



California ISO

Utilization of Synchrophasors for Monitoring System Disturbances at CAISO

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Senior Operations Planning Engineer

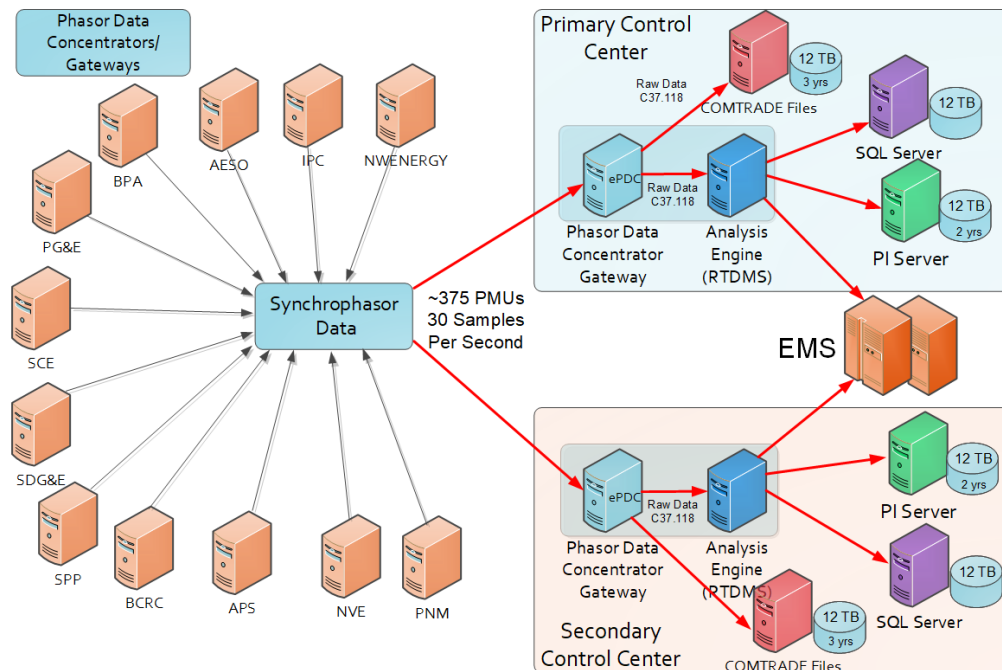
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Overview

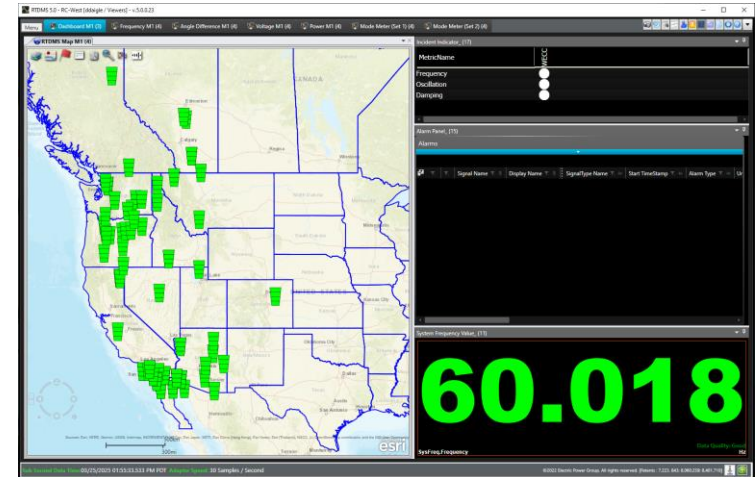
- CAISO Synchrophasor Infrastructure and Adoption
- Incorporation of automated SCADA and OMS tools into our analysis
- November 30, 2024, Oscillation Event: Interaction between conventional and hydro units in the Pacific Northwest

CAISO Synchrophasor Infrastructure



JBH - 3/1/2024

RC WEST/CAISO Operator RTDMS Display



RTDMS Applications

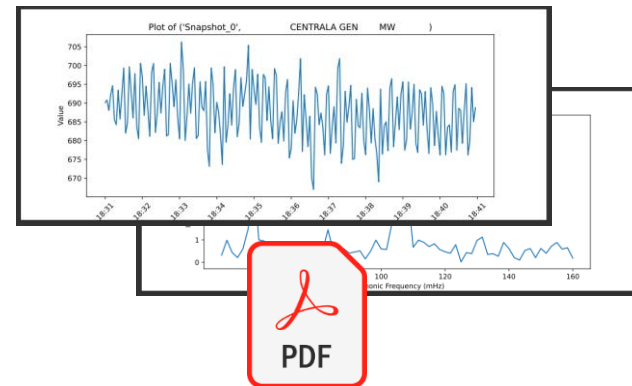
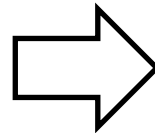
- Phase Angle Difference
- Small Signal Analysis (Mode Meter)
- Oscillation Detection and Monitoring (ODM)

SCADA and OMS Tools for Oscillation Detection

- CAISO is developing ways to incorporate non-PMU data sources:
 - **Synchrophasors/PMUs:** best fidelity, limited coverage
 - **Outage Management System:** critical for sequence of events
 - **SCADA:** Critical for filling in gaps
 - Offline SCADA oscillation detection tool developed by CAISO/Peter Qian/CAISO RMOE Team



Engineer inputs time range and geo areas to search



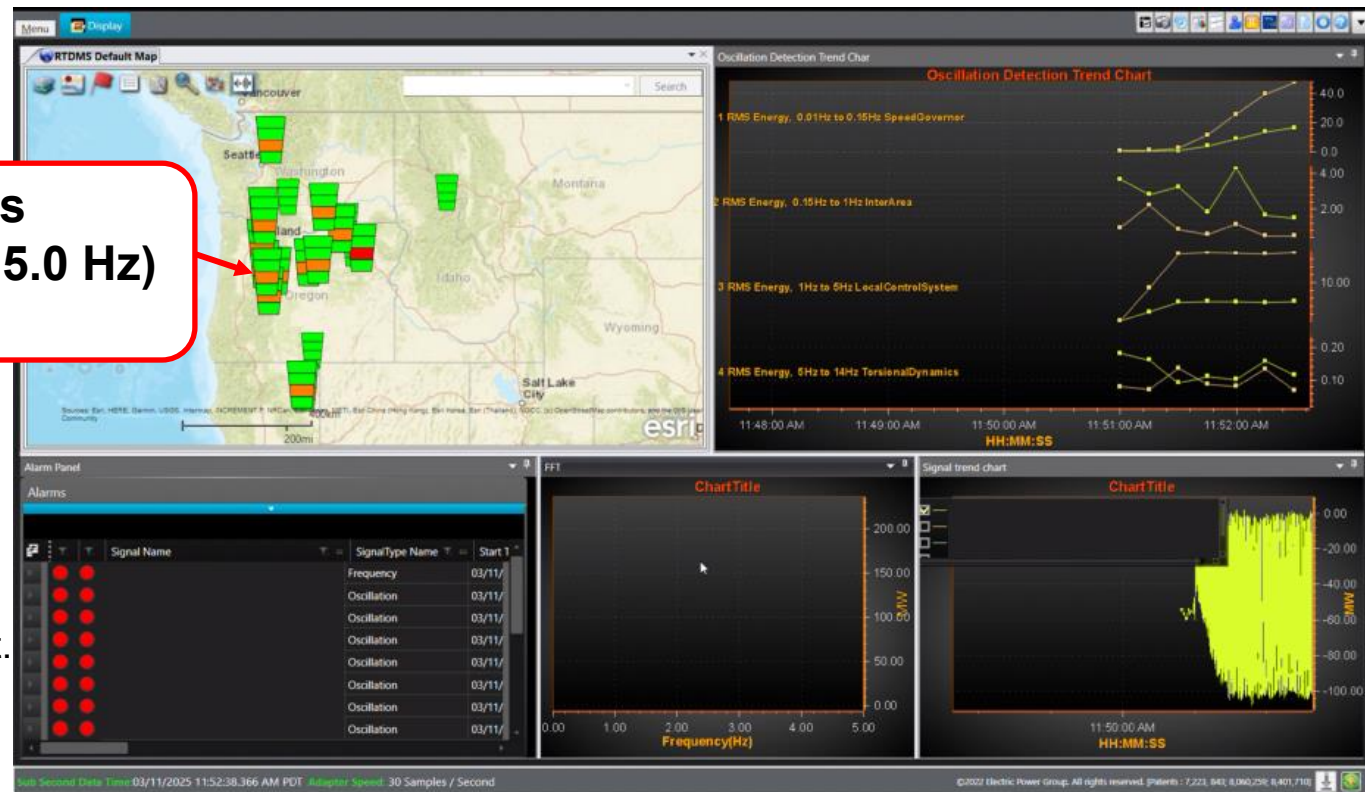
Tool outputs plots and SCADA tags with abnormal frequency content

NOVEMBER 30, 2024 HYDRO OSCILLATION EVENT

In the Control Room

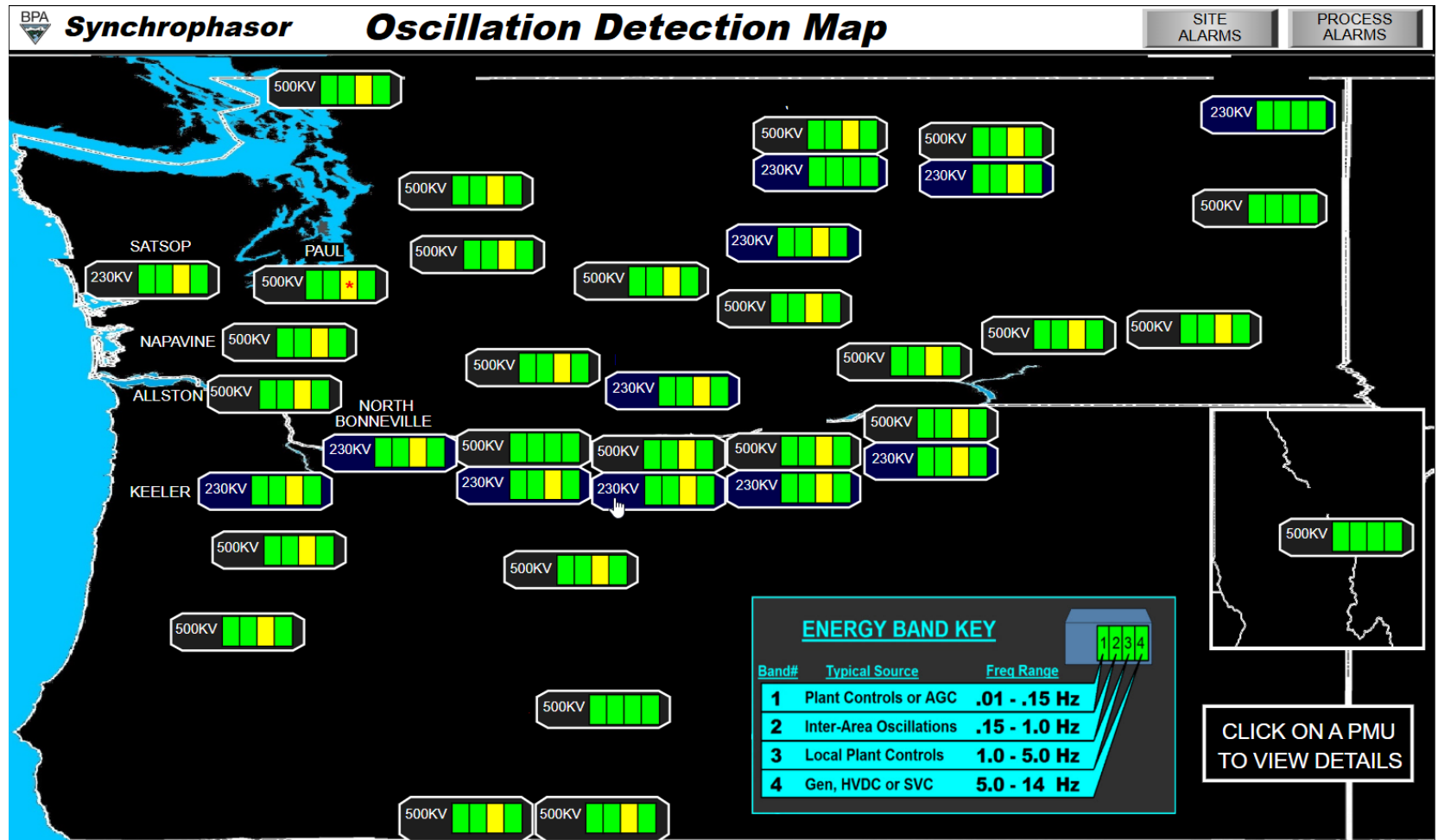
- CAISO Shift Operations Engineer observed MVAR oscillation near BPA Captain Jack roughly between 18:30-18:45
- Oscillations visible in frequency throughout wide area, California Oregon Intertie (COI) flows and adjacent transmission operator areas
- ODM Alarms from CAISO and BPA

**ODM indicates
Band 3 (1.0 – 5.0 Hz)
oscillation**



CAISO RTDMS ODM
offline playback of event.
Screenshot courtesy of
Electric Power Group

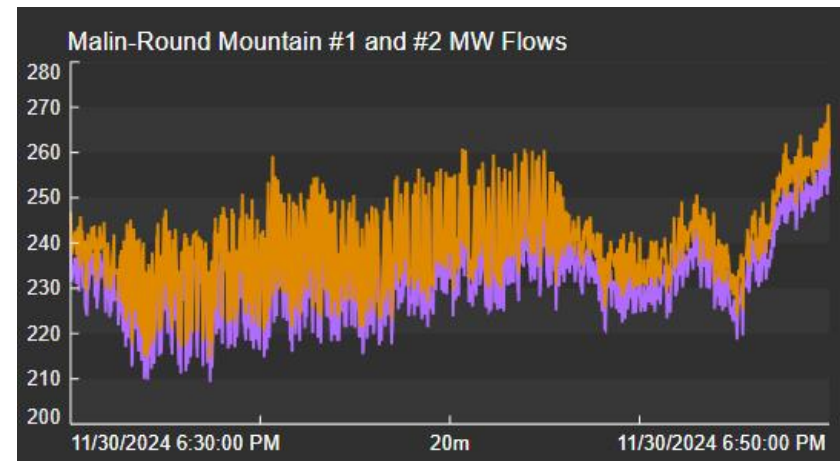
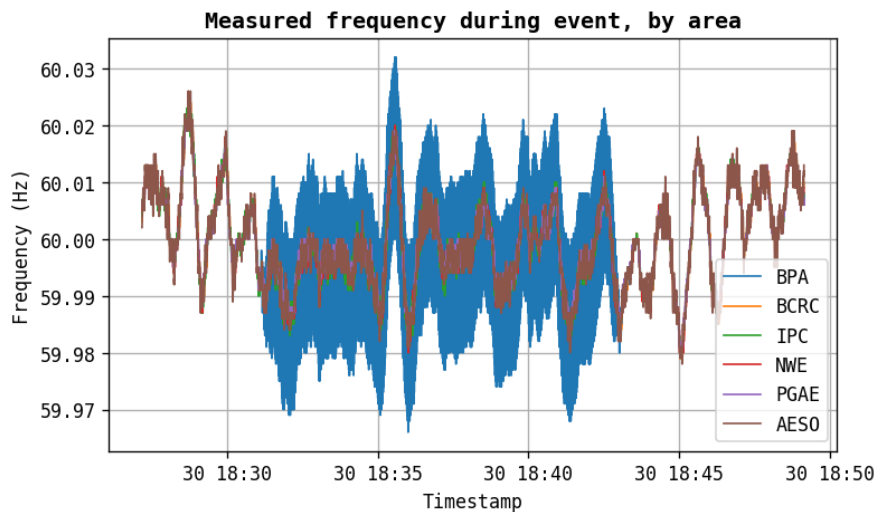
BPA ODM



Screenshot courtesy of Daniel Duran, Bonneville Power Administration

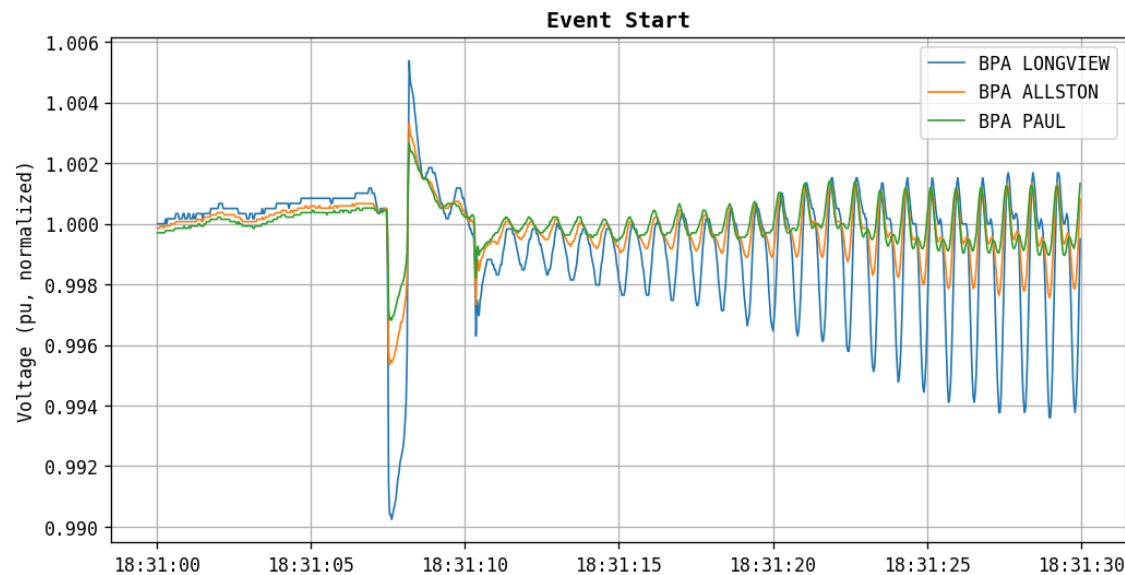
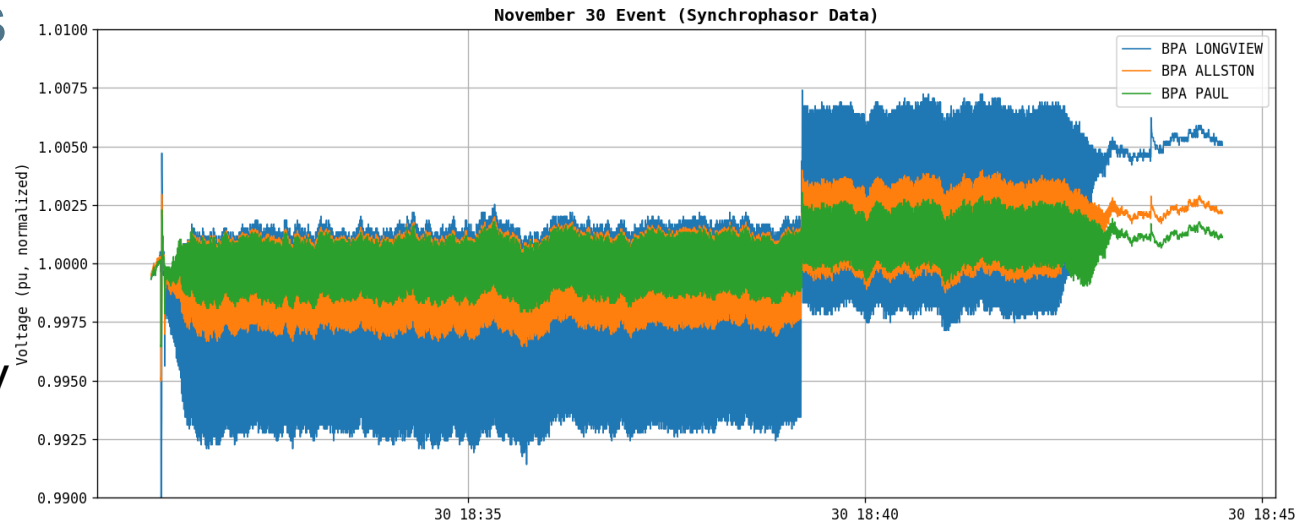
Initial Analysis

- CAISO SCADA screening tool identified oscillating units in Pacific Northwest in Portland General Electric and BPA areas
- Initial reports from TransAlta indicated that Centralia Steam may have a turbine valve issue, but further investigation yielded no issue with these units



Event Analysis

RTDMS initially highlighted high oscillation amplitudes near BPA PAUL 500 kV

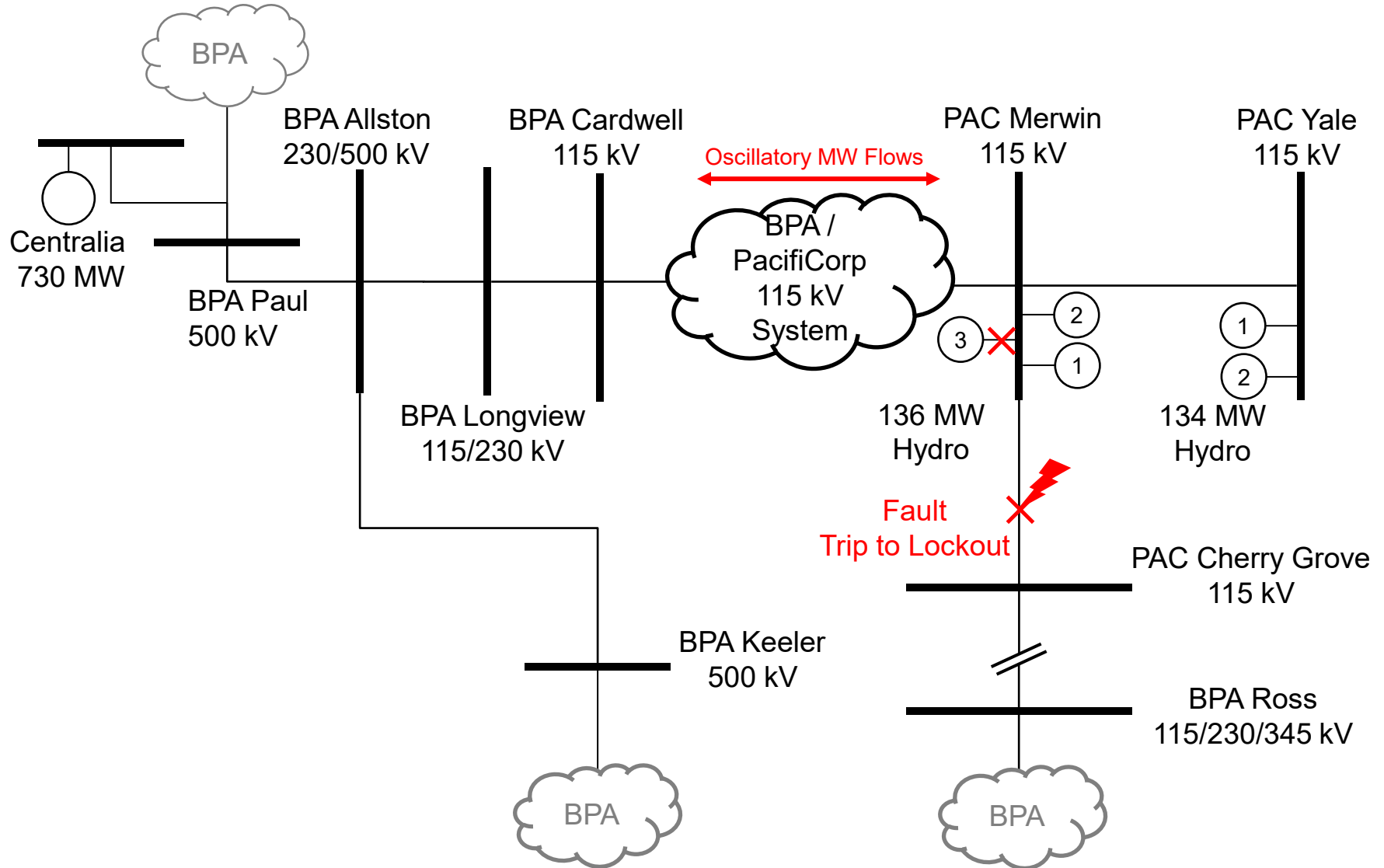


A closer look indicated a likely fault nearby preceding the oscillations

Time to look at SCADA and Outage Management System data...

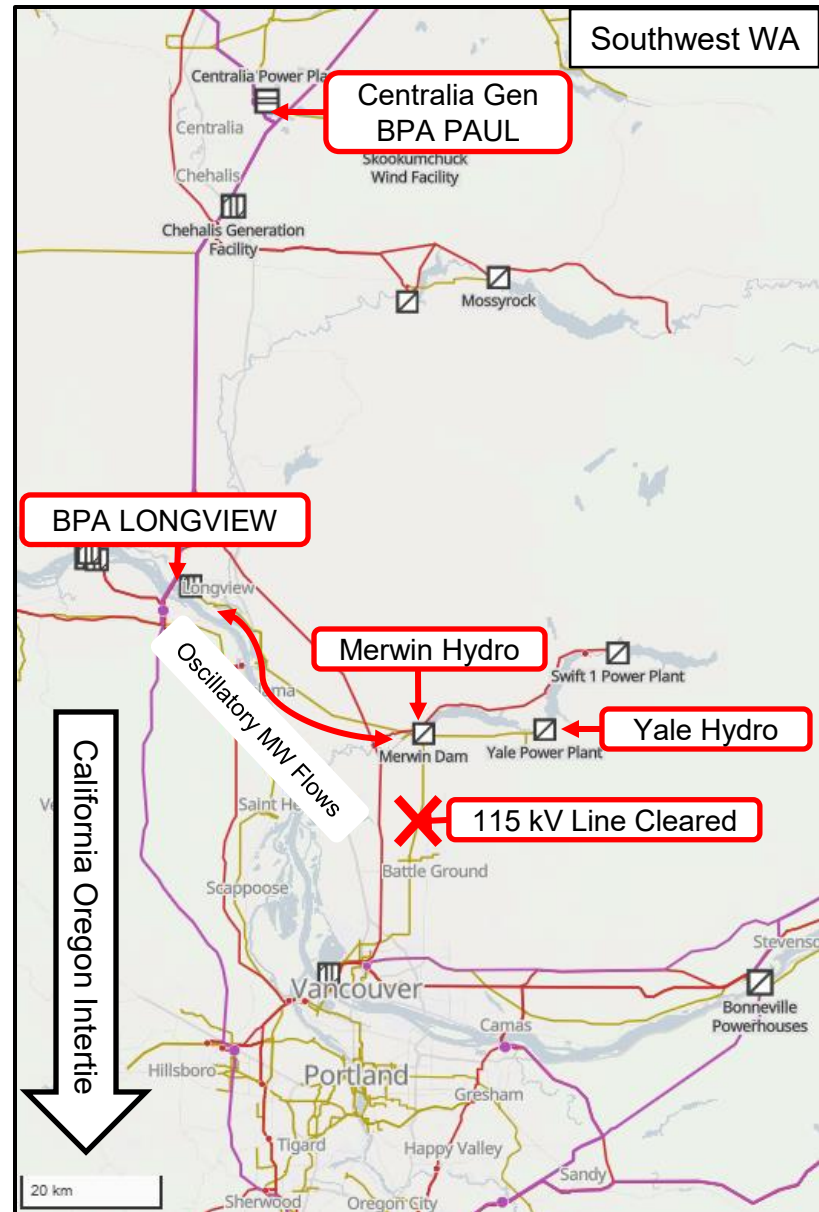
- **18:31:** PacifiCorp (PACW) Merwin-Cherry Grove 115 kV trips to lockout due to fault
- **18:31:** Disturbance trips PACW Merwin Hydro Unit #3 offline
- **18:31-18:43:** Multiple nearby units, including TRANSALTA CENTRALIA, PACW MERWIN, PACW YALE experience MW fluctuations
- **18:43:** PACW gen operator shuts down both Yale hydro units
- **18:43:** System stabilizes

Simplified System One-Line



Simplified Map*

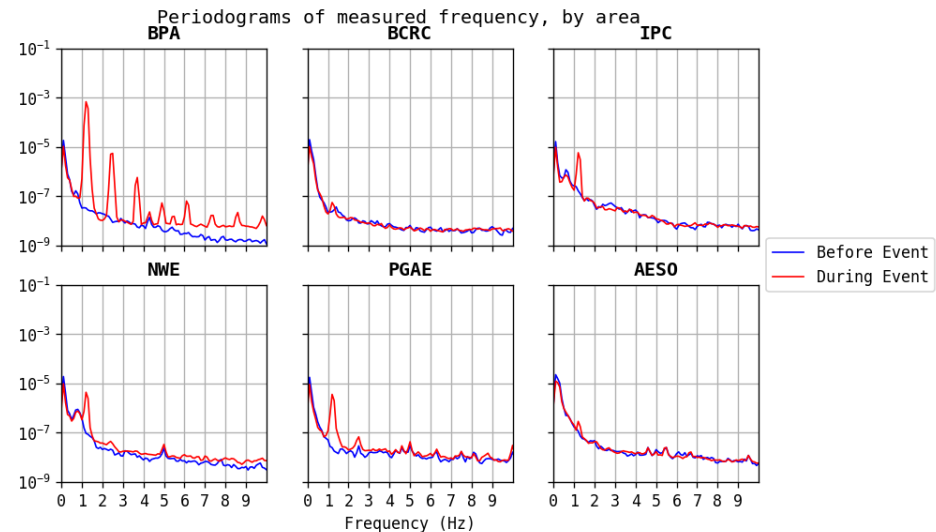
*Map is for illustrative purposes only and is based on open-source data from OpenStreetMap. Errors may be present.



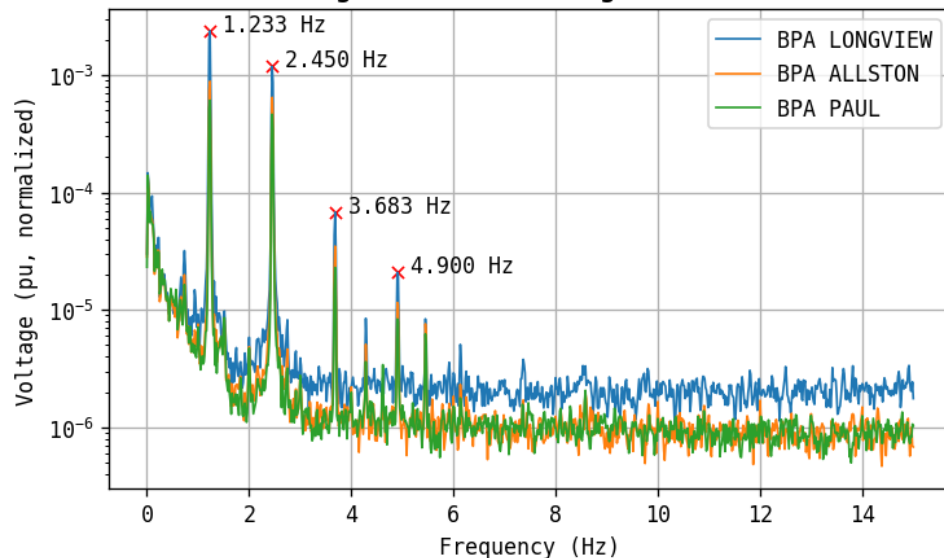
Visualization from [OpenInfraMap](#); ©[OpenStreetMap](#) contributors

Frequency Domain Analysis

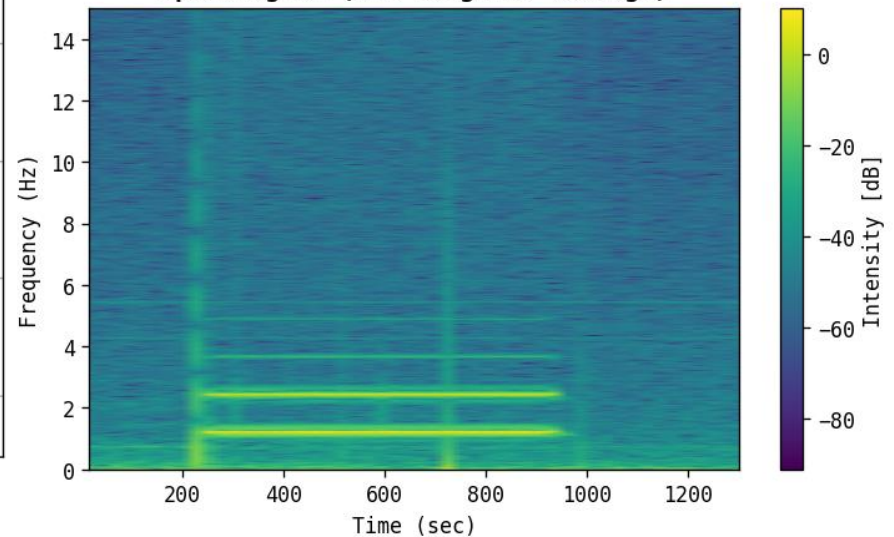
Observed 1.23 Hz fundamental frequency with 2nd, 3rd, and 4th harmonics



Periodogram of PMU Voltage Measurements

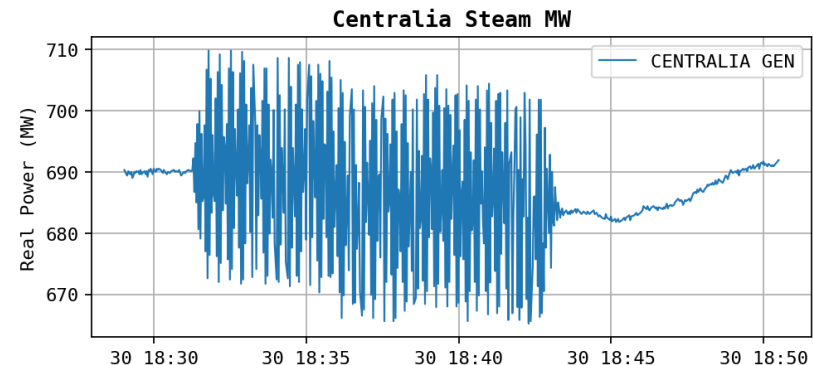
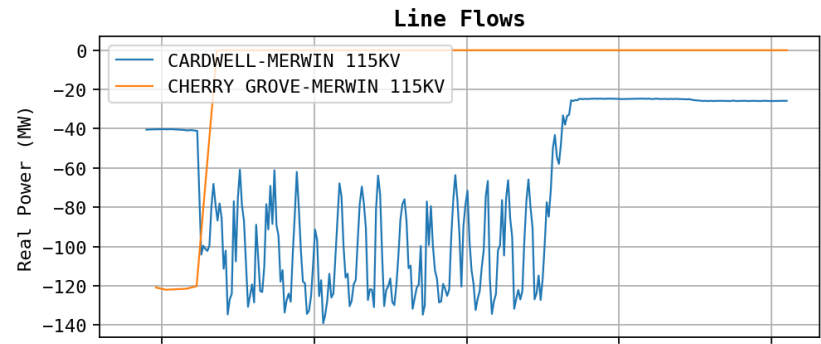
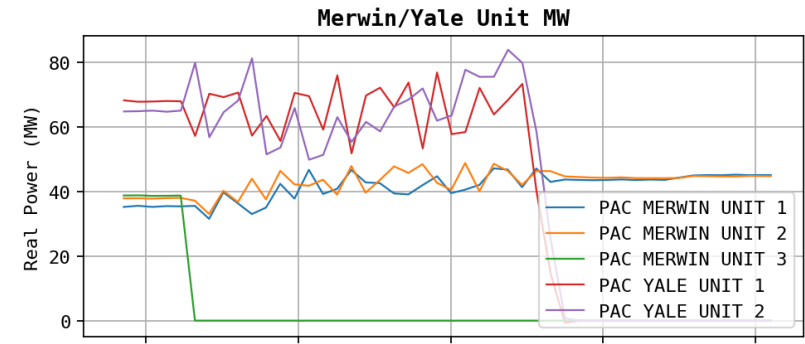


Spectrogram (BPA Longview Voltage)



SCADA Observations

- Loss of Merwin-Cherry Grove transfers ~70 MW to the Cardwell-Merwin 115 kV line which feeds into BPA Longview
- Anomalies visible in SCADA flow despite low sample rate:
 - **Centralia: 0.5 sample/sec**
 - **Merwin/Yale: 0.036 sample/sec**
- The oscillations ceased after Yale units shut off at 18:43



Event Conclusion

The Merwin-Cherry Grove line trip led to an interaction between the Merwin and Yale hydro units and nearby generation, especially Centralia Steam.

THANK YOU!

Acknowledgements

- **David Daigle** – Former CAISO Employee
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- **Peter Qian** – CAISO
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- **Daniel Duran** – Bonneville Power Administration
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- **PacifiCorp**