Study of inter-area resonance from forced oscillations in a 240-bus system

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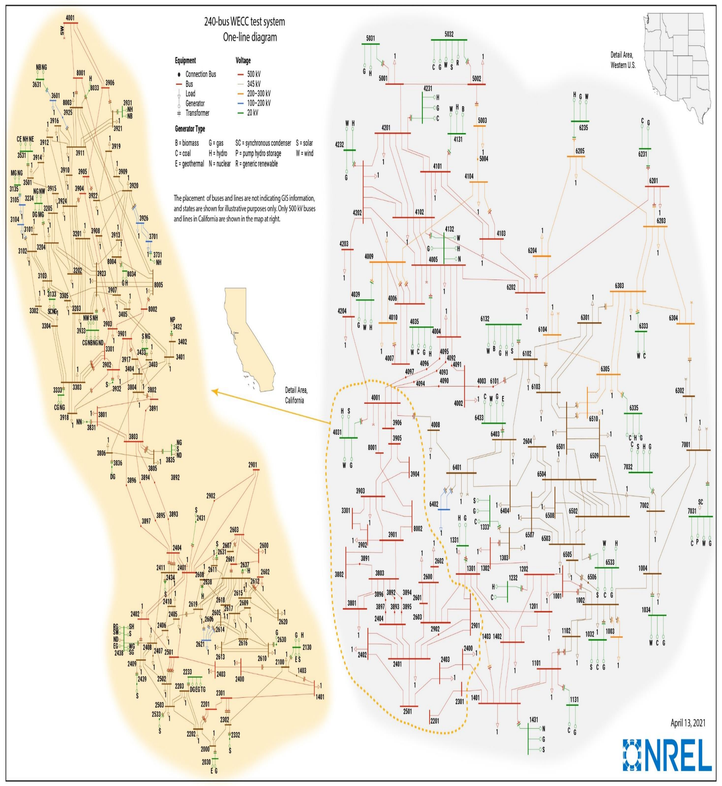
Background

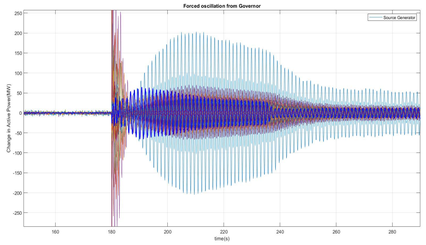
- Forced oscillations (FOs) is a periodic disturbance when there is external input into the system from control failure, abrupt load changes, line tripping etc.
- Effects of FOs is local but sometimes when frequency at which FO occurs matches with inter-area modes then it leads to resonance which might lead to wide area oscillations.
- Simulation of FOs using DSATools is done in 240 bus system during resonance and its effect in the system, its interaction with system modes, oscillation, participation of generators in that mode and effect of change of damping of the system is studied.
- 240 bus system is taken from 2021 IEEE-NASPI Oscillation Source Location (OSL) Contest.



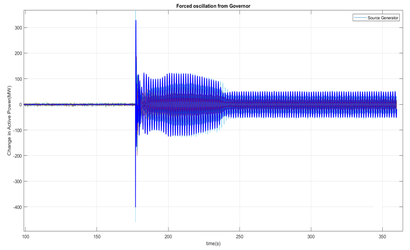
Effect of resonance with inter-area mode

Inter-area mode : 0.74 Hz

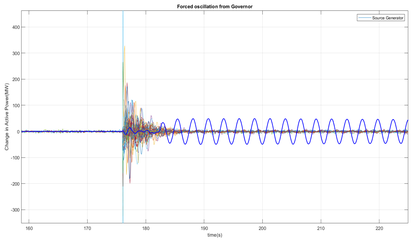
- Resonance high effect
- Poorly damped system mode
- FOs frequency close to system mode
- FOs source in highly controllable location for the system mode.
- Resonance medium effect
- If one of above is true
- Resonance low effect
- If none are true



Case- 9 : 0.762 Hz, 2% damping, Governor source, change in active power : 200 MW



Case- 8 : 0.614 Hz, 5% damping, Governor source, change in active power : 100 MW



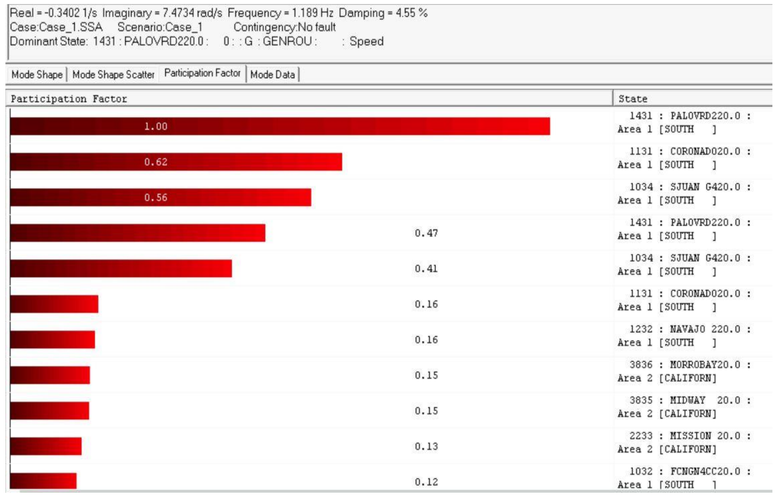
Case- 4 : 0.379 Hz, 5% damping, Governor source, change in active power : 40 MW

Cases are useful for testing source location algorithms and for getting insight into the phenomenon

Effect of damping in resonance

- Low damping mode sees high effect of resonance while high damping mode sees less effect of resonance
- Damping change by tie-line power flow change:
- Either increasing or decreasing active power in station connecting tie–line in power system will increase/decrease the damping of system
- Damping change by PSS remove/PSS parameter change:
- Removing PSS will decrease the damping of the system
- Ks value will change the damping of the system either positive or negative damping based on the value used.

Participation factors



- Participation of states in particular mode is given by participation factor
- SSAT monitors the participation factors of generators in system mode and used to find inter-area mode in the system.

Acknowledgements

[1]. Gregary C Zweigle, Md Arif Khan, Schweitzer Engineering Laboratories
[2]. Bikal Pudasaini, Habib Wajid, Washington State University

References

[1].http://web.eecs.utk.edu/~kaisun/Oscillation/contestcases.html (Accessed: 30 March 2023)
[2]. S. A. N. Sarmadi and V. Venkatasubramanian, "Inter-Area Resonance in Power Systems From Forced Oscillations," in IEEE Transactions on Power Systems, vol. 31, no. 1, pp. 378-386, Jan. 2016, doi: 10.1109/TPWRS.2015.2400133.

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