Large-Scale Test Bed (LTB) - Virtual Grid Simulator with an Energy Management and Control System

Overview

The objective of this project is to develop a software platform for the large-scale test bed (LTB) project that can serve as a real-time grid operation platform to continuously simulate the operation of the power grid with small or large disturbances using communication and control actions as considered under wide-area measurement. As shown in Figure 1, the platform consists of the Virtual Grid Simulator (VGS), which continuously simulates the power grid in real time, and the EMS of Today module, which includes a number of the traditional functions in a typical control center. Also, the top-right block illustrates some potential new controls and algorithms that are used to validate and verify research innovations.

Technology Pathway

Figure 2 shows the procedure and data flow of the proposed platform. The basis of the platform is the virtual grid simulator (VGS). While the VGS simulates the operation of the power grid based on time-domain simulation, short-term load data are continuously fed into the optimal power flow module to calculate the generator set points, which are sent immediately to the VGS. State variable outputs from the VGS are then combined with measurement models and streamed to multiple control modules, as well as the visualization module (illustrated in Figure 3 in a sample NPCC system), over industry standard communication protocols.

In this project, both a MATLAB-based research tool and a commercial software tool are under development. The research tool is flexible and easy-to-customize for conceptual verification, while the commercial software based tool is to be used for demonstration of large-scale systems.

Fig. 1: The proposed LTB platform

Fig. 2: Architecture of the proposed LTB platform
Impact

- An integrated software platform is designed to continuously mimic the dynamic behavior of power systems in the timescales of hours to sub-seconds, which covers the broad scope of power system operation from economic dispatch to electromechanical dynamics within the same tool.
- Measurement and communication are linked to the VGS, as are other conventional and proposed new functions for future power system control rooms.
- Both a MATLAB-based tool and a commercial software tool are under development to allow both research investigation and practical applications.
- This platform will serve as the foundation for evaluating new controls and algorithms, especially in regard to ultra-wide-area measurements.

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**Fig. 3: Visualization of the state variables in the NPCC system**