<u>Webinar Panelists Discussions</u>

Use of Synchrophasor Technology in Control Rooms: Opportunities and Challenges

Moderator: Sarma NDR Nuthalapati
        Co-Chair, NASPI Control Room Solutions Task Team

Description: There are significant efforts taking place in using Synchrophasor Technology in control room operations. This panel will discuss some of the opportunities and challenges in taking technology to the control room.

Panelists:
- **Dr. Aftab Alam**, CAISO
- **Dr. Hongming Zhang**, Joint Synchronized Information Subcommitte (JSIS), WECC
- **Jim Kleitsch**, American Transmission Co (ATC)

15th April 2020

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          Co-Chair, NA

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- **Dr. Hongming Z**
- **Jim Kleitsch**, An

Logistics:
- All participants are muted, camera off
- If you have a question, please type it in the chat window.
- We shall have them answered after the presentation by the panelist
- We shall have Q&A after each presentation and at the end of all presentations as well.
- We shall do our best to answer your questions.

15th April 2020

Control Room Solutions Task Team (CRSTT)

- CRSTT's mission, goals, and objectives can be found on the NASPI CRSTT webpage: https://www.naspi.org/crstt

- Ongoing work items on the CRSTT web page:
  - CRSTT Work Plan
  - Use case documents, Technical reports
  - PMU versus SCADA events summary videos

- Use of Time Synchronized Measurements Training
  - Total Reliability Solutions and PNNL collaborated to develop a Use of Time-Synchronized Measurements in the Real-Time Operations Horizon

- Meets on a monthly basis through conference calls

- Contacts
  - Michael Cassiadoro (mcassiadoro@totalreliabilitysolutions.com)
  - Jim Kleitsch (jkleitsch@atcllc.com)
  - Sarma NDR Nuthalapati (ndrsarma@ieee.org)

NASPI

Contr...

- CRSTT's missi... webpage: https...
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  - PMU versus S...
- Use of Time Sy...
  - Total Reliability... Measurements...
- Meets on a mo...
- Contacts
  - Michael Cassiad...
  - Jim Kleitsch (jkl...
  - Sarma NDR Nut...

NASPI — MENU

Control Room Solutions Task Team

Contacts

Michael Cassiadoro	Jim Kleitsch	Sarma Nuthalapati	Teresa Carlon
Co-Lead	Co-Lead	Co-Lead	Support
(360) 836-9008	(608) 877-8102	(512) 801-3191	(509) 375-3628

Our mission

The NASPI Control Room Solution Task Team's mission is to work collectively with other NASPI task teams to advance the use of real-time synchrophasor applications for the purpose of improving control room operations and grid reliability. The CRSTT will use its experience and regional diversity to provide advice, direction, support and guidance to NASPI stakeholders and other organizations involved in the development and implementation of real-time synchrophasor applications.

CRSTT Work Plan, January 2018 (PDF).
Use case document; Mis-operations with PMU Data Summary Table (PDF).

Additional videos:
NASPI Oscillation Detection and Voltage Stability Workshop, Houston, TX, October 22, 2014;
NASPI's YouTube Channel.
List of PMU versus SCADA Video Events Summary Videos (Updated April 2018, rev6).

Videos

Title	Description	Date
Video 15	Odd voltage oscillations and periodic dips on ATC's southern Wisconsin system captured in synchrophasor data but not visible in SCADA (magenta trend on plot).	Jan 18 2018

Meetings

Cancelled: CRSTT & DisTT Conference Call
Mar 24 2020

CRSTT & DisTT Conference Call
Feb 25 2020

Meeting Archive

CRSTT & DisTT Conference Call
Jan 28 2020

CRSTT & DisTT Conference Call
Dec 10 2019

CRSTT & DisTT Conference Call
Aug 27 2019

CRSTT & DisTT Conference Call
Jul 23 2019

CRSTT & DisTT Conference Call
May 28 2019

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15th April 2020

Bio of Dr. Aftab Alam

Aftab Alam is the Manager of Operations Planning North at California ISO where he provides engineering support for outage coordination and planning, real-time grid operations and market operations for the California ISO and Reliability Coordinator functions for RC West entities. He is also involved in the development of operating procedures and implementation of various tools required to provide situational awareness tooperators. Prior to joining the Operations Engineering and Services at CAISO in Feb 2011, he was as an Engineer in Transmission Planning at ISO New England since June 2007.

Aftab Alam received the Bachelor of Technology degree in Electrical Engineering from the Indian Institute of Technology, Kharagpur, India in 2001 and the M.S and PhD degrees in Electrical Engineering with specialization in Power Systems from Clemson University in 2003 and 2007 respectively.

Bio of Dr. Hongming Zhang

Hongming Zhang is currently with NREL as Chief Energy System Modeling Engineer. He served at Peak RC (formerly WECC RC) as EMS Group Manager responsible for EMS/DTS, real-time stability analysis tools and Synchrophasor Applications.

Hongming Zhang received his PhD degree from Texas A&M University in 2001, and graduated from Shanghai Jiao Tong University for both BSEE and MSEE degrees.

Dr. Zhang is serving as WECC JSIS Chair since 2017.

Bio of Jim Kleitsch

Jim has about 32 years of experience in the electric utility industry. Most of those are in the control center environment. Most of his regular work is in the areas of network applications support for ATC's Energy Management System, which involves modeling, troubleshooting issues, system enhancements, etc..

He is the Lead support person for ATC's synchrophasor systems including troubleshooting when issues arise, identifying need for new installations, configuring data transfer to their PI historian, and related display development. He is responsible for championing synchrophasor technology in System Operations as well as company wide at ATC. He is also the co-chair of the NASPI's CRSTT and is a part of NASPI's leadership team.

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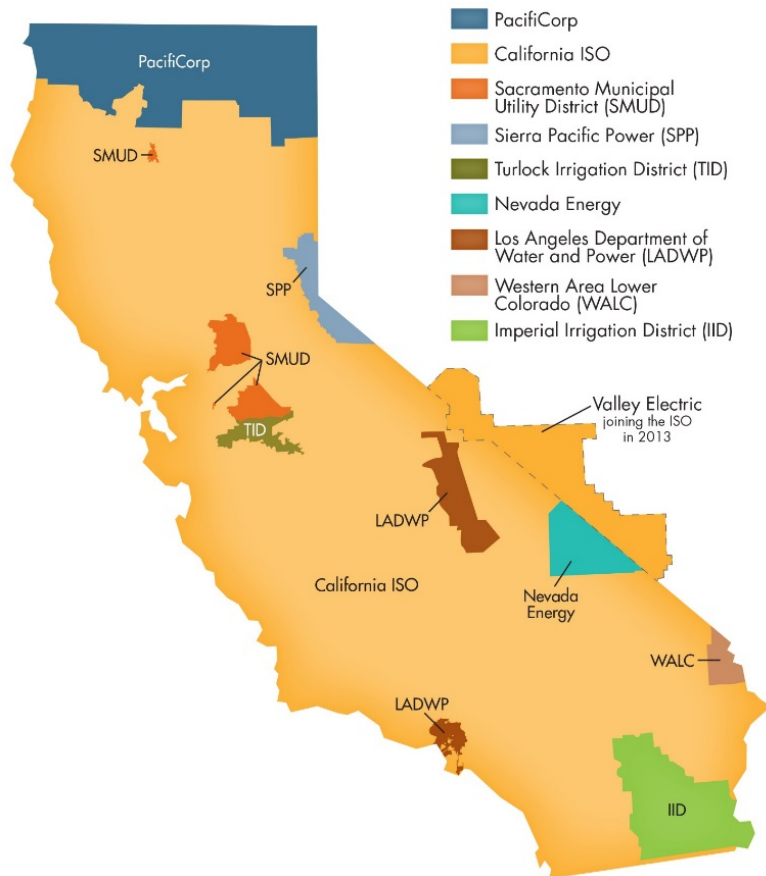- **Jim Kleitsch**, American Transmission Co (ATC)

15th April 2020

Panel: Use of Synchrophasor Technology in Control Centers: Opportunities and Challenges:

Aftab Alam, CAISO

NASPI Meeting, 16 April 2020

California Independent System Operator

PacifiCorp
California ISO
Sacramento Municipal Utility District (SMUD)
Sierra Pacific Power (SPP)
Turlock Irrigation District (TID)
Nevada Energy
Los Angeles Department of Water and Power (LADWP)
Western Area Lower Colorado (WALC)
Imperial Irrigation District (IID)

- One of the 9 ISOs
- Largest of the 38 BAs in the Western Interconnection
- Handles 35% of the electric load in the West
- Manages load for about 80 percent of California and a small part of Nevada (over 26000 circuit miles)

Installed renewable resources *(as of 3/01/2020)*

54.1% solar
29.4% wind
7.4% geothermal
5.3% small hydro
3.6% biofuels

Breakdown
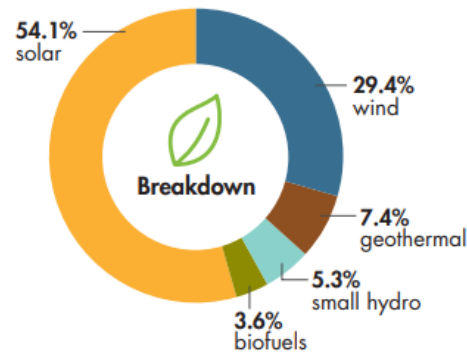
|	**Megawatts**
Solar	12,875
Wind	6,991
Geothermal	1,773
Small hydro	1,256
Biofuels	862
TOTAL	**23,757**

See Today's Outlook

California ISO

Reliability Coordinator Services

- The ISO's Reliability Coordinator, named RC West, launched operations on July 1, 2019

- Official Reliability Coordinator of record for 42 electricity BAs and TOPs in the Western Interconnection.

BA boundaries are approximate and for illustrative purposes only.

California ISO
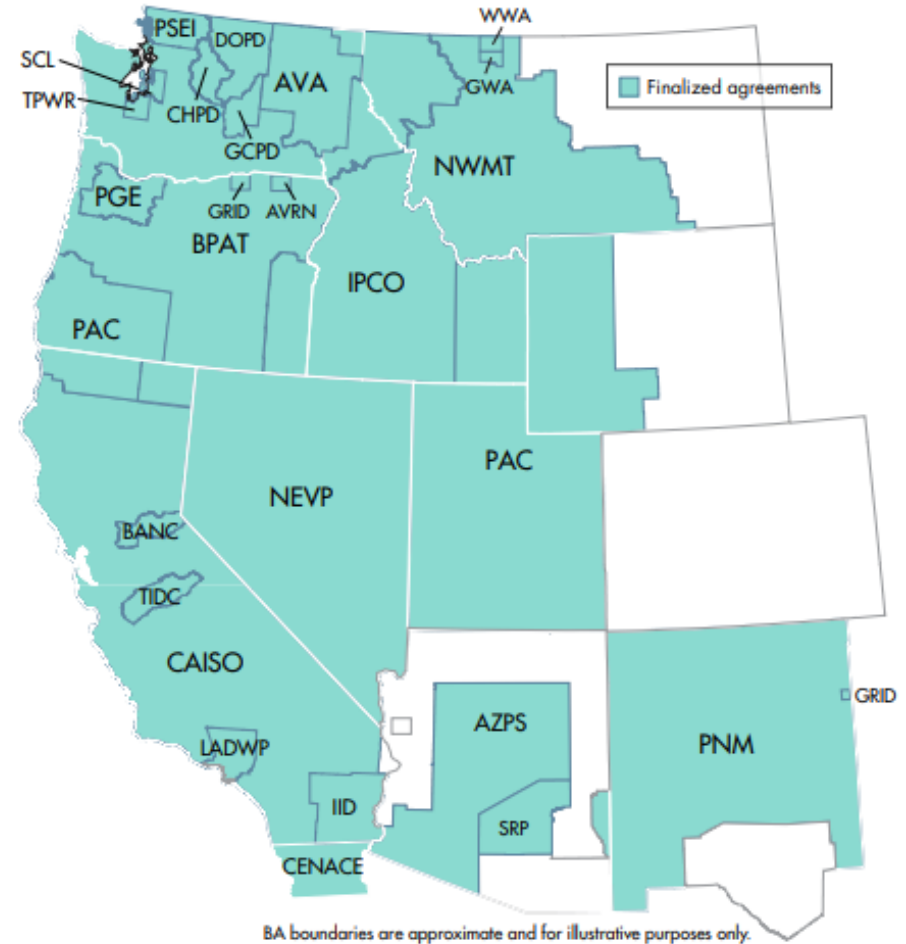
WISP Network Transition and PMU Integration

- Most entities in the RC West footprint are up and running on the new WISP network.

- A few entities have completed circuits and are ready to cut over.

- Incoming PMU data being utilized in RTDMS for monitoring of inter-area modes and detection of forced oscillations.

ISO Public
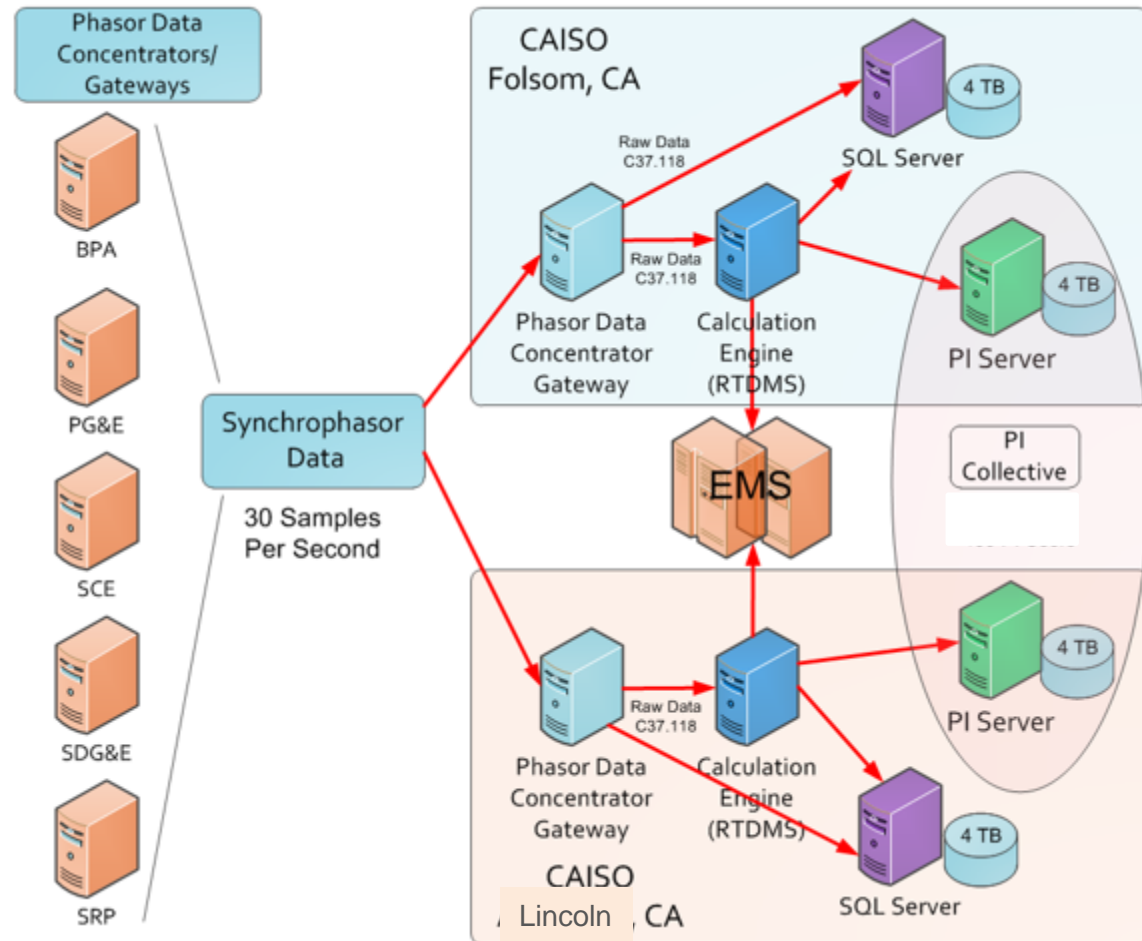
RC West Monitoring of Oscillations

- Operating Procedure developed to supplement monitoring of oscillations for three primary scenarios:
  - Inter-area (electromechanical modes)
  - Forced (Local)
  - Forced causing Inter-area oscillations

- Training and reinforcement

California ISO

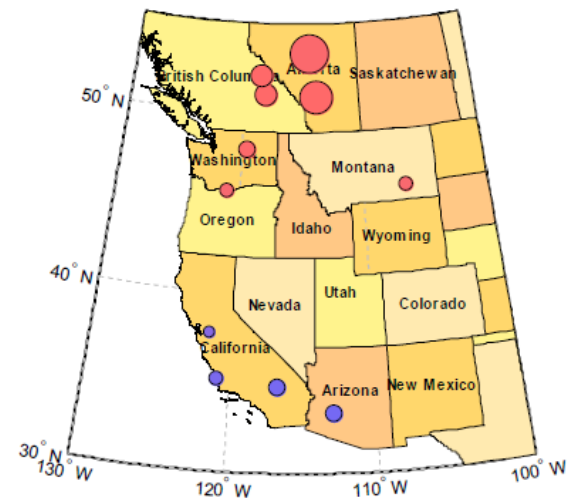# Monitoring of Inter-area modes

Need to ensure that all are utilizing the same settings for monitoring inter-area modes

- – Coordinated effort to ensure that all entities monitoring modes are utilizing the same settings and naming conventions.

- – RCs and TOPs are sharing their settings to ensure all are monitoring the same settings

- – Long term effort to determine consistent approach to determine the quantities to monitor the inter-area modes. (Which one should it be? Angle, frequency, etc. and Why?)

California ISO

Monitoring of Inter-area modes

Need to provide effective guidance to operators on utilizing tools to validate alarms for inter area concerns

- – If damping is low, do we always have inter-area concern?

- – Working on modifying displays for monitoring modes. Thought is to show separate displays for individual modes and show the relevant path flows that are effective in mitigating those modes.

- – Also potentially looking at displaying mode shape maps. This can help with operator validation of scenario when actions may be necessary.

Monitoring of Inter-area modes

<u>Need to determine potential mitigation for damping of inter-area modes</u>
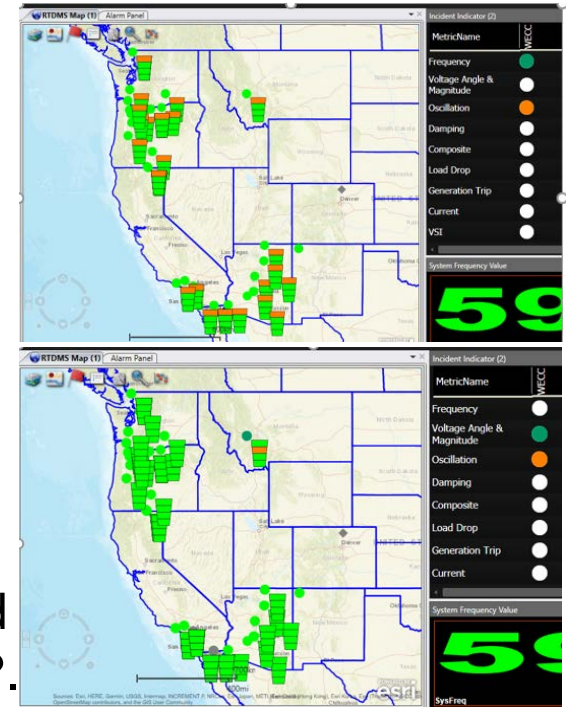
- How can we determine effective mitigation actions?
  What kind of studies and analysis needed.

- How can we validate/determine in real-time, mitigation actions for unstudied scenarios

- Do we have tools to evaluate impact of contingencies on damping?.

State Estimation → Small –Signal Stability Analysis ← Dynamic Mode data
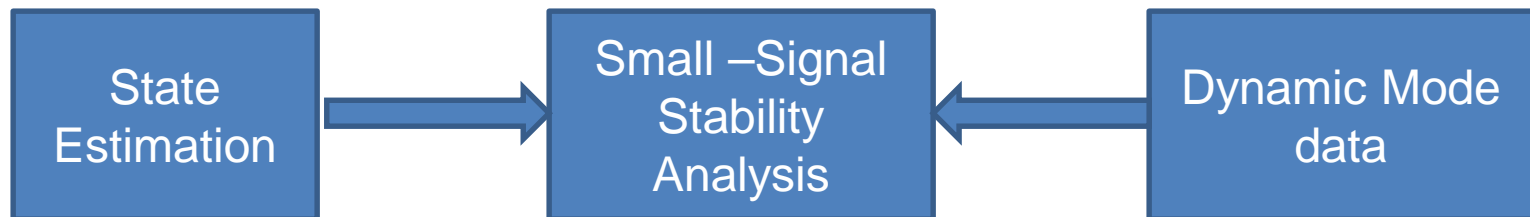
Monitoring of Forced Oscillations

Need to develop consistent approaches to monitoring

- How can we determine how should we monitor forced oscillations. Oscillations appear to be always present.

- How can we validate/determine in real-time, mitigation actions for unstudied scenarios

- Do we have tools and knowledge to evaluate and validate impact of forced oscillations in real-time?.


```
State Estimation  →  Transient Stability Analysis  ←  Dynamic Mode data
```

California ISO

ISO Public

NERC SMS Efforts – Oscillation Analysis for Monitoring and Mitigation

- Ongoing work to create **a new guideline document/report** that provides a **framework** for **methods** to
  - Conduct natural mode related and forced oscillation Analysis to determine common approach to identify issues of concern
  - Determine quantities to be monitored, quantify their boundaries and how to implement these boundaries as monitoring thresholds in tools.
  - Determine and validate mitigation actions. Establish distinction between local and system issues.

Opportunities for Industry

Consistent Approach

Validation

Impact Analysis

Smart

Predictive

Questions

aalam@caiso.com

WECC JSIS Update for NASPI Meeting
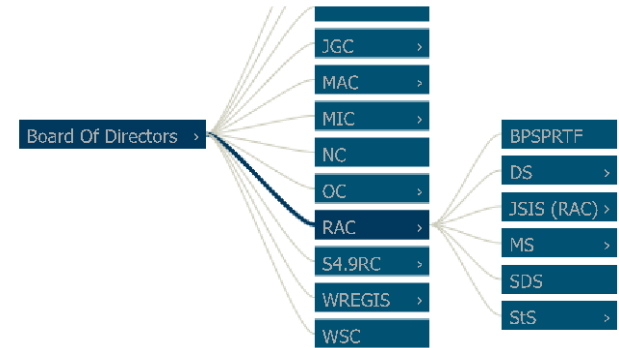
4/15/2020

Hongming Zhang

JSIS Chair

Joint Synchronized Information Subcommittee

- JSIS was was established in 2011 by the Planning Coordination Committee (PCC) and the Operating Committee (OC). JSIS now reports to the OC and the Reliability Assessment Committee (RAC). JSIS and WGs hold both closed door and open session meetings

Oscillation Analysis Work Group (OAWG)

Recent Presentations

- Analysis of the August 2019 WECC System Tests, Jim Follum, PNNL
- Synchrowave Software Update, Arif Khan, SEL
- Iterative Matrix Pencil Method for Electric Grid Modal and Oscillation Analysis and Visualization, Tom Overbye, Texas A&M
- Oscillations Detection Monitor Events And Analysis, BPA
- Sub-Synchronous Oscillations, GE

Oscillation Analysis Work Group (OAWG)

WECC Oscillation Modes Report:
- Motivation
  - Six years since last update to the report
  - Improved PMU coverage
  - Changing generation mix may be impacting modes
- Study components
  - Analysis of measured PMU data
  - Analysis of transient simulation models
  - Study of the impact of possible future system configurations and generation mixes

Oscillatory event reviews:
- Alex Ning provided overviews of oscillatory events prior to the Peak winddown
- Dan Goodrich and Gage Marek presented on recent oscillation events during the groups two monthly closed door meetings in 2020
- OAWG coordinated with BPA to resume event reviews during monthly open meetings

OAWG Topics Planned for May 6 JSIS Meeting

- Update on Oscillation Monitoring at SPP, Ryan Lott

- Update on Oscillation Monitoring at CAISO, Aftab Alam

- Progress on the WECC Modes Report, Dan Trudnowski, Montana Tech

- Oscillation Damping Using Wide-Area Measurements and Modulation of Loads, Dave Schoenwald, Sandia National Laboratories

Data Delivery Management Work Group (DDMWG)

- DDMWG secure site is now available through WECC.org

- DDMWG is in the process of migrating the PMU and signal registry from Peak to WECC. Right a spreadsheet has been setup to assign and track PMU IDs.

- PMU data quality reporting is being performed at BPA until RCs take it over. In May 6 JSIS meeting, DDMWG will cover

  o PMU registry update and future requirements

  o SPP data quality reporting

  o Update on WECC data repository

  o Post-event data sharing format

Transient Stability Analysis Work Group (TSAWG)

- TSWAG is meeting every other month to discuss updates that have been made with the Transient Stability Analysis Tool <u>Topics include</u>:
    - Developing best practices in using and implementing a TSA tool
    - Mapping the .dyd file to the network model
    - Joint ownership unit modeling for inertia tracking
- The group is pursuing better situational awareness for transient stability in the Western Interconnection
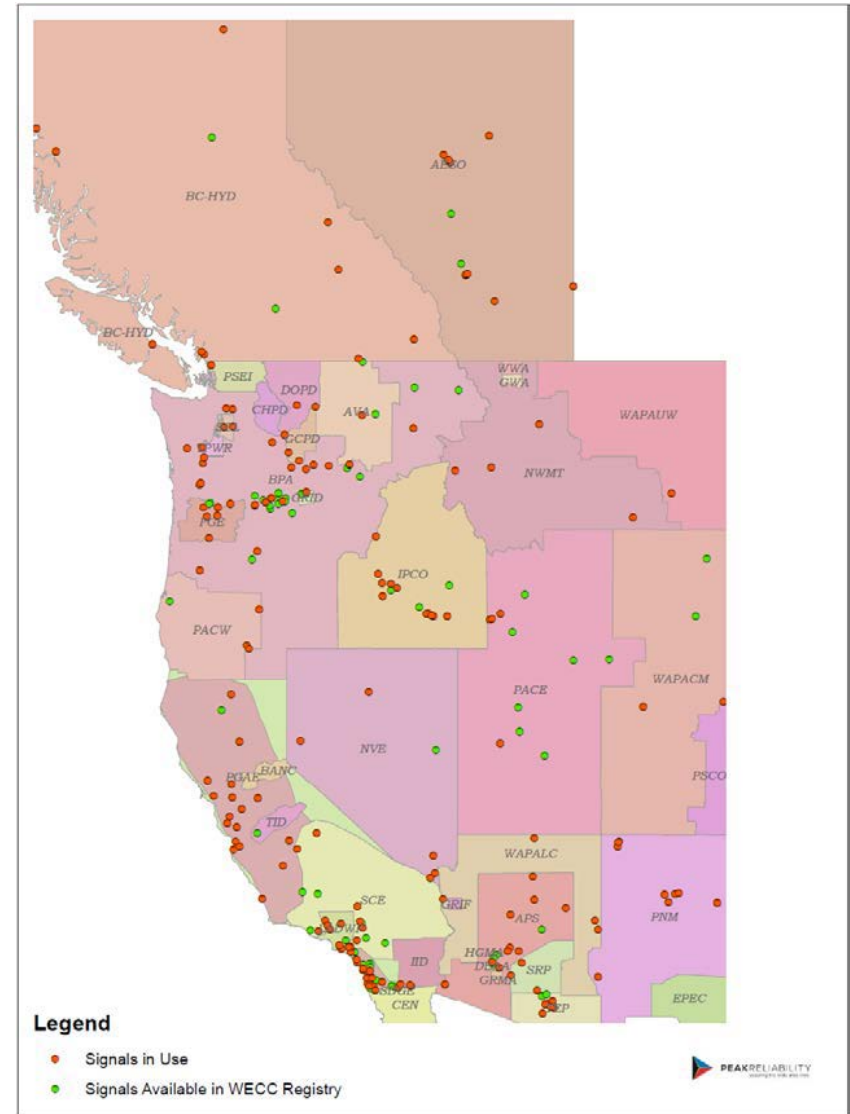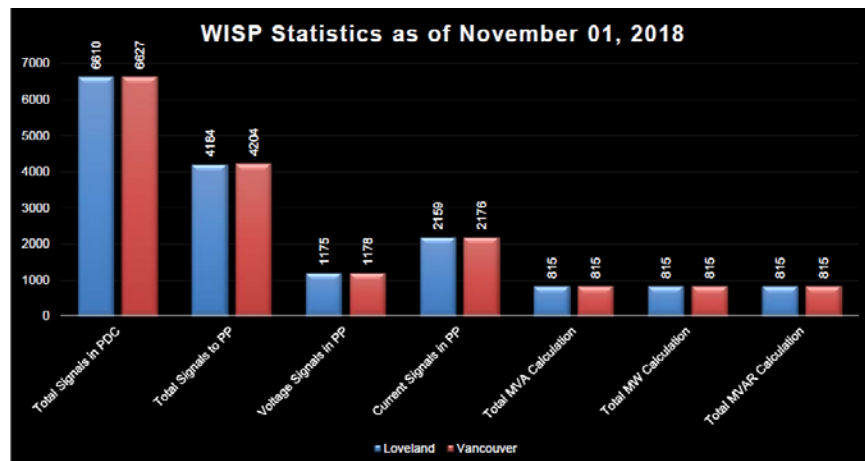
Synchrophasor Map and Statistics (07/2019)

Prior to shutdown of WISP Network in July 2019, there were

- 425 PMUs being streamed into Peak RC

- 756 PMUs reported in Registry

- Most PMU data integrated into EMS and PI platforms at Peak RC to
    - Improved Control Room Solutions with Visualizations
    - Improved PMU based Engineering Analysis

- Deployed Synchrophasor based Automated Controls at BPA

Transitioned from Peak RC to Multi-RCs

Prior to 07/2019, Peak RC implemented and ran online Oscillation Monitoring and Forced Oscillation Source Location Tools :

- o MontanaTech's MAS built in GE-PP
- o Washington State University's OMS

After Peak dissolved in 12/2019, CAISO and SPP RCs took over the duty of monitoring western system oscillations in real-time

WI RC Footprints

Legend:
- RC West Phase I
- RC West Phase 2
- SPP RC
- AESO RC
- BCH RC

Boundaries are for illustrative purposes only

Lessons Learned

- It takes years to mature a new real-time tool and develop internal SMEs capable for driving it. Start with simple use cases tied to operations

- Need to develop hybrid approaches using both measurements and model-based simulations for oscillation analysis and mitigation control.

- Run a pilot project for proof of concept in Test or Lab environment before implementing new technology in Production

- WECC JSIS/Peak SMART work groups promoted sharing of real-time PMU data, synchrophasor expertise, and joint analysis of system events among stakeholders

- Keep engaged with IEEE/PES, NASPI and SMS

WECC

Electric Reliability and Security for the West

Contact:

Hongming Zhang

Hongming.Zhang@NREL.gov

ATC Phasor Measurement Unit System Overview

NASPI CRSTT Webinar – April 15, 2020
**Presented by: Jim Kleitsch**

Helping to **keep the lights on**,
businesses running and communities strong®

atcllc.com

American Transmission Company

- Privately owned electric transmission company formed in 2001 with $550 million in assets. Now a $5 billion company.
- Facilities in Wisconsin, Michigan, Illinois, and Minnesota
- Operate 9,890 miles of electric transmission lines and 568 substations.
- Significant hydro/wind/solar generation to north and west – large load centers to south and east
- Significant shift coming in generation resources within our footprint.

ATC OFFICES AND SERVICE AREA

ATC Synchrophasor System

PMU installations as of 4/13/2020
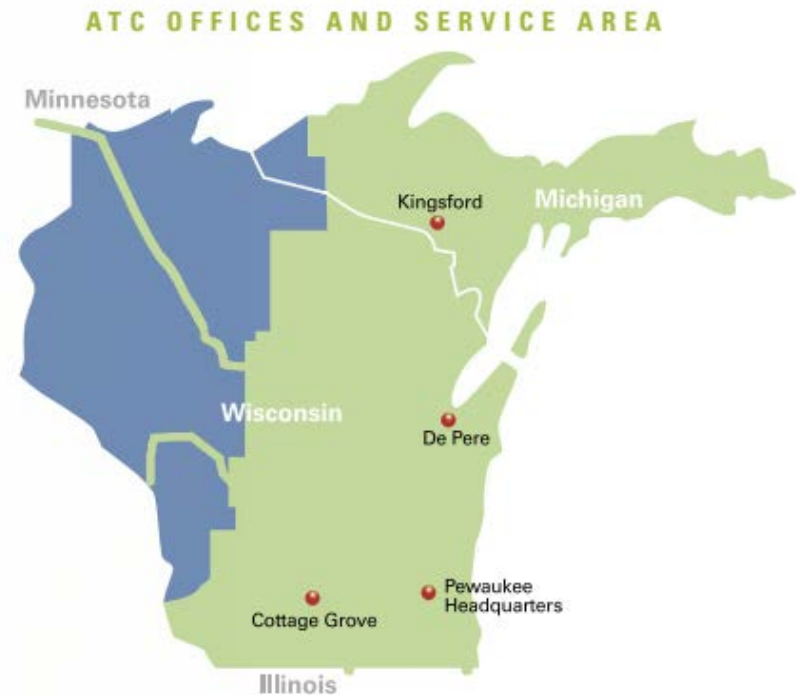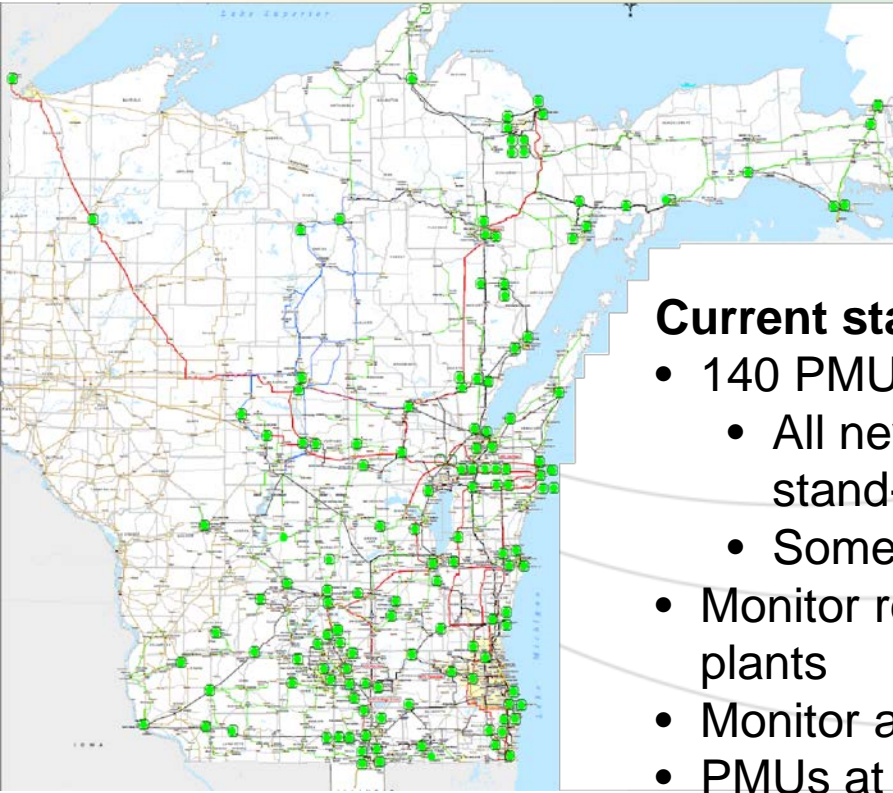
Current status
- 140 PMUs in service
  - All new PMUs and majority of existing PMUs stand-alone
  - Some older multi-function DFRs
- Monitor response of 37 generators including 7 wind plants
- Monitor all significant external tie line flows
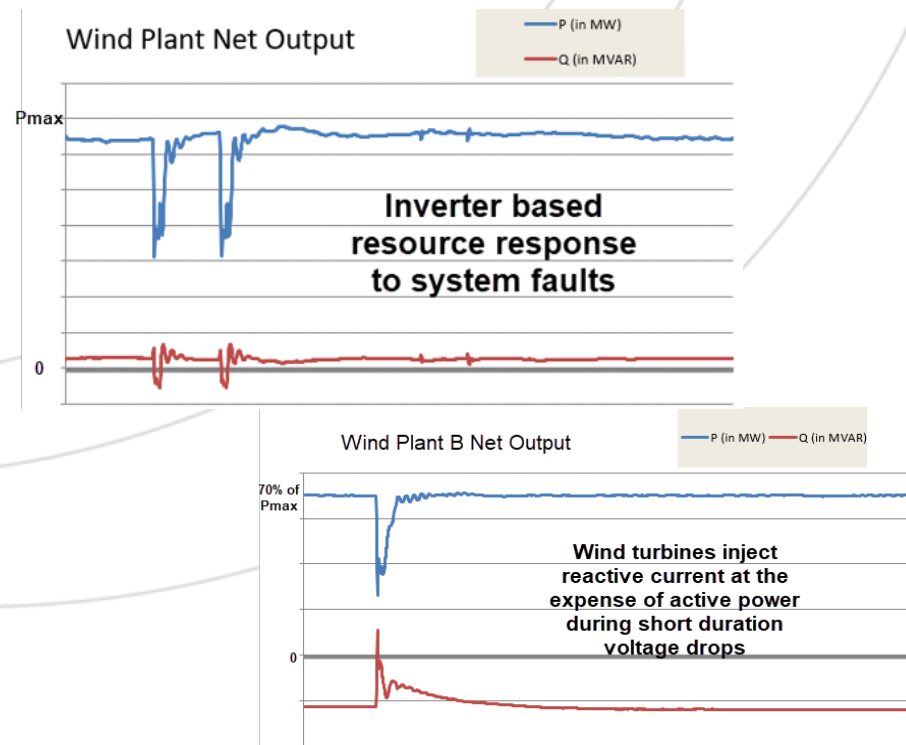- PMUs at every 345 kV station

Planned PMU Additions (10-20 per year)

• All new 345 Kv stations

• Lower voltage stations on a "per case" basis to fill holes in system coverage

• All new generator interconnections (GSU high side or interconnection tie line)

• Existing Significant Generation Not Already Monitored

• New external interconnections

• New technology (Battery Storage/ HVDC/ SVC/ ???)

• Starting to monitor loads for dynamic model support

Considering moving from stand alone PMUs to multi-function protection relays serving as PMUs which could open up many new opportunities for data collection (concerns about PMU firmware updates didn't materialize)
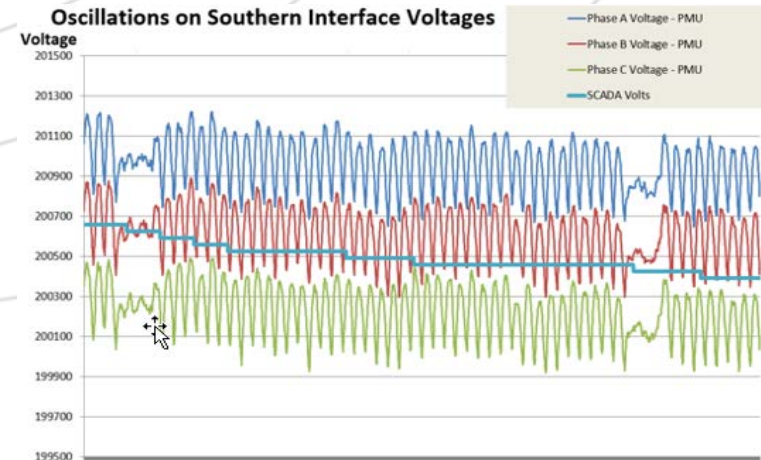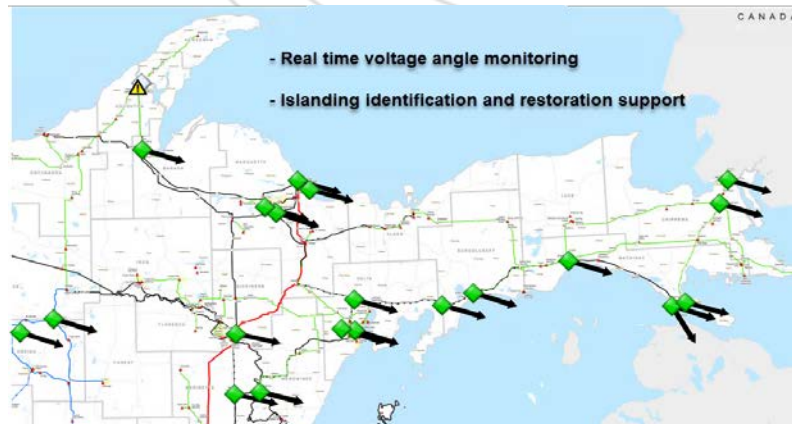
- Use the data to monitor system dynamic characteristics (see when outside events influence our system – FNET info)
- Able to monitor individual unit response to events to better understand their operation (wind plant plots)
- Able to respond to customer event inquiries with certainty (see between the SCADA 4 second scans)
- Quick verification of fault types and fault clearing times
- Considering implementing system inertia monitoring

Wind Plant Net Output

P (in MW)
Q (in MVAR)

Pmax

Inverter based resource response to system faults

0

Wind Plant B Net Output

P (in MW)   Q (in MVAR)

70% of Pmax

Wind turbines inject reactive current at the expense of active power during short duration voltage drops

0

GE PhasorPoint Implementation

- Better visibility into real time angle information
- Tools in development to monitor oscillations and alert when exceed thresholds
- Needed integration with EMS vs stand-alone application
- Struggles to maintain – lower priority when compared to real time requirements

- Real time voltage angle monitoring
- Islanding identification and restoration support

Oscillations on Southern Interface Voltages

- Phase A Voltage - PMU
- Phase B Voltage - PMU
- Phase C Voltage - PMU
- SCADA Volts

Use of Synchrophasor Technology in the Control Room: Challenges

Where we are
- After the fact event analysis
- Support of dynamic model validation
- Provide event info to customers after the fact upon request

Where we want to be someday
- Data and tools providing situational awareness of dynamic events
- Using the data to support real time decision making
- Data helping us manage dynamic resources (wind/solar/batteries/etc..)

What's stopping us?
- No clearly defined killer apps driving implementation
- Need doesn't justify use of video real estate (SCADA good enough to see most events on the system)
- CIP Concerns if used for real time decision making

Q & A

Questions?

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Q & A

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aalam@caiso.com
Hongming.Zhang@NREL.gov
jkleitsch@atcllc.com