Technology Innovation Project

Closing Project Brief

TIP 352: Development and Demonstration of a Phasor-Driven Tool for Adaptive Stability Model Calibration using GE PSLF

Context

Results from many mathematical models developed to simulate power plant models don't agree with actual data from phasor measurement units (PMU) and digital fault recorders (DFR). The Bonneville Power Administration (BPA) is concerned when information from these models is used to make planning and operational decisions. Similar concerns are observed across the industry.

WECC has dedicated significant efforts to model validation through its Modeling and Validation Working Group (MVWG). While these efforts greatly advanced the model validation and calibration practices, several obstacles still exist, including 1) identification of problematic parameter(s); and 2) baseline testing for generators requiring a disruption of their service.

Model validation and calibration has been identified as one of the most wanted phasor applications in several recent meetings of the North American SynchroPhasor Initiative (NASPI) working group.

Description

This project developed a prototype tool for generator model validation using the Alstom Grid E-terra Phasor Analytics platform and parameter calibration using the GE Positive Sequence Load Flow software. (GE PSLF)

The developed tool features several advantages over existing techniques:

1) Automated identification of system event information from PMU data

2) On-Demand calibration process of model parameters

3) Automated/Periodic validation of models 4) Leverages the suite of standard dynamic models library in GE PSLF to eliminate the need to develop hundreds of models from scratch

5) Optimally calibrating model parameters while considering measurement noise and model uncertainties

6) Features the flexibility to perform system-level, simultaneous model validation and calibration for multiple generators

7) Generate reports quantifying model quality and summarize calibration results.

Four major tasks were undertaken to design and develop the prototype tool:

Task 1–Development of E-terra Phasor Analytics platform for event and phasor data retrieval, and creating equivalent systems for model validation: An innovative phasor data analytics platform was developed on top of Alstom's commercial tool, which can read in historical PMU data stream, import system model and parameter files, and export the full topology model representing the operating condition before the detected event.

Task 2–Improve Kalman filter-based algorithms for stability model calibration under different test scenarios. Enhance the Kalman filter-based methodology developed at Pacific Northwest National Laboratory (PNNL) for generator model calibration once model deficiencies are identified.

Task 3–Integration of the model validation and parameter calibration tool in Phasor Analytics and GE PSLF: Integrate the main pieces developed in Task 1 and Task 2 into the E-terra Phasor Analytics platform, and focus on developing the remaining features for automatic model validation and on-demand parameter calibration.

Task 4–Demonstration and Evaluation

Benefits

This tool complements as well as eliminates power plant baseline tests saving significant costs associated with generator staged testing.

It can enhance the quality of the BPA power system models for planning and operational studies.

Better models yield more realistic study results. As a consequence, this tool can help obtain realistic transmission line limits, when using real-time cases for studies.

Accomplishments

The project developed an improved phasor platform that implements innovative methodologies and the corresponding tools for stability model validation and on-demand parameter calibration. The methodology enhances the Kalman filter method for scenarios like wind farm model calibration or remote installation of PMU devices and significantly speeds up the process of model validation.

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Project Start Date: October, 2015

Project End Date: February, 2018

Deliverables

The project provided the following deliverables:

A detailed project progress report including: a) the design of the prototype tool; b) performance of model validation module; c) functionality of application programming interfaces (APIs) developed

A presentation to demonstrate the performance of parameter calibration algorithms.

A demonstration of the parameter calibration method linking to the stability model library in GE PSLF software.

A demostration of the integrated software prototype that connects all pieces together for model validation and parameter calibration.

Final Deliverables:

1) A project report on the overall project outcomes (PNNL-SA-27164)

2) A prototype of the model validation tool

Funding

Total Project Cost:	$2,000,000
BPA Cost:	$1,000,000

For More Information Contact:

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Participating Organizations

Pacific Northwest National Laboratory (PNNL)
Alstom Grid (now GE Grid Services)
General Electric Energy Consulting
Peak Reliability Coordinator (PEAK RC)

Conclusions

Model integrity is critical to ensure secure and economic planning and operation of modern power systems, with their increasing stochastic and dynamic behavior. To better comply with industry standards for improving model performance (NERC MOD26 and MOD27), this work presents an integrated methodology and software tool suite to systematically validate stability models and identify and calibrate problematic model parameters using online PMU measurements. A power plant model validation (PPMV) tool is introduced to validate models in a batch model with a trajectory-sensitivity–based approach to identifying highly sensitive parameters for calibration. An EnKF-based algorithm is developed to calibrate candidate parameters simultaneously in a dynamic simulation. The tool suite is tested on a realistic hydro power plant and demonstrates outstanding success in greatly improving model performance. As suggested in the NERC guidelines, the PMU-based approach can effectively reduce the frequency of costly staged generator tests; the parameters calibrated using the proposed tools will be sent to generator owners for further testing and verification before they will be used in actual planning and operational studies.