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Panelist Remarks: Synchrophasor Data

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Texas A&M Engineering Experiment Station (TEES) Smart Grid Center
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Outline

- The value of high-speed time-synchronized measurements
- The North American SynchroPhasor Initiative (NASPI)
- Synchrophasor applications
- Some examples of PNNL synchrophasor data analysis projects
- Time synchronization security / robustness
- Conclusions

Notional representation of the difference between synchrophasor and SCADA measurement

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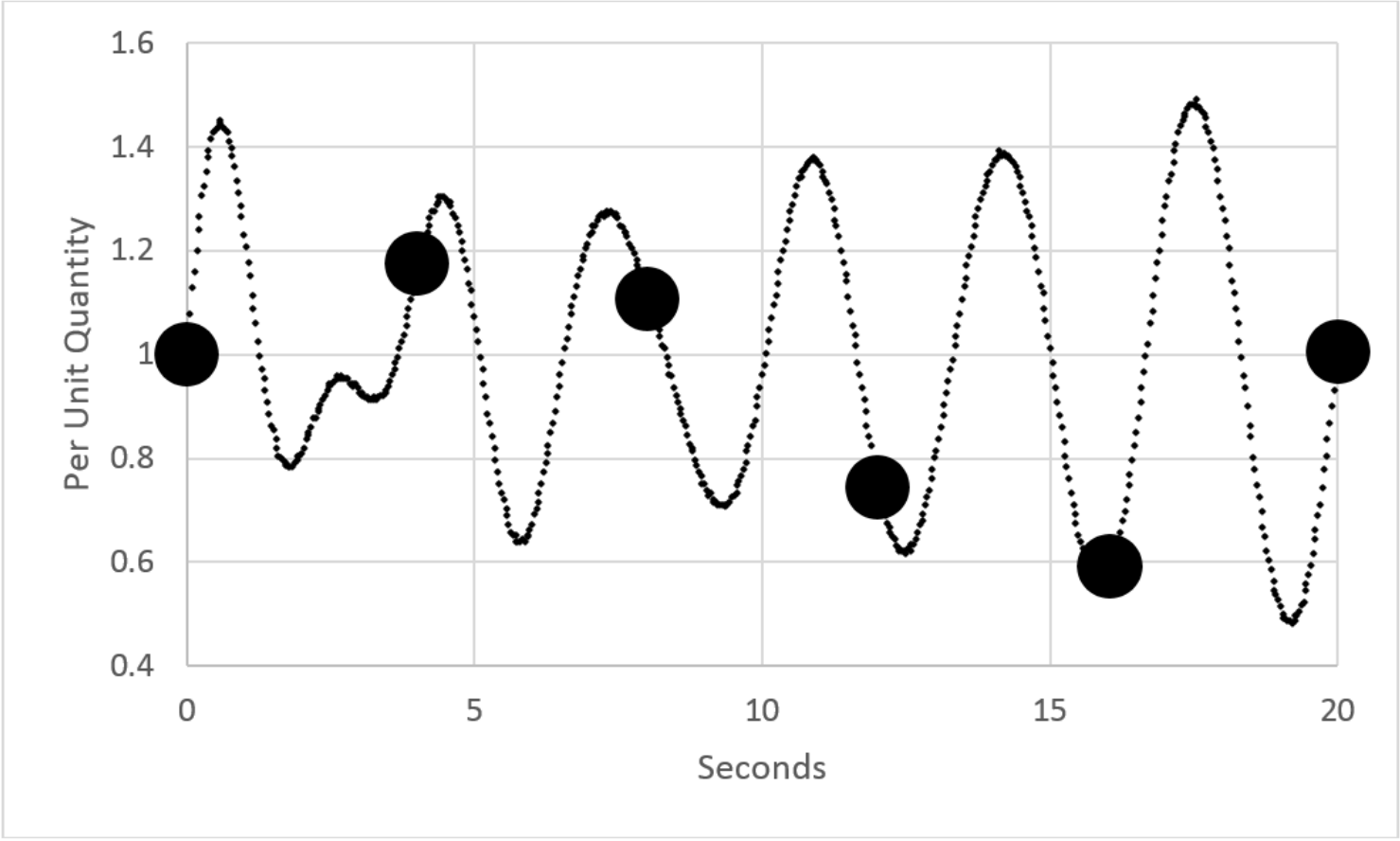
Supervisory Control and Data Acquisition (SCADA): every 4 seconds

Synchrophasors: 30 measurements per second



Lessons Learned from the August 10, 1996 Western Blackout

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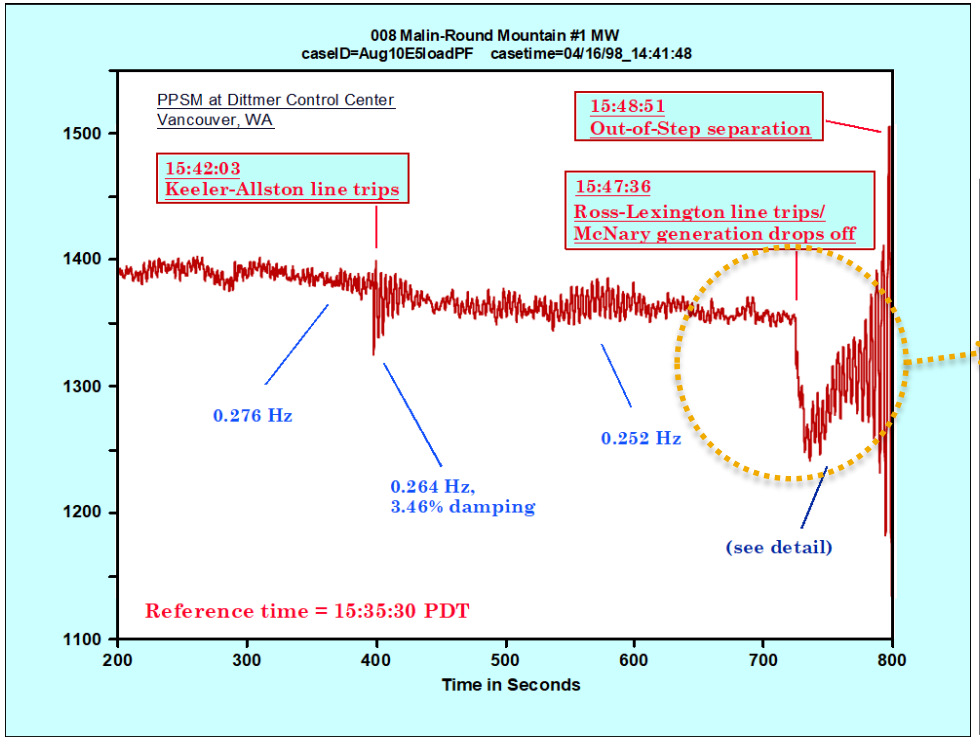
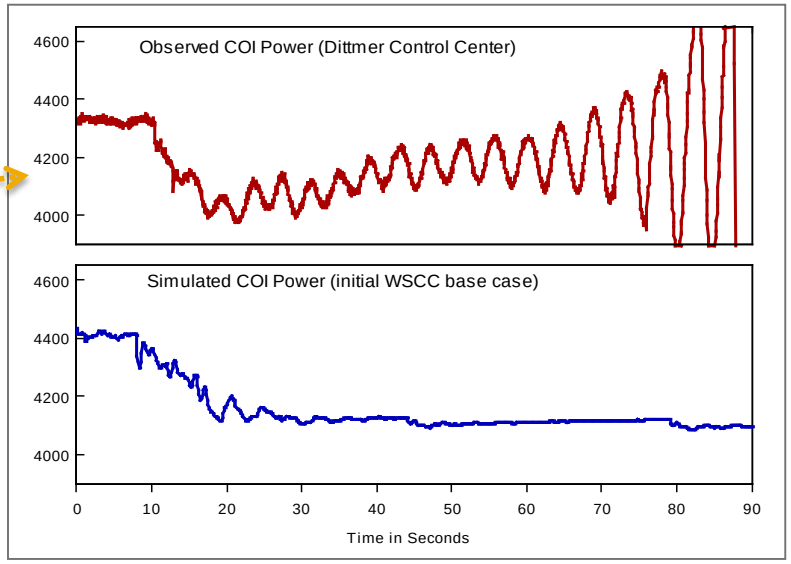
High-speed, time-synchronized data was essential to support the blackout investigation



The need for better model validation was demonstrated



North American SynchroPhasor Initiative

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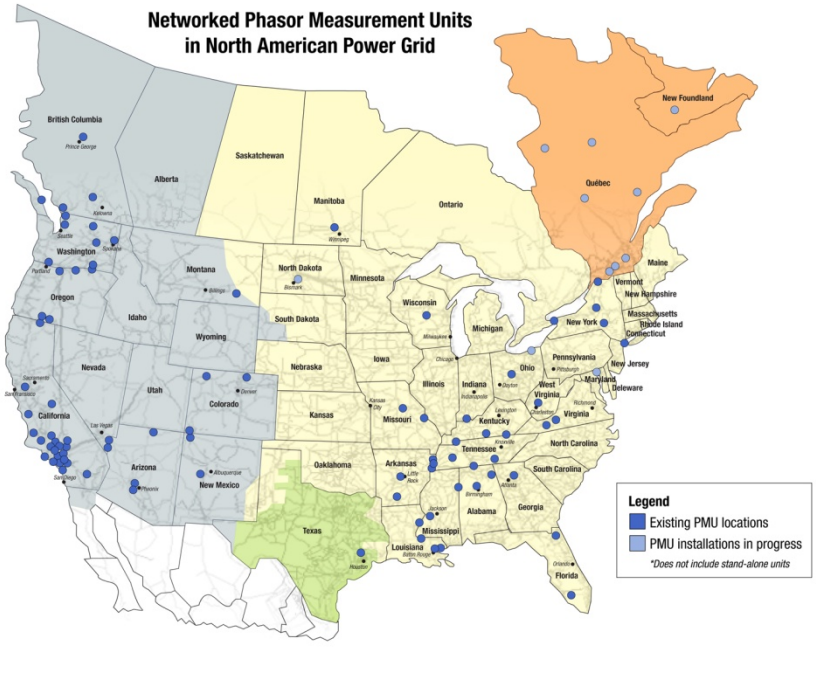
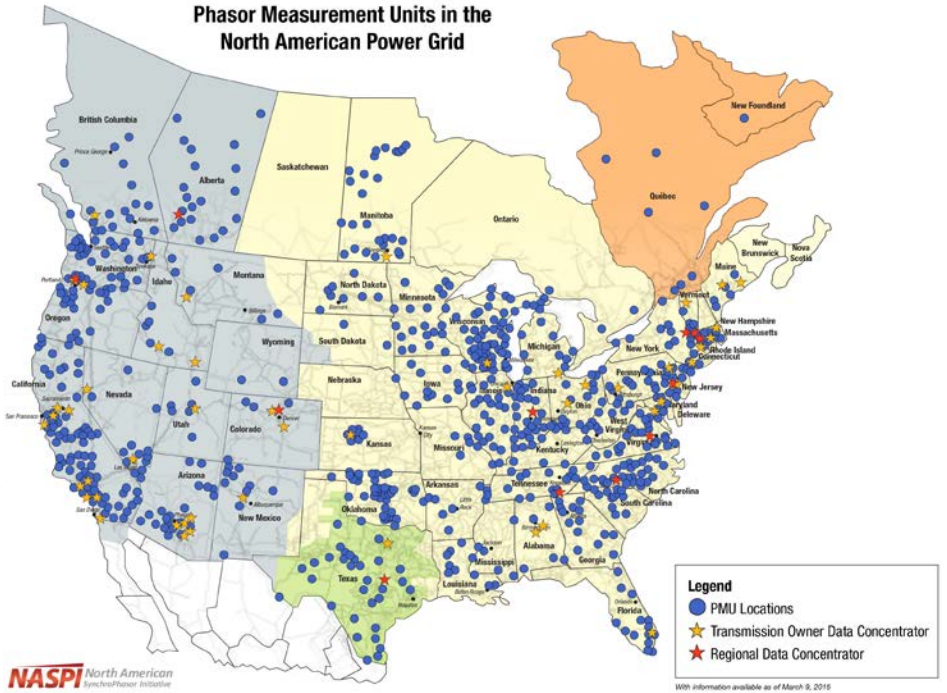
The U.S. Department of Energy (DOE) and EPRI are working together closely with industry to enable wide-area time-synchronized measurements that will enhance the reliability of the electric power grid through improved situational awareness and other applications

April 2007



March 2015



"Better information supports better - and faster - decisions."

NASPI North American SynchroPhasor Initiative

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY DELIVERY & ENERGY RELIABILITY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Applications for Wide-Area Monitoring, Analysis, and Control

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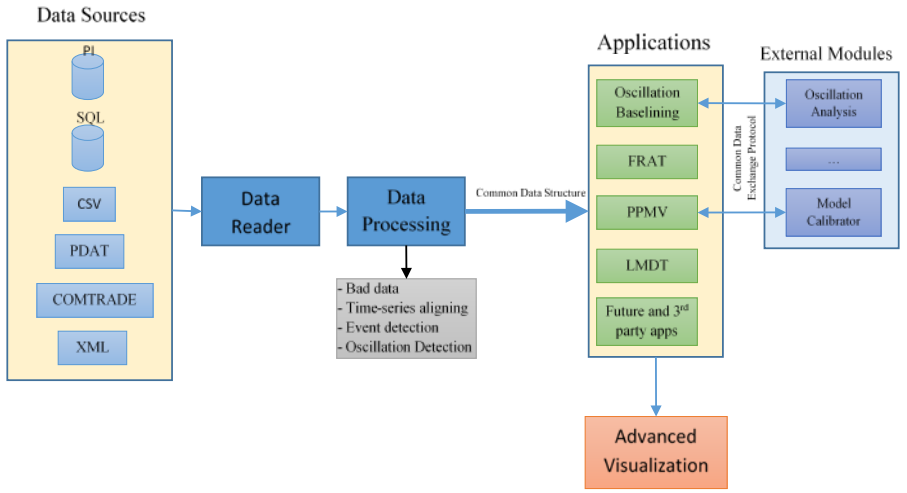
Monitoring	Analysis	Control
• Frequency • Voltage • Oscillation Detection • Wide-area Visualization • Operator Decision Support • State Estimation (hybrid or linear state estimation / state measurements) • Renewables Integration	• Post-Event Analysis • Model Validation • State Estimation	• Adaptive Islanding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

Open Platform for Engineering Applications

- Developed by Pacific Northwest National Laboratory
- Development is funded by the DOE through GMLC program and by the Bonneville Power Administration (BPA)
- Tools are used by BPA and other major utilities



- Based on open-source components
- Create building blocks and solutions for future and third-party applications
- Common data structure and data exchange protocols
- Support external modules/solvers

Examples of PNNL Tools based on the Open Platform for Engineering Applications

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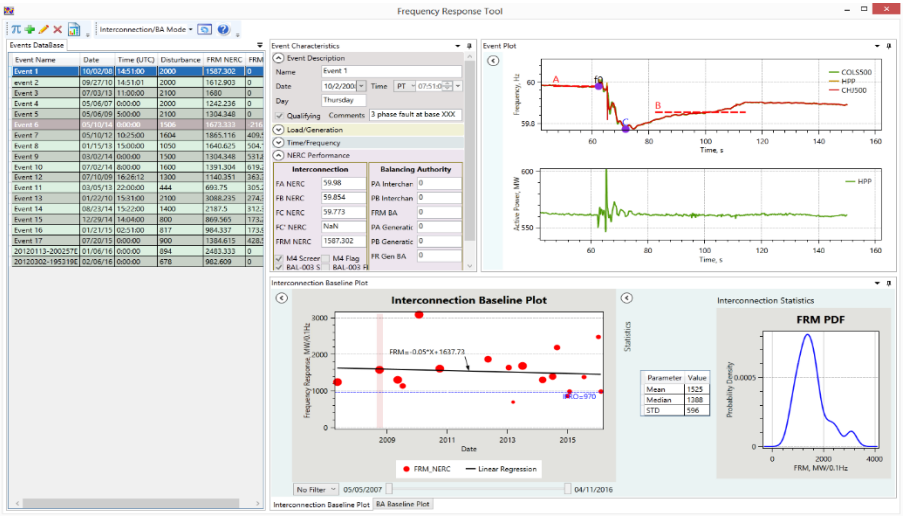
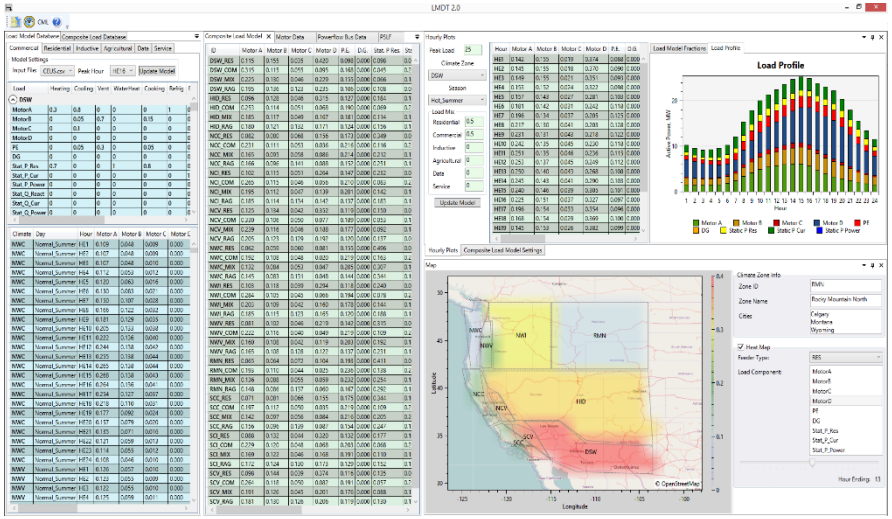
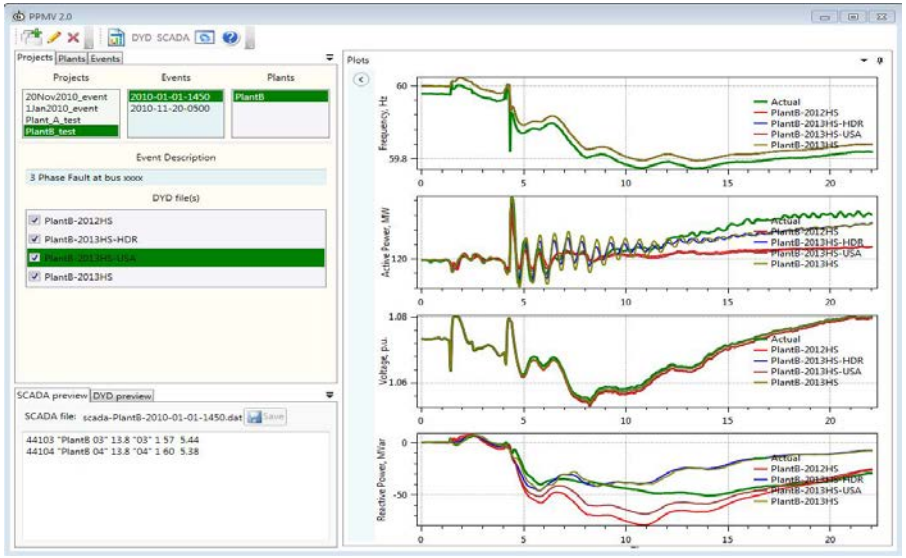
Frequency Response Analysis Tool (FRAT 2.0)



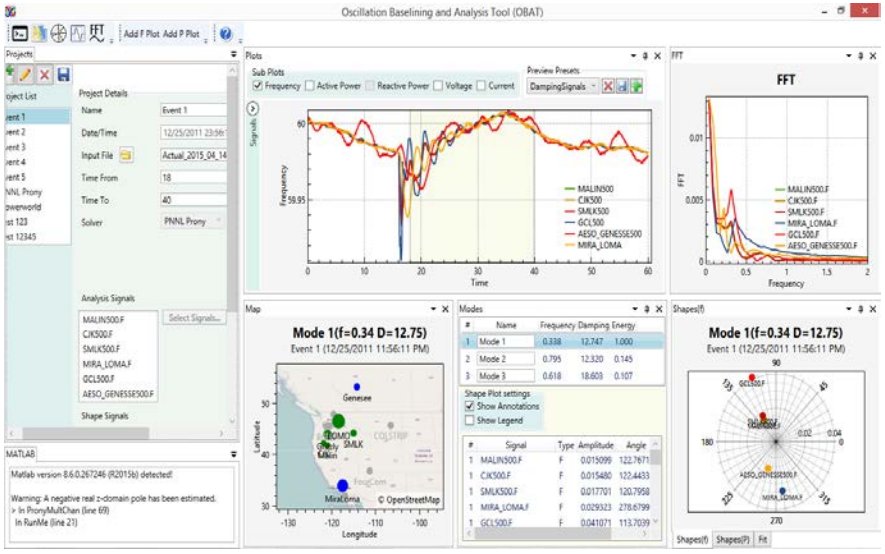
Load model Data Tool (LMDT 2.0)



Power Plant Model Validation Tool (PPMV 2.0)



Oscillation Baselining and Analysis Tool (OBAT)



Baselining Leading to Anomaly Detection: Near real-time visualization

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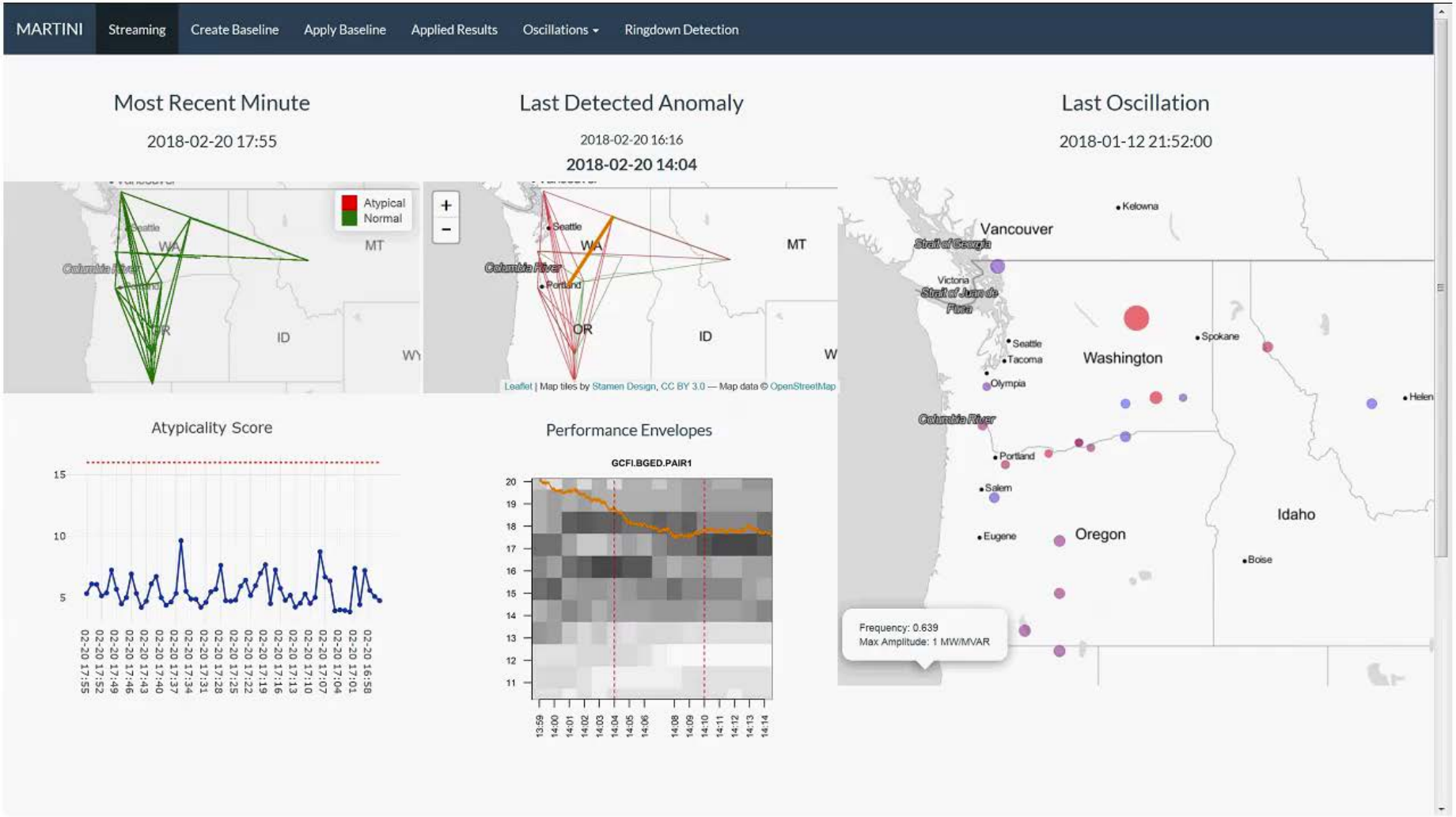

Testing Vulnerabilities Associated with Satellite Clocks for Precision Timing Applications in the Power System

Test Objectives:

- Determine the susceptibility of GPS satellite clocks to spoofing that could undermine the accuracy of Phasor Measurement Units (PMU)
- Tests carried out at the PNNL Electricity Infrastructure Operations Center (EIOC) December 2011 with Northrop Grumman and University of Texas-Austin
- Three different satellite clocks were utilized in the testing

Test Results:

- All three satellite clocks that we tested were susceptible to GPS spoofing
  - Some differences in the rate of change that could be implemented (defeating the internal error checking algorithms)
  - Some differences in how the clocks responded when the spoofing signal was turned off
- Recommending an alternative method for time synchronization associated with control applications that require secure timing
- The North American SynchroPhasor Initiative (NASPI) Time Synchronization Task Force is investigating various alternatives and recommended practices

Conclusions

- Precise timing is widely used to support synchrophasor applications in the electric power sector
- Synchrophasors have long been used for important applications, such as validating power system dynamic models
- There are emerging applications being deployed that utilize synchrophasors for operational applications
- Increased robustness of wide-area time synchronization is required to support these emerging operational and control applications

http://www.naspi.org/