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

presented by

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Team:

PNNL – Renke Huang, Yuanyuan Li, Pavel Etingov, Henry Huang, Xinya Li, Shaobu Wang GE Energy Consulting – Juan Sanchez-Gasca, Brian Thomas GE Grid Solutions – Manu Parashar, Guru Pai PEAK RC – Slaven Kincic, Alex Ning

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Goal: help industry to better meet NERC compliance requirements

- More stochastic and dynamic behavior observed in today's power grid
- Good model quality is critical for secure and economic planning and operation



WECC policy and NERC standards requiring periodic model validation

NERC standards	Requirements	
MOD-033	Steady-state and dynamic system model validation	
MOD-026	Model&data for exciters	
MOD-027	Model&data for governors	(ege



Overview of the Project

- Funded by the 2016 BPA Technology Innovation program; with cost share provided by DOE AGM program
- Objective: to develop a phasor driven tool for on-demand model validation and parameter calibration
- Project Team
 - PNNL: Ruisheng Diao, Henry Huang, Renke Huang, Pavel Etingov, Shaobu Wang, Yuanyuan Li
 - GE Energy Consulting: Brian Thomas, Juan Sanchez-Gasca
 - PEAK: Slaven Kincic, Alex Ning
 - GE Grid Solutions: Manu Parashar, Guru Pai
 - BPA: Gordon Matthew, Dmitry Kosterev, Steve Yang, Thong Trinh, Tony Faris, Greg Stults
- Timeline: Oct. 2015 Sept. 2017



Key Innovation

- Gaps
 - Not easy to prepare cases for model validation studies
 - Link to PMU measurements
 - Link to operational information
 - Available calibration techniques are standalone tools, not integrated with validation function in commercial packages. Not easy for users
- We are developing a more integrated tool
 - Directly use real-time EMS cases for validation
 - Ease of use in creating archives of data needed for model validation/calibration, e.g., PMU data, EMS snapshots and calibrated parameters
 - Develop and study metrics for comparison of measured and simulated data



Architecture Design of the Tool



Developed Model Validation and Parameter Calibration Procedures

- **Step 1**: model validation via PPMV
 - Inputs: voltage, freq (or phase angle)
 - Outputs: active and reactive power
- Step 2: identification of problematic parameters
 - Sanity check: find unrealistic pars and status of controllers
 - A trajectory sensitivity approach
- Step 3: calibrating parameters using an ensemble Kalman filter approach
- Step 4: model verification using multiple events



Main Flowchart





EnKF-Based Calibration Algorithm



Calibration Performance on a Hydro unit



PPMV Tool with Sensitivity Analysis

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Integration Architecture

- Event based PMU data retrieval, from the PMU data repository.
- Consumption of operations Network case, and mapping to PMU measurements.
- Case preparation and launch PSLF.
- Retrieve, display and analyze simulation reconstruction with PMU observations.



Model Manager

Allows the user to

- visualize the model
- Make changes

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- Solve power flow
- Map PMU measurements to model "node" elements

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Visualization of Results

Frequency Voltage Magnitude Angle Real Power

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Thank you!

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Publication:

Y. Li, R. Diao, R. Huang, P. Etingov, J. Sanchez-Gasca, B. Thomas, X. Li, Z. Huang, S. Wang, "An Innovative Software Tool Suite for Power Plant Model Validation and Parameter Calibration using PMU Measurements," to be submitted to the 2017 IEEE PES general meeting.



