Wide-area Forced Oscillation Event in the Western Interconnection - 27th and 28th January 2022

Urmila Agrawal
Sr. Operations Engineer

Aftab Alam
Manager, Operations Planning North

JSIS Meeting 2022
05/19/2022

Battery Oscillation Event - Overview

- Wide-area forced oscillations event recently occurred in the Western Interconnection (WI) on 27th and 28th January, 2022
  - Caused by two battery units in the Southern California
  - Frequency of forced oscillations close to that of the WI's dominant North-South A (NS A) mode and therefore forced oscillations interacted with the NS A mode
  - Root cause identified to be the interruption of the network connectivity in the battery facility which resulted in some issue in the software control causing oscillations
  - Issue has been resolved since then

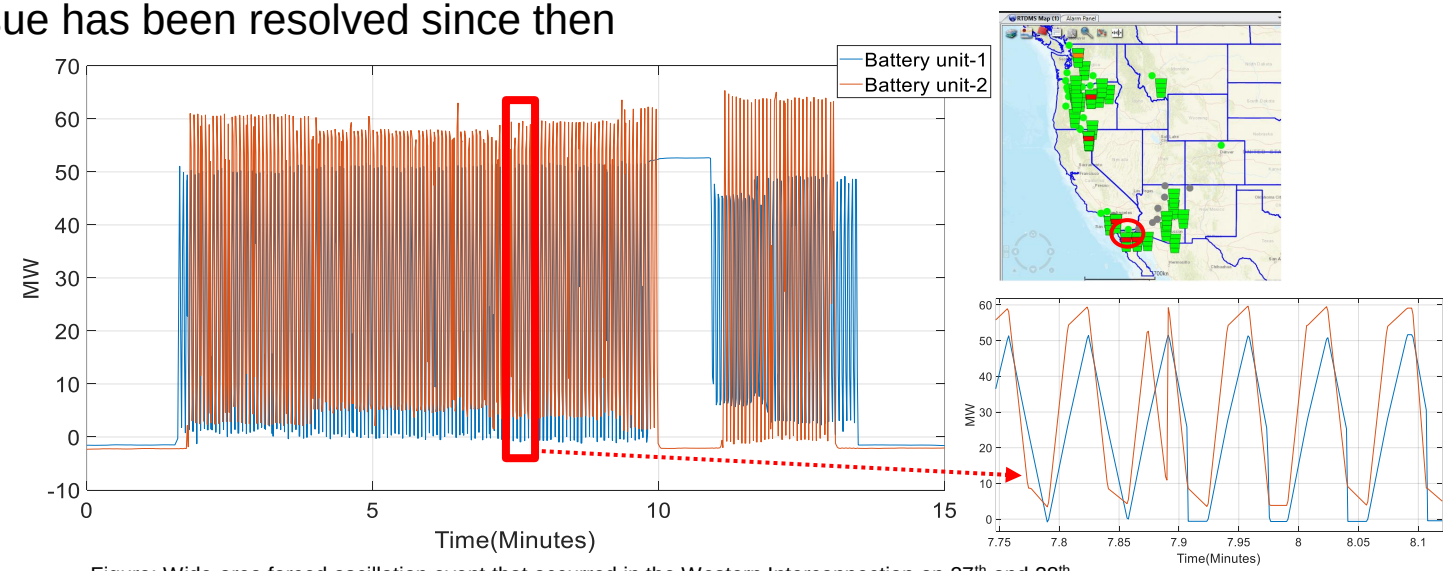

Figure: Wide-area forced oscillation event that occurred in the Western Interconnection on 27th and 28th January, 2022. Figure shows MW output from the oscillation originating units in Southern California.

Wide-area Forced Oscillations Observed on 27th and 28th January 2022– Sequence of events

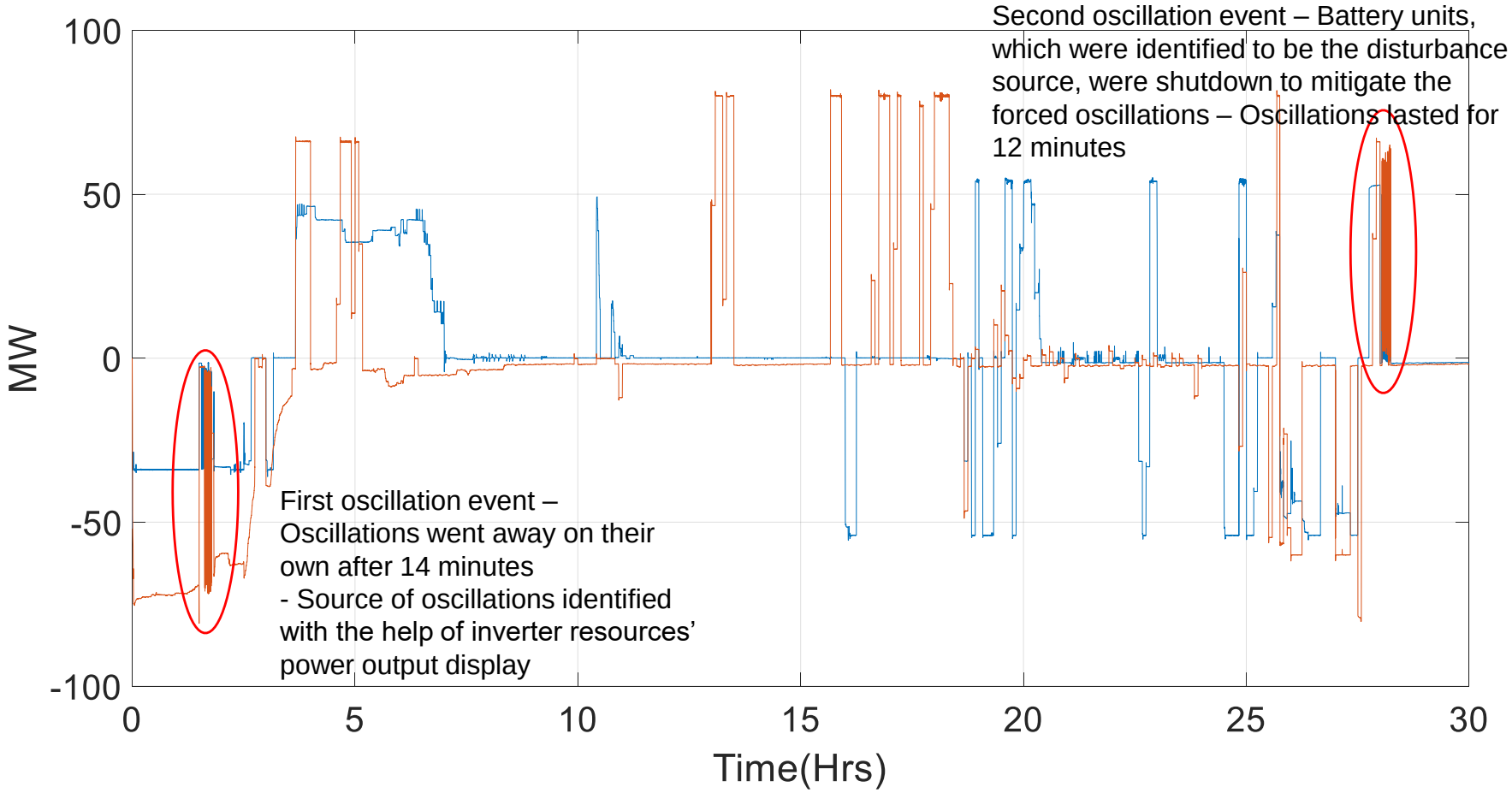

Figure: Wide-area forced oscillation event that occurred in the Western Interconnection on 27th and 28th January, 2022 that originated in the Southern California. Figure shows MW output from the oscillation originating units.

Wide-area Forced Oscillations – Analysis (1)

- Forced oscillations consisted of odd harmonic components at 0.75 Hz, 1.25 Hz, 1.75 Hz and 2.25 Hz along with the main component at 0.25 Hz
  - Frequency of the main component of the forced oscillation close to that of NS-A mode and the disturbance source in the area participating in the NS-A mode meeting two of the three resonance conditions[1]
  - Damping ratio of the mode was high (estimate ~15%) indicating this event to be a near-resonant event
  - Damping ratio estimate of the NS-A mode was biased toward 0% (Actual damping ratio remains unaffected in the presence of forced oscillations)

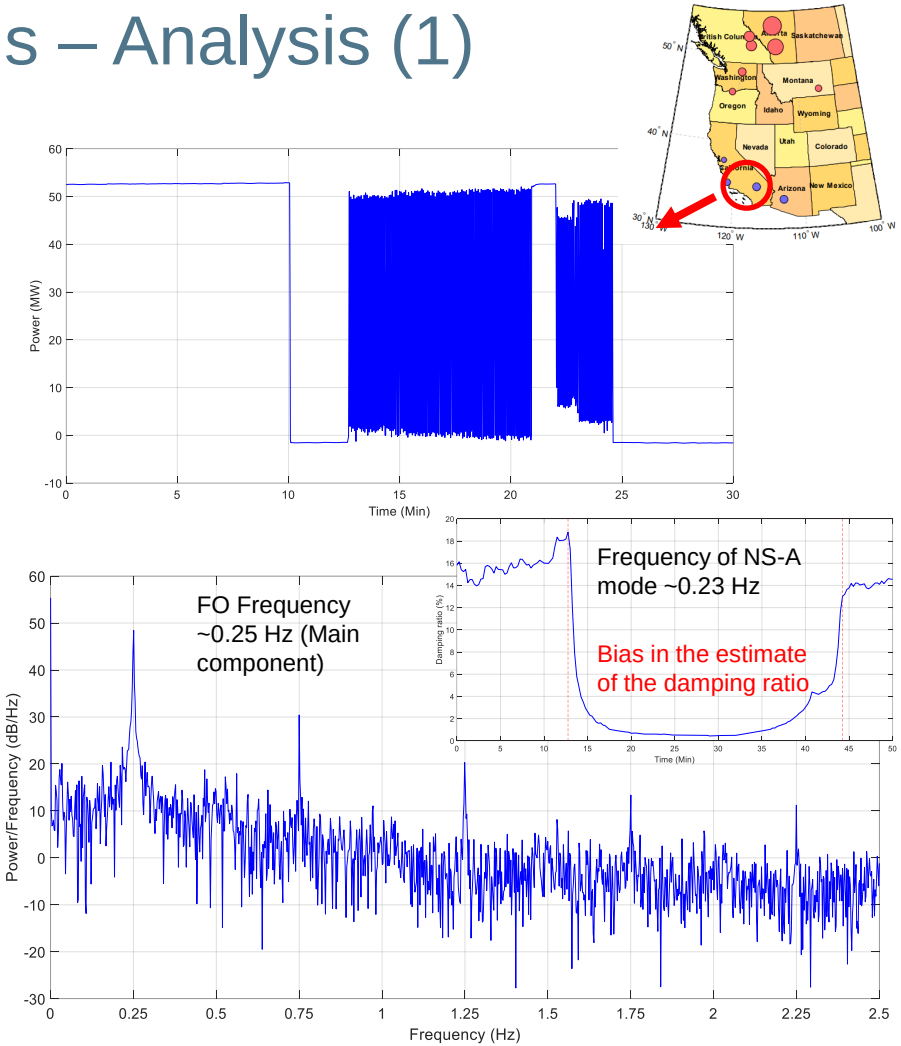

Figure: PMU measurement and the estimated periodogram spectrum for the oscillation originating unit.

[1] NERC, "Recommended Oscillation Analysis for Monitoring and Mitigation Reference Document", November 2021, Available at https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Oscillation_Analysis_for_Monitoring_And_Mitigation_TRD.pdf.
[2] [1] Mode-shape plot obtained from: WECC, "Modes of Inter-Area Power Oscillations in Western Interconnection", May 2014.

Wide- area Forced Oscillations – Analysis (2)

- Oscillations observed in several locations in the North and South of the WI and in inter-tie flows such as California – Oregon Intertie (COI).
  - 200 MW power swings observed in COI flow
  - 3rd and 5th harmonic components having frequencies 0.75 Hz and 1.25 Hz also observed in the North

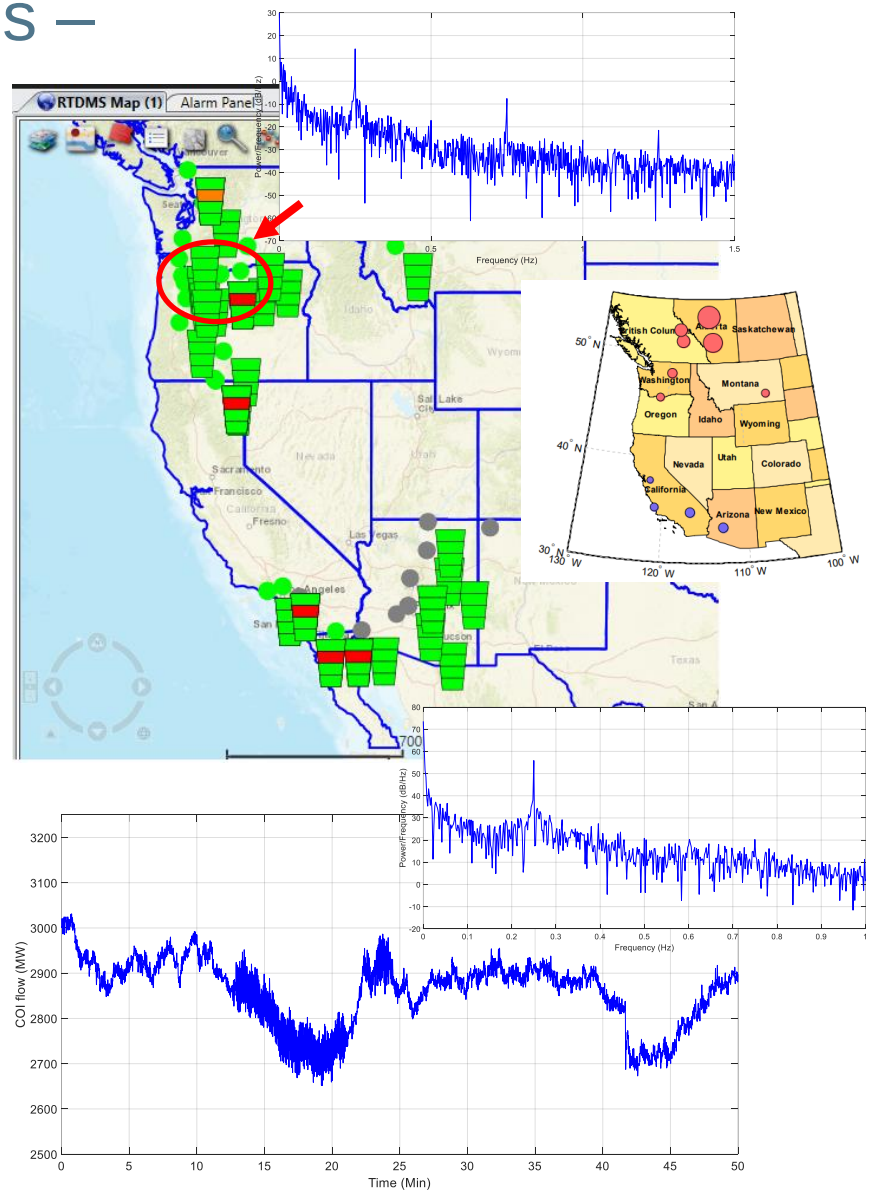

Figure: Example of wide-area forced oscillations in Western Interconnection originating in Southern California.

Discussion and Conclusion

- Wide-area forced oscillation event recently occurred in the WI
  - Two of the three resonance conditions were met for this event resulting in a near-resonance forced event
  - Oscillations observed across the WI in the North and the South
- Even though the frequency of the main component of the forced oscillation was close to the dominant NS-A mode, the damping ratio of the mode was high
  - Still, forced oscillations resulted in ~200 MW power swings in the COI flow
- Wide-area situational awareness helped with the detection of the oscillations and also identification of the source disturbance
  - CAISO monitors the output of the inverter based resources in the control center
- Proactive action by the RC operators helped with the mitigation of the oscillations.

Thank you!!!

Questions??