Integration of Microgrids, DER Aggregators, and DERMS with ADMS

Panel: Microgrids – Perspective & Experience from Utilities, DOE, and National Labs

Murali Baggu, Laboratory Program Manager – Grid Integration National Renewable Energy Laboratory (NREL)
Problem Statement and Project Objective

Problems:
• Distributed energy resource (DER) management and control is disjointed, siloed, and, at times, conflicting.
• Behind-the-meter (BTM) assets can provide significant flexibility but are poorly integrated with the grid.
• Centralized control methods alone are not scalable.

Objective: Develop and demonstrate an architecture that:
• Provides reliable, resilient, and secure grid services
• Enables scalable, near-real-time management of utility- and small-scale DERs
• Supports transactive control, aggregation, and direct control of DERs
• Incorporates existing utility management systems.
FAST-DERMS

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

Develop a controls architecture to manage a broad range of DERs across the grid for bulk system services through transactive, aggregation, and direct control methods.

Key architecture features:
- Total distribution system operator (DSO) approach
- Distributed controls
- Follows laminar coordination principles.
FAST-DERMS and Microgrids

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

Encompasses DERs aggregated in a microgrid (ugrid) or a building (Bldg).
The DSO aggregates and controls individual DERs to provide transmission services defined and measured at the transmission-and-distribution interface.

Microgrids can be managed directly by a FRS or through an aggregator or transactive market.
Coordination and Control via the FRS

- Simultaneous distribution management and transmission service provision
- Temporal hierarchy of coordination and control via the FRS:
  - **Day-ahead** stochastic optimal power flow-based for wholesale market bidding
  - **Intra-hour** stochastic model predictive control (MPC) for DER management and response allocation
  - **Real-time** signal disaggregation for distributed control.
Real-Time Control in the FRS

Goal: Minimize the difference between the transmission system operator (TSO) dispatch signal and the measured output at the substation:

- Prices updated on a 5-minute basis
- Capable of 4-second direct dispatch for frequency regulation
- Dispatch signal from TSO disaggregated based on allocation outcomes in MPC
- Simplicity is key: FRS intends to primarily provide one-way communications in real time to DERs and aggregations.
Coordination with Existing Utility Management Systems

- The FRS operates as a local DERMS for its substation.
  - No other DERMS commands resources subscribed to the FRS.
- The utility systems provide the system model, legacy equipment states, and real-time measurements.
- The distribution utility control systems maintain the highest authority.
  - Existing utility management systems can override/bound offers made by the FRS if they create issues elsewhere in their grid.
  - This causes the FRS to re-optimize with the newest available information.
Transactive Elements of FAST-DERMS

- The FRS will connect with a transactive market manager (TMM).
- The TMM will aggregate the transactive resources.
- The project team is evaluating two transactive methods differentiated by the level, or sophistication, of communication.
Implementation and Evaluation

GridAPPS-D Overview

- An open-source platform for ADMS application development
- Built-in distribution simulator, cosimulation, and common services for developers and applications
- Can integrate with external software systems using standard communications (e.g., DNP3).
Implementation and Evaluation

Advanced Distribution Management System Test Bed

- A vendor-neutral test bed to evaluate existing and advanced distribution management system (ADMS) functionalities in a realistic laboratory setting
- Real-time software simulation and distribution system hardware.
ADMS Test Bed and GridAPPS-D

Platform Integration

- The ADMS Test Bed emulates the utility environment.
- FAST-DERMS controls are implemented as applications on GridAPPS-D.
- Integrated with Oracle ADMS
- Demonstration use case: wholesale electricity market participation with high afternoon prices.
- Scenarios include:
  - Normal conditions
  - Overload/overvoltage conditions
  - Evaluate with planned and unplanned load transfers
  - Evaluate one scenario with Oracle ADMS issuing additional operating constraint.
- Target running experiments in late 2022.
Team and Resources Summary

National Laboratories

• National Renewable Energy Laboratory
• Lawrence Berkeley National Laboratory
• Pacific Northwest National Laboratory
• Oak Ridge National Laboratory

Partners

• ComEd – An Exelon Company
• San Diego Gas and Electric Company
• Electric Power Research Institute
• Southern Company
• New York Power Authority
• Oracle
• GridBright
• Iowa State University
• University of North Carolina at Charlotte
For Further Reading

**Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions (FAST-DERMS)**
https://www.nrel.gov/docs/fy22osti/81566.pdf

**Grid Architecture Guidance Specification for FAST-DERMS**
https://gridarchitecture.pnnl.gov/media/Grid_Arch_Guidance_for_FASTDERMS.pdf
Thank you

annabelle.pratt@nrel.gov

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Communications Architecture

- TSO Level
- DSO Level
- Substation Level
- Aggregation Level
- Local Area Control Level
- DER Devices Level

Communication Interfaces for FAST-DERMS

Device-Level Interfaces
Group-Level Control Interfaces
Group-Level Transaction Interfaces
Group-Level Transmission Services Interface
Intra-DSO Interfaces
Distributed FRS Interfaces