

Long-Term Power System Dynamic Simulation using Time Sequenced Power-Flows

Thad Haines

Montana Technological University - Master's Thesis Research Project

October 22nd, 2019

What is a Power System?

What is Dynamic Simulation?

What is Long-Term?

What is a Power Flow?

What are Time Sequenced Power Flows?

Putting it all together...

Project Goals:

- ▶ Develop software for (long-term dynamic) LTD simulations.
- ▶ Incorporate useful parts of GE software (PSLF):
 - ▶ Power Systems (*.sav* files)
 - ▶ Dynamic model data (*.dyd* files)
 - ▶ Power-flow solver
- ▶ Create simplified dynamic models compatible with LTD time steps.
- ▶ Investigate long-term events.
 - ▶ Turbine governor and AGC interaction
 - ▶ System response to wind ramps

This simulation assumes:

1. Time steps of 0.5 to 1 second.
2. Fast dynamics are 'mostly' ignored.
3. System remains synchronized.
4. System frequency is described by the combined PU swing equation:

$$\dot{\omega}_{sys} = \frac{1}{2H_{sys}} \left(\frac{P_{acc,sys}}{\omega_{sys}(t)} - D_{sys} \Delta \omega_{sys}(t) \right)$$

5. No system damping ($D_{sys} = 0$).

Software used:

- ▶ Python 3, IronPython
- ▶ Erlang / AMQP
- ▶ MATLAB

► Agent

An autonomous individual object with properties and methods in a computer simulation.

► Agent-Based Modeling

The idea that a system can be modeled using agents in an environment, and a description of agent-agent and agent-environment interactions. [2]

Current Conclusions

- ▶ Software (PSLTDSim) produces valid output for small to medium size systems.
- ▶ Governor and AGC interactions can happen easily
- ▶ Deadbands and conditional logic should be used to limit governor and AGC conflicts

Future Work

- ▶ Incorporation of more PSLF type objects into simulation.
- ▶ Creation of additional dynamic models and agents.
- ▶ Addition of definite time controller.
- ▶ Departure from reliance on GE software.

References

- [1] GE Energy. "Mechanics of Running PSLF Dynamics" Phoenix, AZ, 2015
- [2] Rand, W. (2018). Agent-Based Modeling: What is Agent-Based Modeling? [Online] Available: <https://www.youtube.com/watch?v=FVmQbfsOkGc>
- [3] P.M. Anderson and A.A. Fouad, Power System Control and Stability, 2nd ed. IEEE Press, 2003, p20.