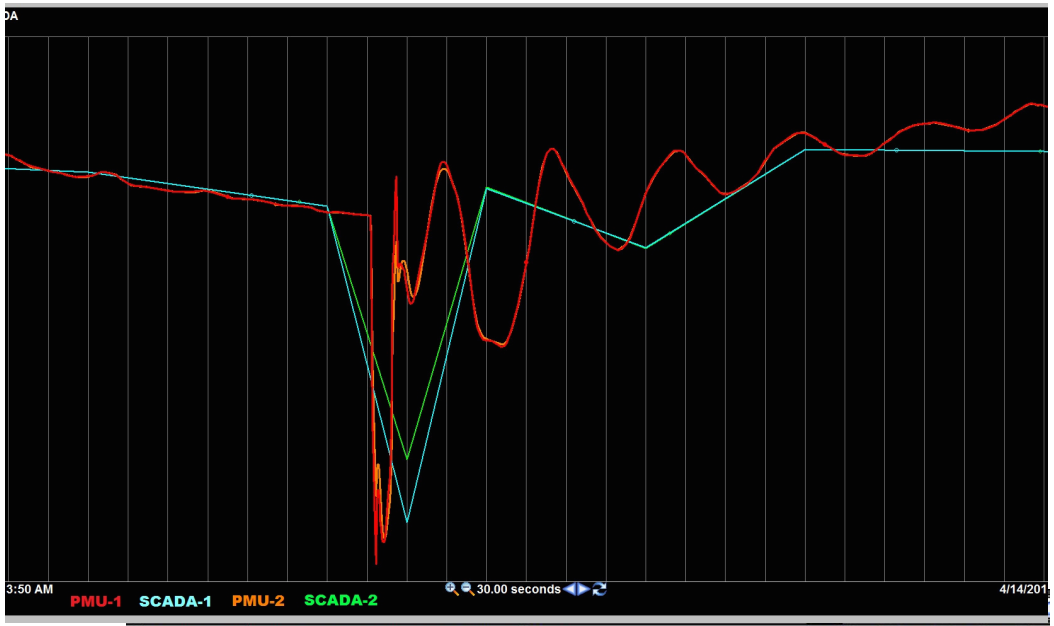
Synchrophasor systems and applications are moving from promise to maturity.

- Almost 2,000 production-grade PMUs installed, most networked to reliability coordinators
- Many applications have matured, providing value to asset owners and RCs
- NASPI has grown and DOE-EPRI support is strong
- Current challenges and priorities

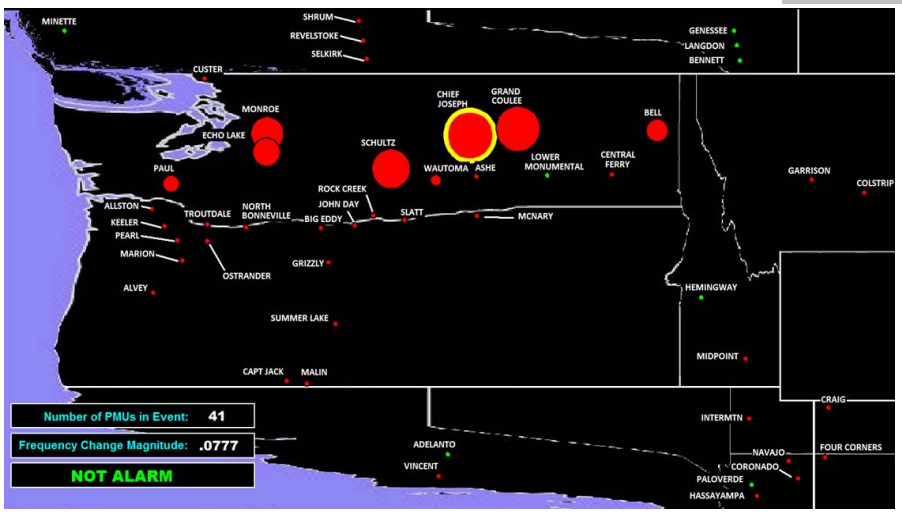
Reminder – PMUs v. SCADA

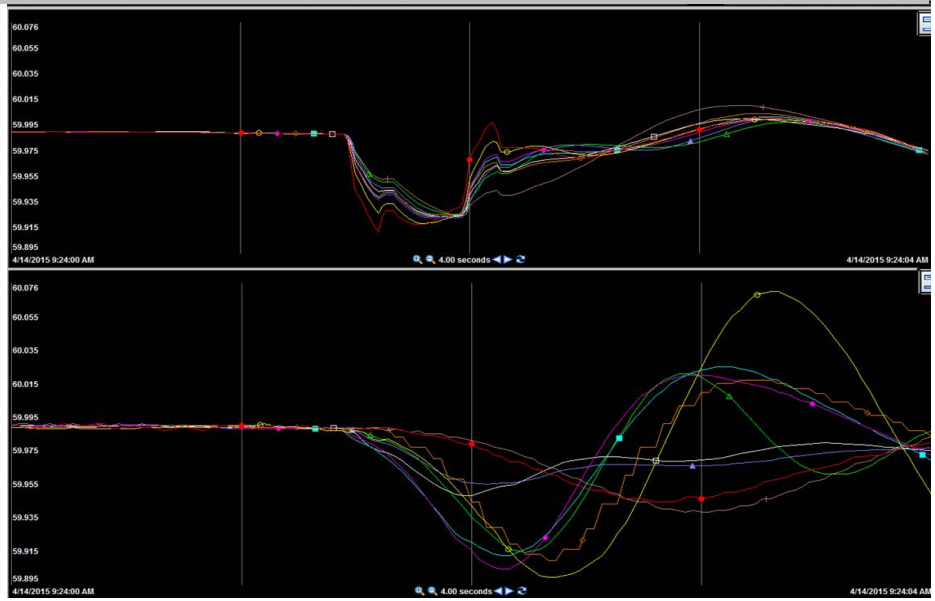
Benefits

- Time granularity
- Time-synchronized measurements
- Phase angles



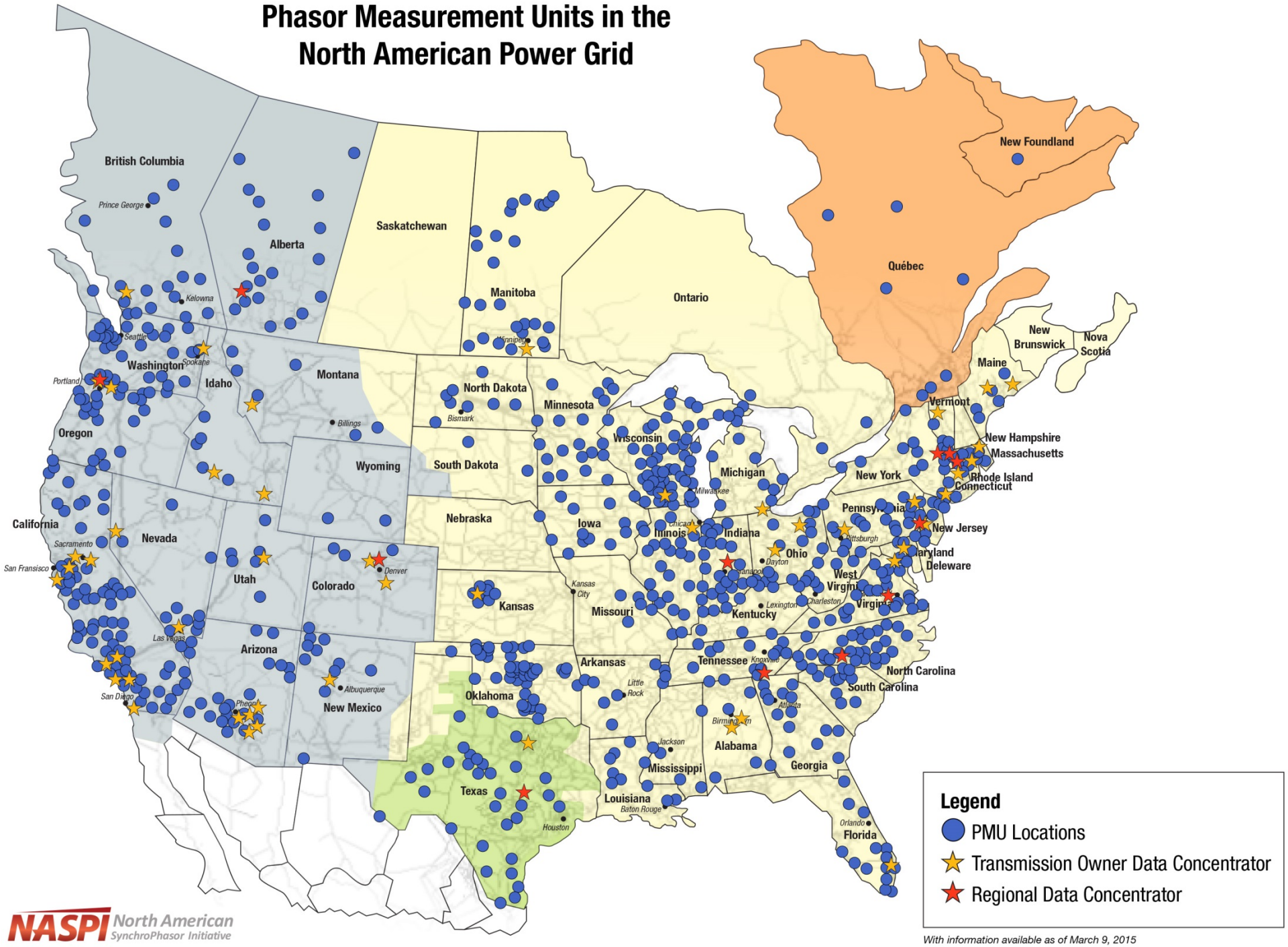
BPA Chief Joseph brake test
Frequency plots (right)
PMU locations (below)





Source: BPA

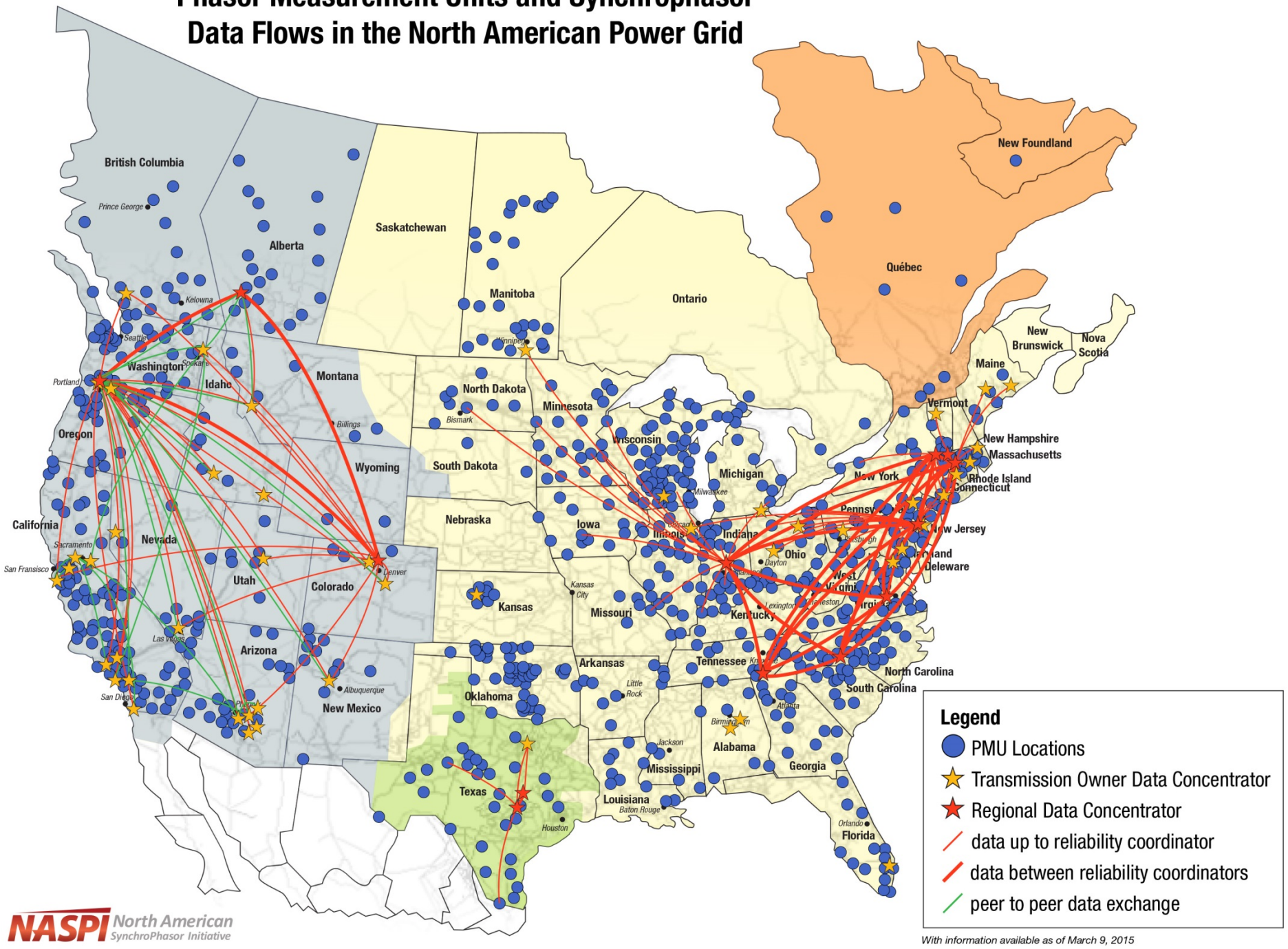
Phasor Measurement Units in the North American Power Grid



NASPI North American SynchroPhasor Initiative

With information available as of March 9, 2015

Phasor Measurement Units and Synchrophasor Data Flows in the North American Power Grid



NASPI North American SynchroPhasor Initiative

With information available as of March 9, 2015

Synchrophasor application maturity

Important maturity distinction between technical capability v. production-grade v. accepted usage, particularly in control rooms….

Technically mature today	Maturing quickly
Model validation	Wide-area visualization
Oscillation detection & mode monitoring	Linear state estimation
Frequency monitoring & compliance	Data quality and availability
Voltage stability monitoring	Diagnosing equipment health & mis-operations
Forensic event analysis	Black-start operations & restoration coordination
Operator training (PMU-based simulations)	Synchrophasor data network support and maintenance
Automated RAS scheme (BPA)	Renewables integration
	Dynamic line loading/dynamic line transfers
	Geomagnetic-induced current identification
	Operator decision support tools
	Automated protection & controls

Value from synchrophasor technology

Major sources of value include:

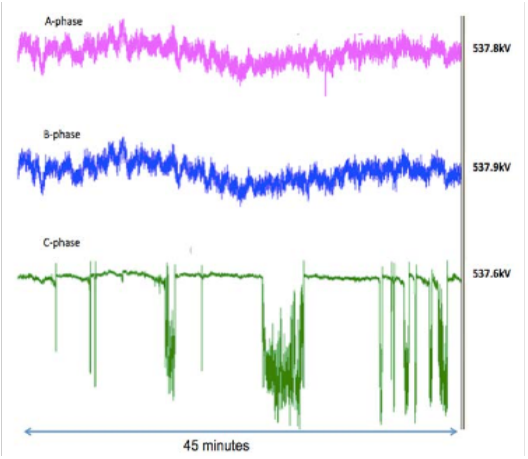
- Diagnosing equipment health and mis-operations (*PRC-004*)
- Frequency monitoring and compliance (*BAL-003*)
- Oscillation detection, mode monitoring and voltage stability monitoring
- Support black-start system recovery and load restoration (*EOP Standards*)
- Model validation – Generation, load, FACTS, HVDC; system model validation efforts under way (*MOD Standards*)
- Linear state estimation and hybrid state estimation
- Forensic event analysis (*PRC-002* *future*)
- Back-up data source to EMS

Newest value source – diagnosing equipment mis-operations

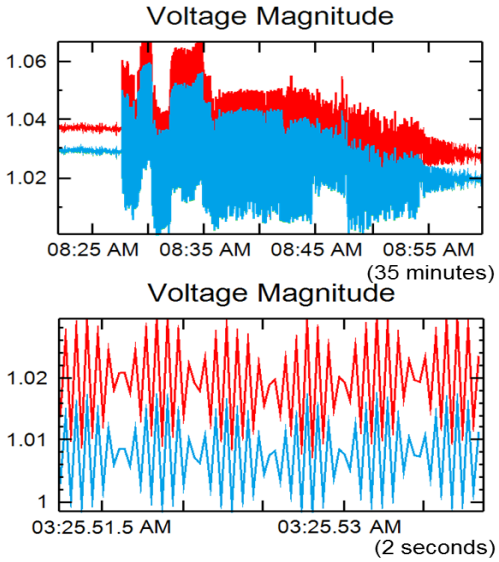
We can use PMU data to identify and diagnose generation and transmission events, mis-operations, and asset health.

- Classes of PMU-observable assets:
  - Generator performance & generating equipment failures (e.g., AVR and PSS, power oscillations)
  - Transmission events & equipment (e.g., verify equipment installation)
  - Proactive uses for equipment installation and protection
  - Wind & solar plant performance and oscillations
- Benefits include safety, reliability, asset protection, damage avoidance

Failing CCVT (Dominion)



Wind plant oscillation (OG&E)



NASPI

The North American SynchroPhasor Initiative is a collaborative effort between electric industry, government and vendors to advance the adoption and value of synchrophasor technology for grid reliability and efficiency.

- 1,000 members, international scope
- Two meetings/year plus technical workshops
- Begun in 2005; 2007-2013 funding from NERC; funded by DOE in 2014+ with EPRI support

2014 and 2015 October meetings held in conjunction with CIGRE-NA Grid of the Future conference

Archives at www.naspi.org

NASPI and synchrophasor technology accomplishments

- Developed key standards and guidelines for synchrophasor technology, all adopted by IEEE and IEC
  - Recent – PMU uniform test plan and test lab certification for C37.118.1 conformance
- Pushing technology and focused work efforts on PMU device functionality, network design, data quality, applications needs, and more
- Guidance for and lessons learned from ARRA-SGIG and demo projects – see NASPI archives and technical reports
- Growing professional and student community and interest in synchrophasor expertise (NASPI grown from 700 to 1,000 members; meetings now attract 250 attendees)
- Dedicated committees & task forces in IEEE-PES and NATF

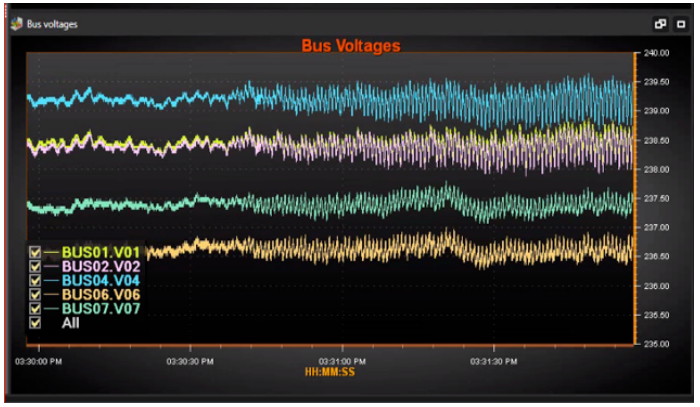
Continuing synchrophasor challenges

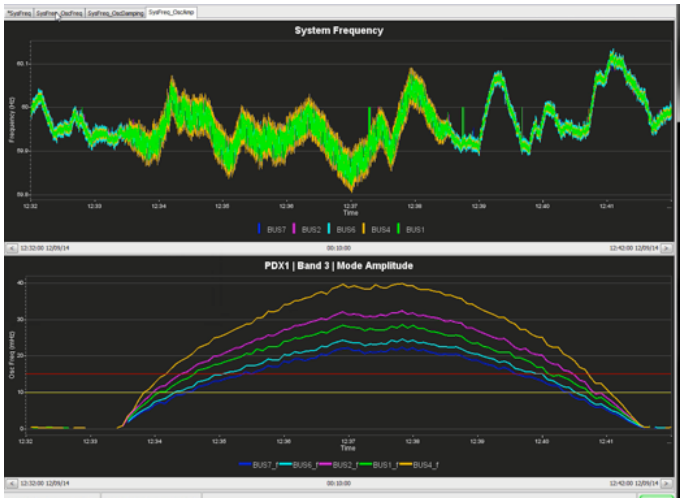
- Communicating the value proposition
- Still not enough data-sharing
  - Hampers researchers
  - Hampers ability to find regional and interconnection-wide patterns and event details using big data analytical techniques
- Physical and cyber-security
  - Includes GPS vulnerabilities
- Making it easy for new adopters to install synchrophasor system and use PMU data for high-value uses
- Integrating synchrophasor-based insights into operators' existing tools for easier acceptance)

NASPI priorities today

- Demonstrating the value of synchrophasor technology for asset owners
- Assuring end-to-end data quality of delivered PMU data
- Make synchrophasor system adoption easier; document best practices
- Using big data techniques on PMU data for pattern recognition and grid condition baselining
- Moving more synchrophasor applications into trusted use in North American control rooms and planning departments
- Three new DOE-funded studies -- cyber-security, next network design, & value proposition

Sample screens from NASPI oscillation detection tools test





Sources and more information

NASPI website (www.naspi.org)

Recent NASPI technical reports (https://www.naspi.org/documents)

- Diagnosing equipment health & mis-operations (3/15)
- Model validation using synchrophasor data (3/15)
- Proposed maturity model for synchrophasor deployment (3/15)
- Factors affecting PMU installation costs (10/14)

Recent NASPI technical workshops (https://www.naspi.org/techworkshops)

- State estimation & synchrophasor data (3/15)
- Oscillation detection and voltage stability tools comparison (10/14)
- CIGRE-NASPI GOTF synchrophasor tutorial (10/14)
- Model validation using synchrophasor data (10/13)

NASPI meeting archives (https://www.naspi.org/meetings)

Synchrophasor software exchange (https://www.naspi.org/synchrophasorsoftware)

NASPI Project Manager alisonsilverstein@mac.com

NASPI North American SynchroPhasor Initiative