



NARUC Summer Meeting 2017

# SYNCHROPHASORS & THE GRID

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**NASPI** *North American  
SynchroPhasor Initiative*

# Synchrophasor technology improves grid reliability

- 30-60 samples/second – 100 times faster than SCADA –& time-synced, provides real-time situational awareness
- Highly granular, high volumes of data enable insight into grid conditions
  - Early warning of grid events & dynamic behavior
  - Fast identification of failing equipment and asset problems
  - Better models of equipment, generators and power system
- Redundant, secure operator tools and automated system protection



# Grid visibility -- PMUs v. SCADA



# Synchrophasor technology elements

**Install PMUs at  
key  
substations &  
generators**

1

**High-quality  
applications  
and analytical  
tools**

3

**Technical  
interoperability  
standards**

4

**Business  
practices that  
support reliable  
systems**

5

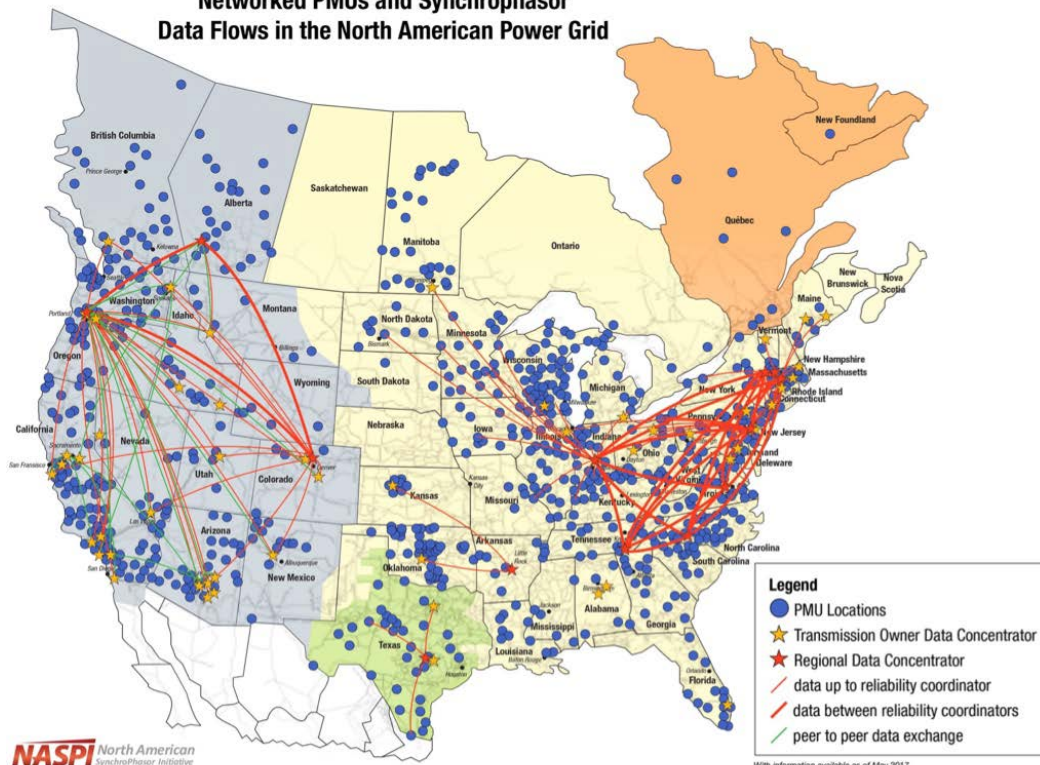
**Fast, secure, reliable  
communications  
networks**

2

## 2017 North America Synchrophasor networks

- Over 2,500 networked PMUS
- Most RCs are receiving and sharing PMU data for real-time wide-area situational awareness

**Networked PMUs and Synchrophasor  
Data Flows in the North American Power Grid**



# Current uses for synchrophasor technology

## Situational awareness

- Wide-area visualization
- Oscillation detection
- Angle monitoring
- Voltage stability monitoring
- Trending
- Event replay
- Alarms and alerts
- Linear state estimation
- Fault location

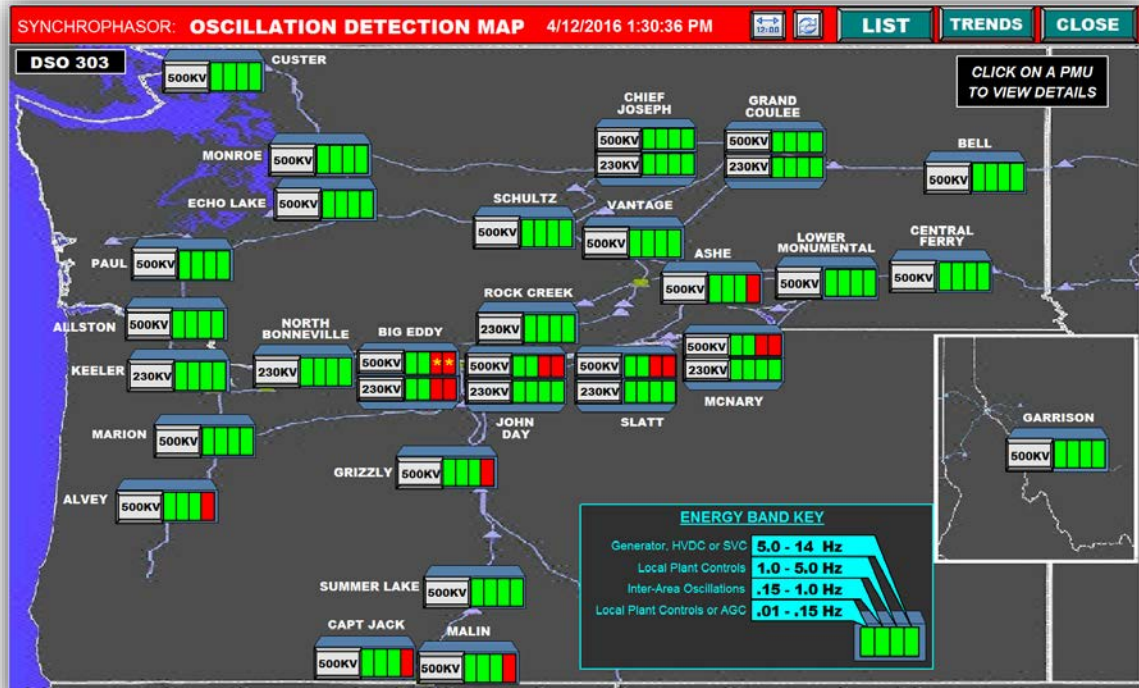
## Off-line analysis

- NERC standard compliance
- Forensic event analysis
- Model validation (equipment, generation, power system)
- Identify equipment problems
- Equipment commissioning

# A bad day in the Western Interconnection



# BPA oscillation detection tool



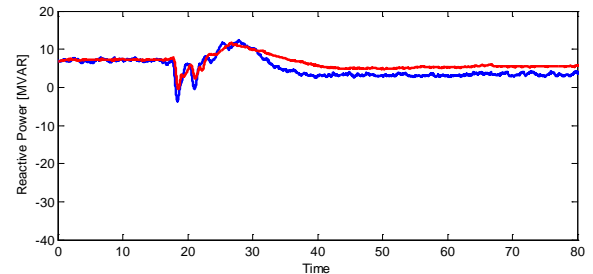
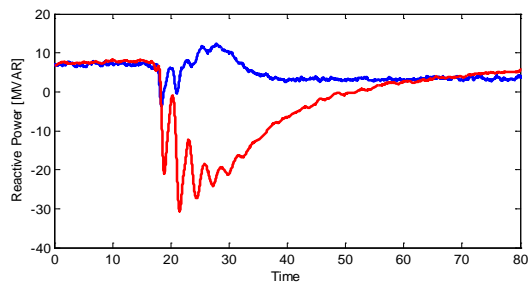
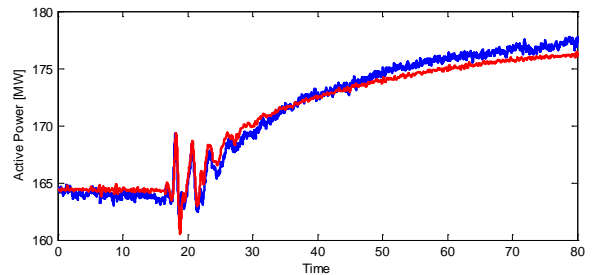
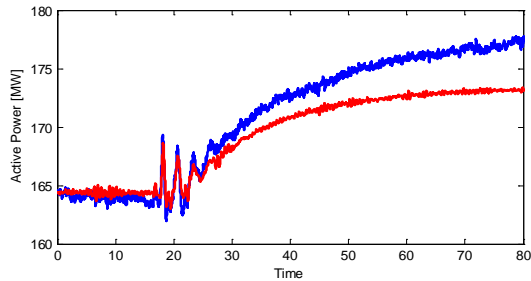
## Wind farm oscillations discovered with PMU data



# Better data yields better generator models

## BPA generator model - before (2014) and after (2015) PMU data validation

Blue – actual event recording, red = model





## More synchrophasor uses

- Renewables integration – modeling, oscillation mitigation, transmission management
- Dynamic line loading for greater throughput w/o more capital investment
- Baselineing – understanding “normal” and discovering new potential problems
- Electrical island detection and blackout restoration
- Automated system protection operations

## Synchrophasor Technology Stars



# What's next for synchrophasor technology

- Advanced machine learning using PMU data to identify anomalous events and develop operator decision support tools
- Automated, autonomous system protection schemes, including wide-area damping
- Distribution-level uses for synchronized grid-level measurements (e.g., for two-way grid monitoring and analysis)
- Advance PMU deployment and applications use and data-sharing across TOs and RCs



## Video credits

- PMUs v. SCADA – Electric Power Group
- Southwest blackout – FNET -- Dr. Yilu Liu, CURENT-University of Tennessee Knoxville
- Windfarm oscillations – Electric Power Group  
RTDMS

## Other credits

- Map – North American Synchrophasor Initiative
- BPA application screen captures – BPA

More information – [www.naspi.org](http://www.naspi.org)



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# THANK YOU!

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