Multi-Scale Integration of Control Systems

CHALLENGE

Traditional grid operations and control systems rely on decoupled approaches to transmission, distribution, and local energy networks. This approach cannot accommodate the holistic system approach offered by complex smart grid systems, in which the monitoring effects of renewables and electric energy storage in the distribution network and end users have a significant impact throughout the entire network.

Future grid operations and control systems must be able to monitor, protect, and automatically optimize the operation of the grid's interconnected elements—from the central and distributed generator through the high-voltage network and distribution system, to building automation systems, to controllers for distributed energy resources, and to end-use consumers, including their thermostats, electric vehicles, appliances, and other household devices.

APPROACH

This project aims to create an integrated grid management framework—akin to having an autopilot system for the grid's interconnected components—from central and distributed energy resources (DERs) at bulk power systems and distribution systems to local control systems for energy networks, including building management systems. Research and development will be performed to enable testing of advanced grid applications that will incorporate new control theory and power flow control concepts that allow systems to operate with lower reserve margins, thereby dramatically enhancing the energy efficiency of the overall system.

To enable achievement of this vision, it will be necessary to achieve greater end-to-end integration across all levels of the supply and delivery infrastructure. To this end, the project team will conduct two major tasks:

- Develop an open framework to coordinate the operation of energy, distribution, and building management systems (EMS, DMS, and BMS), and then test the new framework on a use case at national laboratory facilities. The test system will have more than 15,000 transmission substations and will involve high penetration of DERs or microgrids (more than 50 percent).
- Deploy and test new operations applications, probabilistic risk-based operations, forecasting data integration and decision support, and heterogeneous sensor data integration.

At-A-Glance

PROJECT LEADS

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PARTNERS

- Washington State University

BUDGET

$3.5 million

DURATION

May 2016 – December 2018

TECHNICAL AREA

Systems Operations and Control

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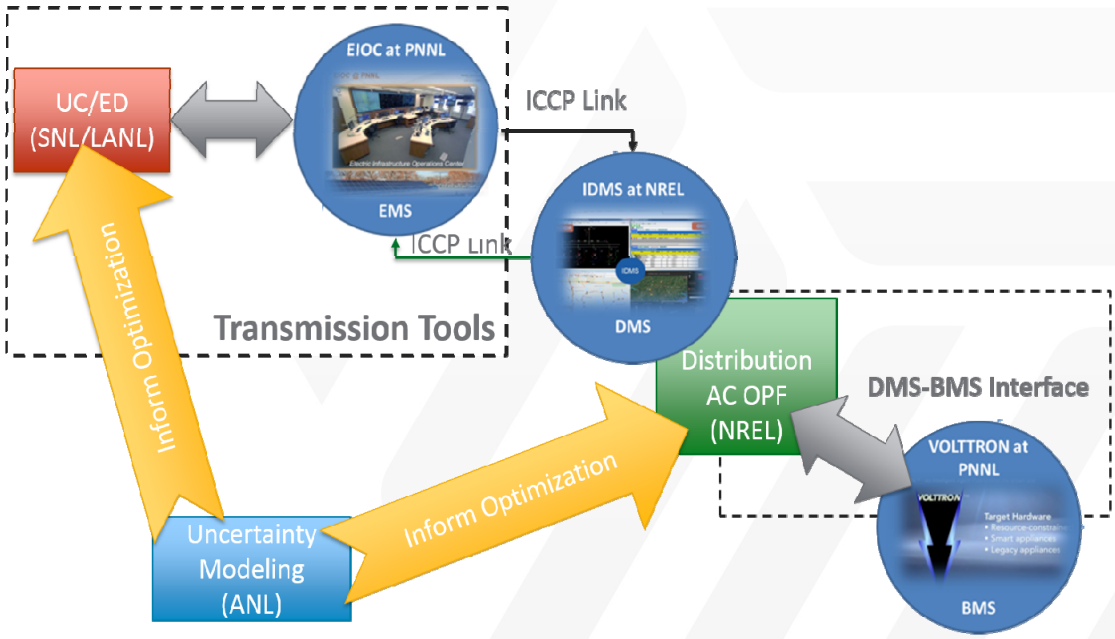
EXPECTED OUTCOMES

The open platform represents a significant advancement of present state-of-the-art capabilities. It will lead to future grid operating systems that can meet the increasing power demands of a digital society, as well as the increasing use of renewable power production. New applications from this project will allow practitioners and researchers to explore the use of new grid operating systems that manage a two-way flow of electricity and information, enabling them to create automated, widely distributed energy delivery networks.

This project will yield the following significant economic benefits of a modernized grid:

- **Reduce the economic costs of power outages**. It will help grid operators leverage distributed energy resources and avoid conditions that could lead to load shedding or cause outages.
- **Decrease the cost of reserve margins while maintaining reliability**. It will substantially reduce the amount of system reserve capacity needed to cope with generation and load fluctuations, while maintaining and even increasing system reliability.
- **Decrease the net integration costs of distributed energy resources**. EMS/DMS/BMS coordination with controllability to engage response loads will help balance the variability of DERs.



EMS/DMS/BMS System Architecture

LAB TEAM

Argonne NATIONAL LABORATORY
Lawrence Livermore National Laboratory
Los Alamos NATIONAL LABORATORY
NREL NATIONAL RENEWABLE ENERGY LABORATORY
Pacific Northwest NATIONAL LABORATORY
Sandia National Laboratories

Launched in November 2014 under the U.S. Department of Energy's Grid Modernization Initiative, the GMLC is a strategic partnership between DOE Headquarters and the national laboratories, bringing together leading experts and resources to collaborate on national grid modernization goals. The GMLC's work is focused in **six technical areas** viewed as essential to modernization efforts:

Devices and Testing | Sensing and Measurements | Systems Operations and Control
Design and Planning | Security and Resilience | Institutional Support