TIP 357: Techniques and Tools for System Level Validation of Transient Stability Models using PMU Data

Context

A transient stability simulation assesses the short term (several to 30 seconds) angular and voltage stability of the power system, following a major disturbance. Power system models and software packages are used to run these simulations, as well as make decisions regarding design, planning and operating the grid. In the past two decades, it has been noted that in some cases models are still not able to accurately represent actual system response. This is a cause of concern as operational limits are set based on simulation studies, and hence inaccurate models can cause over or under-utilization of the grid, or even lead to cascading disturbances and black-outs.

Description

This project is a follow-up to the ongoing Technology Innovation Project (TIP) 268: Verification and Validation of Transient Stability Model and Results involving BPA, University of Illinois and Washington State University. To date, TIP 268 has been successful in comparing and resolving discrepancies seen across commercial transient stability packages used by BPA for their system studies such as PowerWorld Simulator, GE-PSLF, and TSAT, and has brought about improvements in certain packages to make simulation results significantly more consistent.

This project intends to automate, as much as possible, the process of validation and providing tools that can be useful to BPA engineers to quickly perform dynamic simulations using real-time cases, and find or at least narrow down to the root causes when simulations do not match measurements. The project will explore the feasibility of automatic dynamic performance monitoring of synchronous generators, wind farms, and other control devices by combining PMU responses from major events with model based simulations.

In order to meet the objectives of this proposed project, five main tasks must be performed. These tasks pertain to the development of tools/methodologies and the associated features of what will eventually be a “holistic” validation tool. The major tasks are listed below:

1. Develop tools to create validation base cases using real-time cases and dynamic data from planning cases
2. Develop tools to automatically quantify differences between PMU data and simulations, and visualize/ summarize results
3. Develop sensitivity analysis based tools to determine causes of discrepancies between simulations and PMU data
4. Develop parameter estimation / optimization techniques to determine better model parameter values
5. Develop tools for performance monitoring of dynamic models

Why It Matters

Validation of dynamic models is an ongoing effort in WECC as well as in BPA. This work will supplement those efforts, by developing tools for system-level validation that utilize transmission system-level PMU measurements across the large system, perform sensitivity analysis to determine which models and subsystems are causing validation errors issues in validation, and determine suitable parameters for them. Thus, the existing model validation work in BPA will benefit from this project. Our investigation of the different dynamic performance criteria such as generator ringdown, frequency droop and voltage regulator operation etc. can help BPA in its efforts to monitor their components and system performance automatically.

The qualitative benefits of this project will be validated dynamic models, leading improved system studies (planning and operations) and hence better decisions regarding grid operations. The economic benefits of optimal grid performance are monumental, potentially saving both BPA and its customers a substantial amount of money. Better operational strategies arising from validated models will enable more reliable power service which will thus benefit the electricity consumers at large.

Goals and Objectives

The overall goal is to provide BPA with better models and simulation tools to perform more trustworthy dynamic studies on their systems, leading to better planning and operations.

Deliverables

All the methodologies and tools developed in this project, documentation on how to use them will be provided at the end of this project. We will also perform validation studies using these tools and the results of those will be delivered through reports, including the discrepancies found between simulations and measurements, and the model or parameter adjustments made to make them match. Similarly, the results of dynamic performance monitoring studies will also be reported.

A final report will be provided, describing the execution and achievements of the entire project in detail, as well as charting out the future steps for this work.

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Project Start Date: October 1, 2015

Project End Date: September 30, 2017

Reports & References

Related Technology Innovation Projects:

TIP 268: Verification and Validation of Transient Stability Model and Results

Links

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For More Information Contact:

BPA Project Manager:
Katie Wood, Technical Operations
krwood@bpa.gov

Principal Investigators
Thomas J. Overbye, Ph.D., Fox Family Professor
Electrical & Computer Engineering, UIUC
overbye@illinois.edu

Komal S. Shetye, M.S., Sr. Research Engineer,
Information Trust Institute, UIUC

Mani Venkatasubramanian, D.Sc. Professor Electrical Engineering & Computer Science, WSU

Participating Organizations

University of Illinois at Urbana-Champaign (UIUC)
Washington State University (WSU)