Control Theory

CHALLENGE

The increasing penetration of stochastic and variable renewable power generation (both centralized and distributed) in many electrical transmission and distribution grids decreases the availability of traditional forms of generation used to control real power for balancing load and reactive power for regulating voltage magnitude. These changes are driving an emerging transition to leverage a large latent capability in the grid to control distributed energy resources (DERs), which include distributed generation, battery storage, and loads.

To address these concerns, solutions must be developed and deployed that allow a vast number of DERs to participate in "grid control," enabling the grid to operate with leaner power reserve margins, and thus more reliably and cost effectively for stakeholders such as utilities and consumers.

APPROACH

A team of multi-national laboratory researchers and their industry partners are developing new solutions in grid control topologies, algorithms, and deployment strategies that will alleviate the impacts of large DER deployments to the power grid and help to maintain the most efficient and cost-effective power operating margins. The main objectives of the project are to:

- Develop hierarchical control strategies to enable control and coordination of more than 10,000 DERs with widely different responses.
- Ensure the compatibility of newly developed control solutions with new and modern grid architectures addressing legacy systems, communications-heavy systems, and communications "lite" systems.
- Systematically manage uncertainty from intermittent power generation.
- Incorporate power flow physics and network constraints into control solutions.
- Enable integration of DERs with legacy systems and bulk power system markets.

At-A-Glance

PROJECT LEADS

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PARTNERS

- Oncor Electric Delivery
- PJM Interconnection
- United Technologies Research Center

BUDGET

$6.5 million

DURATION

April 2016 – September 2019

TECHNICAL AREA

Systems Operation and Control

Lead: Jeff Dagle
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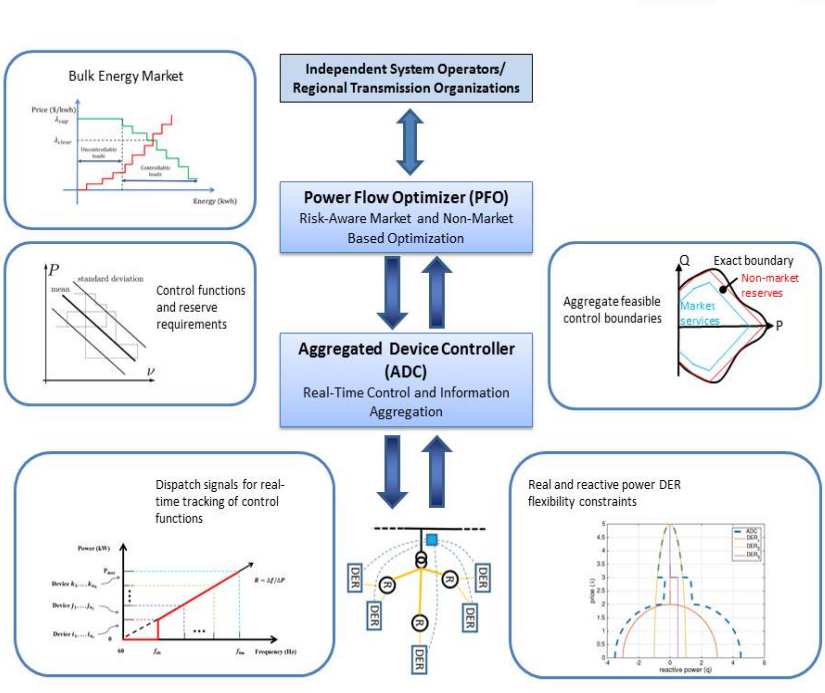
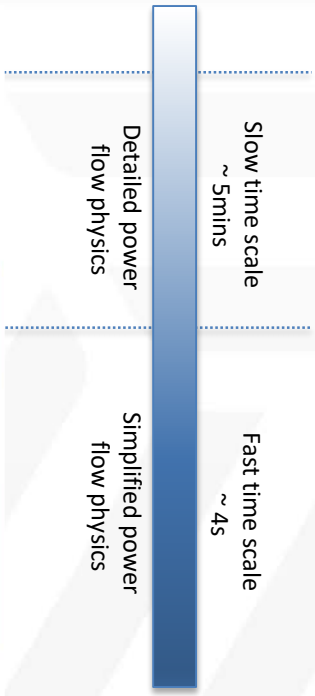
OUTCOMES

- A comprehensive roadmap of all viable choices of architectural and control strategies.
- Integrated optimization and control systems based on spatio-temporal separation of scales to enable efficient deployment in large systems with a large number of distributed energy resources.
- Flexible framework that can be adapted to the specificities of the system in consideration such as available communication and sensing infrastructure, and regulatory requirements.
- Algorithms for grid-wide optimization and aggregated DER dispatch, and algorithms for flexibility aggregation, and real-time control of DERs.





LAB TEAM

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

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