NASPI Phasor Tools Visualization Workshop
a quick summary

Jodi Heintz Obradovich, Ph.D.
Scientist, Cognitive Systems Engineer
jodi.obradovich@pnnl.gov / 509.371.7984

NERC Improving Human Performance on the Grid
NERC Atlanta
March 2012

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

North American SynchroPhasor Initiative (NASPI)

▶ Mission – to "improve power system reliability and visibility through wide area measurement and control."

▶ Collaborative effort between

  ■ U.S. Department of Energy,

  ■ North American Electric Reliability Corporation, and

  ■ North American electric utilities, vendors, consultants, federal and private researchers, and academics

Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by* **Battelle** *Since 1965*

SynchroPhasors

► Synchrophasors

- Precise grid measurements available from monitors called phasor measurement units (PMUs)

- Typically 30 measurements per second – compared to one every 4 seconds using conventional technology

- Time-stamped – allowing synchrophasors from different utilities to be time-aligned (or "synchronized") and combined together providing a precise and comprehensive view of the entire interconnection

- Enable a better indication of grid stress, and can be used to trigger corrective actions to maintain reliability

► Applications include

- Wide-area monitoring

- Power system planning

- Forensic analysis of grid disturbances

- Real-time operations

Phasor Measurement Units in North American Power Grid

Legend
- Networked
- Installed
- Aggregators
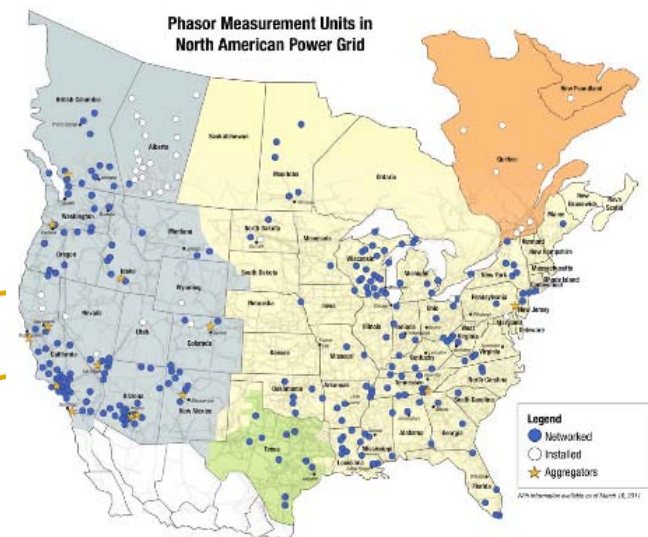
Visualization Workshop Purpose

▶ Initiate discussion on improving situation awareness for operators of the bulk power system through the use of effective visualization tools

▶ Provide observers ability to view tools from operators' perspectives

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Participants

- ▶ 125 attendees
- ▶ 20 operators
  - 5 from East and 15 from West
  - Reliability Coordinators and Balancing Authorities
- ▶ 4 software vendors
  - Alstom Grid
  - Electric Power Group
  - OSIsoft
  - PowerWorld
- ▶ 3 human factors experts
  - PNNL
  - ERCOT
  - NERC

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Workshop Structure

▶ Introduce operators and observers on goal of workshop

▶ Provide "things to think about/look for" from human factors perspective

▶ View event clips from visualization tools that use synchrophasor data

▶ Have operators provide initial reactions to these tools, what works or doesn't to meet their information needs

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Grid Events

Four grid events:

1. Large generation outage in the west (SoCal)
2. Islanding in the west (Alberta from US)
3. Growing oscillation in the west
4. Line outages and oscillations in the east
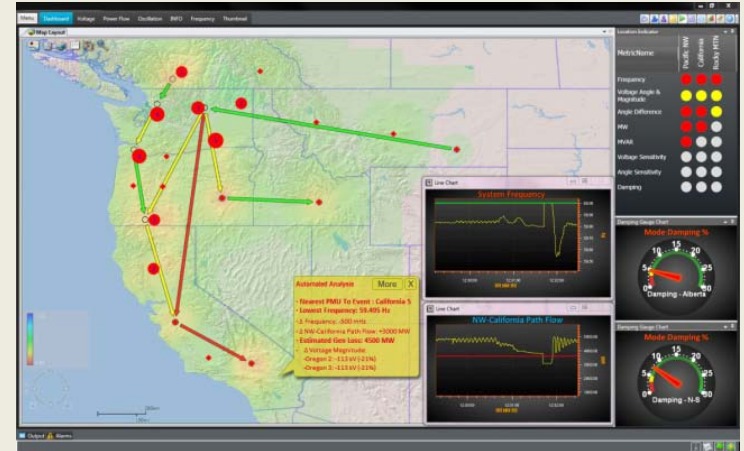
Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle *Since 1965*

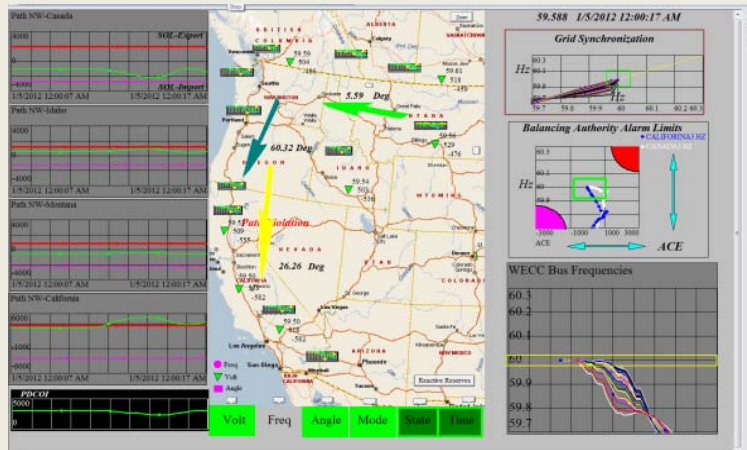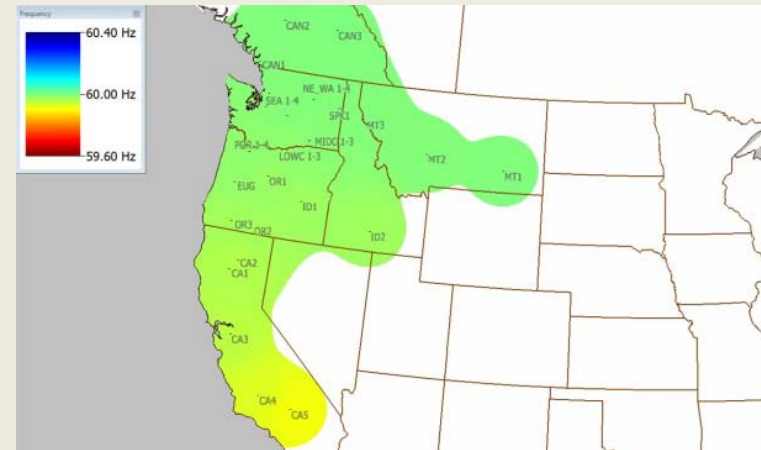# Event 1: Western Generator Outage
Sample screen shots
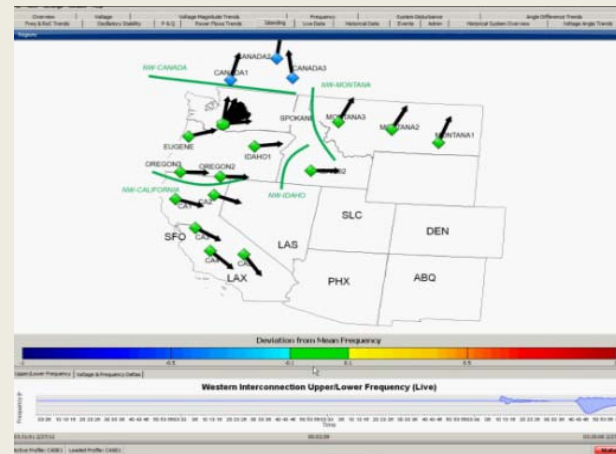

Tool A

Tool B

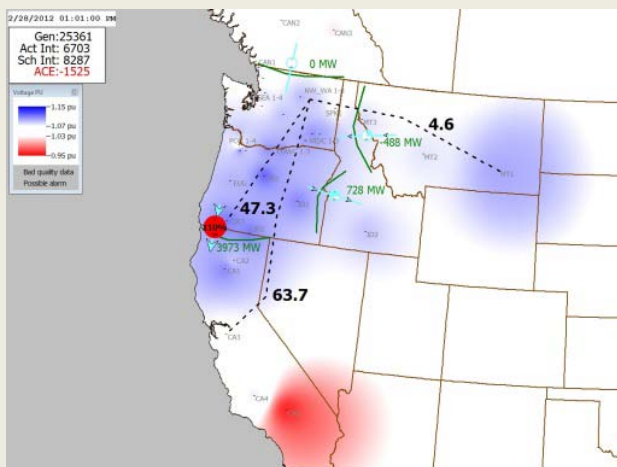
Tool C

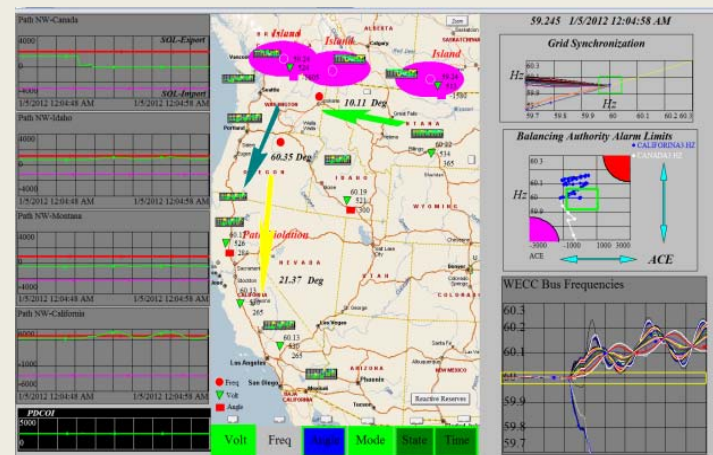Tool D

5

Event 2: Western Islanding
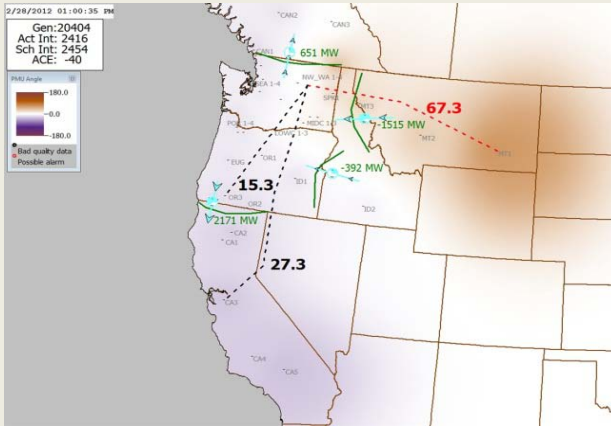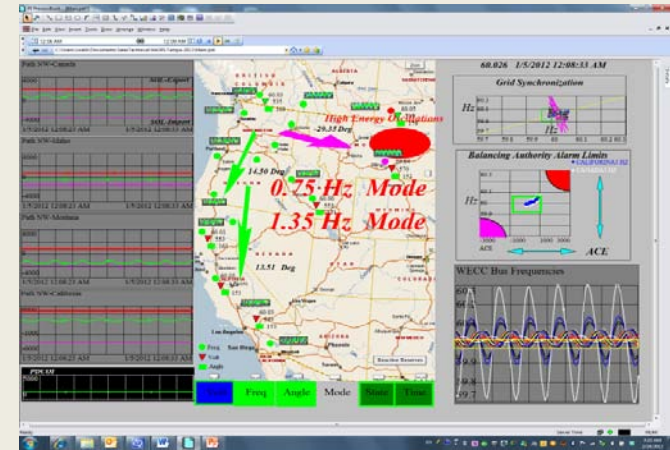## Sample screen shots

Tool A

Tool B

Tool C

Tool D

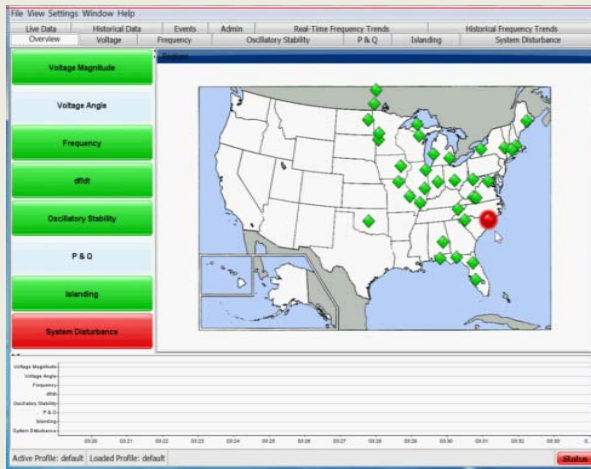# Event 3: Western Oscillation

Sample screen shots

Tool A

Tool B

Tool C

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

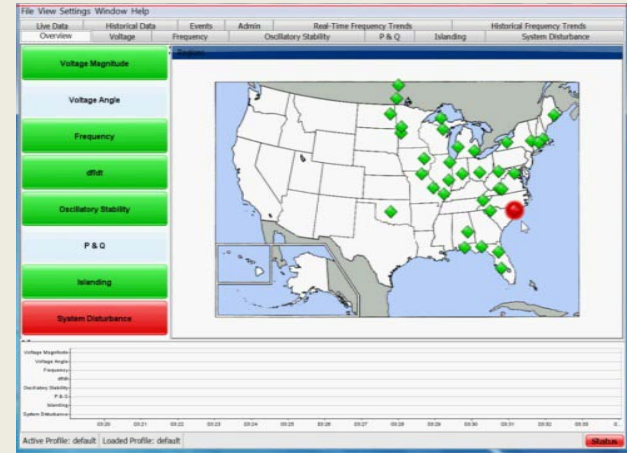# Event 4: Eastern Oscillation
Sample screen shots

Tool A

Tool B

Tool C

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*
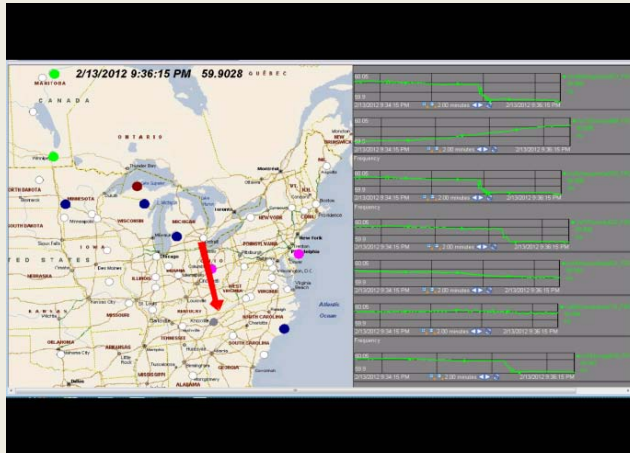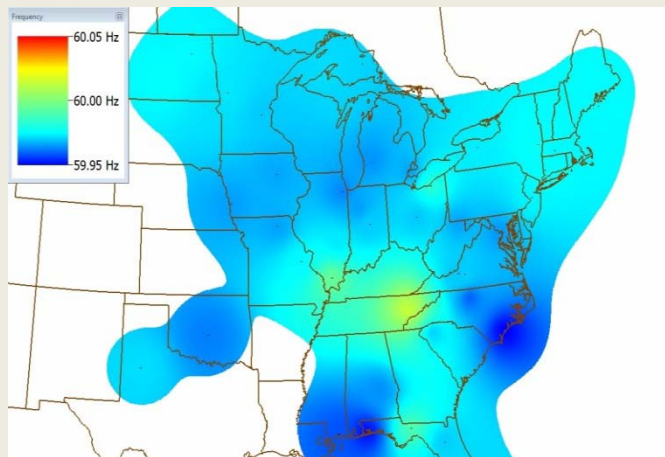
REAL-TIME DATA PORTRAYAL

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Sampling of Operator Comments

▶ "I would easily get lost. I have lots of monitors…if I have to flip back and forth to displays in real-time, can't do it."

▶ "Needed an overview"

▶ "Had more geographical information, which is good."

▶ "Didn't need all of that geographical information; don't need highways."

▶ "Going from green to red was good; magnitude of dots; draws my attention."

▶ "Lots going on, lots of flashing, didn't know where to look; distraction"

▶ "Just show me what's not normal; have a computer smart enough to know what is not the norm, then allow me to dive in for further analysis"

▶ "Use operator terminology"

▶ "All displays showed information that I didn't need to solve the problem."

▶ Gave alarms in tabular; some alarms masked others."

▶ "When I look at displays, there is data I want to see in the first couple of minutes, and then other data I want to see over time."

▶ If I wasn't looking at some of the displays in the first few seconds, I would have missed what the precipitating event was."

What We Learned

▶ Each visualization tool had strengths and weaknesses

▶ Operators have different preferences, e.g., graphs vs. numbers

▶ Operators may have different goals, requiring different information for decision making

▶ Synchrophasor data reveals some conditions (e.g., oscillations) that SCADA doesn't

▶ Operators seem to offer conflicting critiques

▶ Only the beginning of further exploration, learning, and design

Next Steps

▶ Summary of insights gleaned from workshop participants

▶ Share visualization principles from human factors experts with workshop participants

▶ Visualization tool vendors already thinking about how to improve their tools based on this feedback

▶ Exploration of follow-on activities

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

For More Information

▶ All summary materials and event clips will be posted on the NASPI website: www.naspi.org

▶ NASPI Phasor Tools Visualization Workshop and event clips:

https://www.naspi.org/site/Module/Meeting/Reports/SubReports/workgroup.aspx

(scroll to February 28, 2012 for links)

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle *Since 1965*

Thank You

Questions?

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Suggestions for Looking

▶ Consistency

▶ Number of items & associated meanings

▶ Ease of interpretation

▶ Relationships between data

▶ Actionable information

▶ Distraction or clutter

▶ Directing attention

▶ Ease of viewing

▶ Levels of detail

▶ Sensemaking

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*