FAST-DERMS

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

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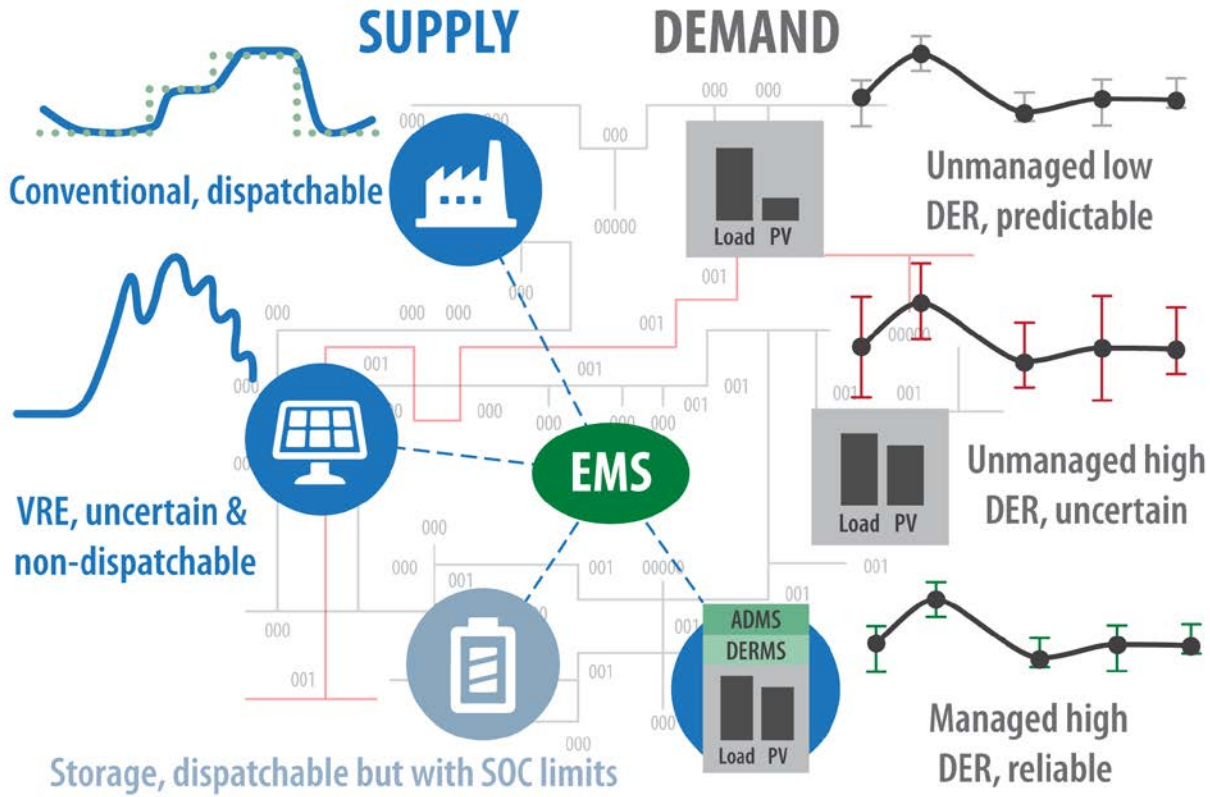
Motivation

Increased uncertainty in supply and net demand

- There are fewer conventional, dispatchable generation resources and more variable renewable energy (VRE) and distributed energy resources (DERs).
- There is more uncertainty from bulk-level VRE and net demand from distribution systems with high DER levels.
- FAST-DERMS aims to develop and demonstrate a scalable solution for managing uncertainties in supply and demand at the grid edge.
- We propose that distribution system operators (DSOs) provide firm net load forecasts to the bulk system operator's energy management system (EMS).



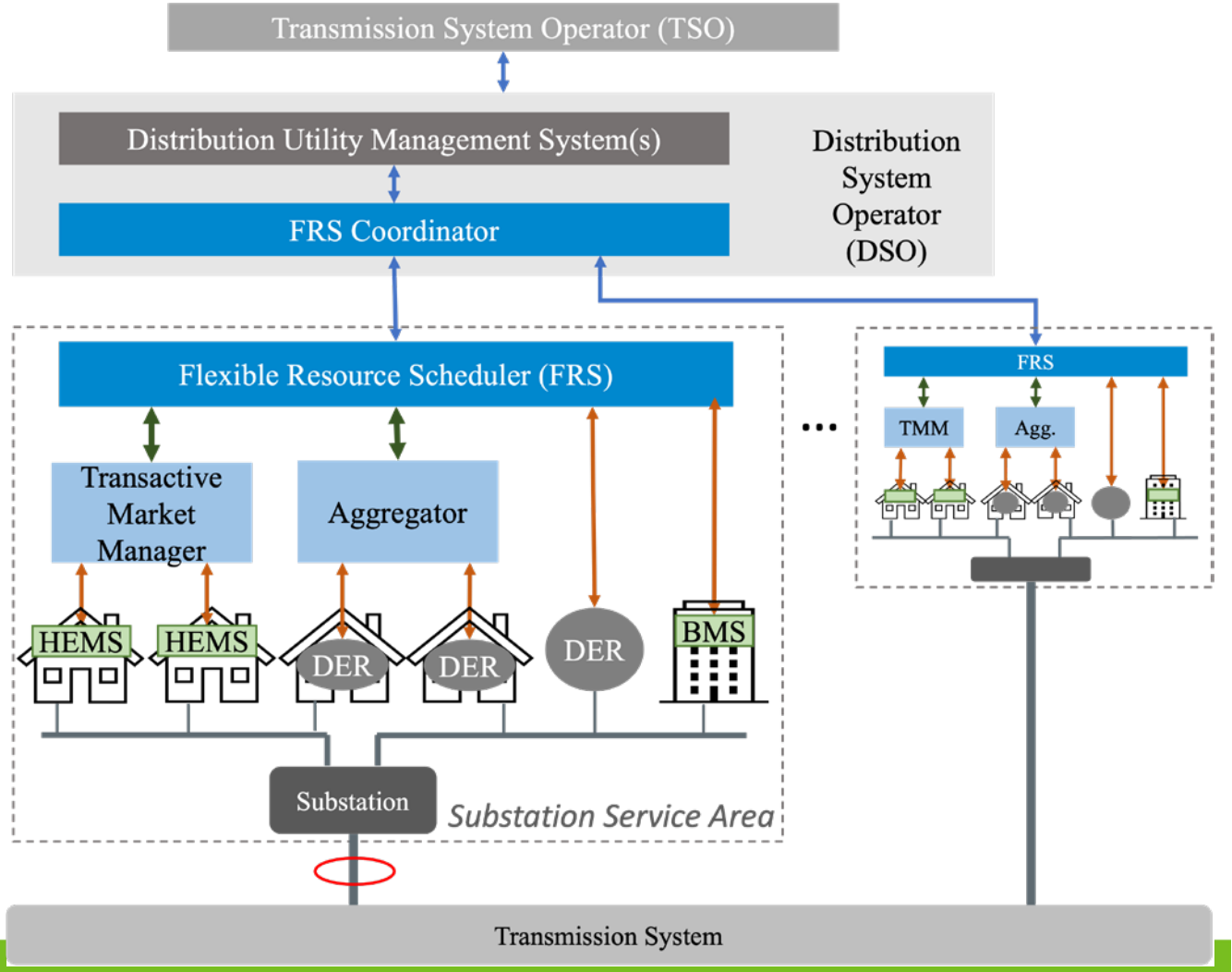
FAST-DERMS

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

Develop a control 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:

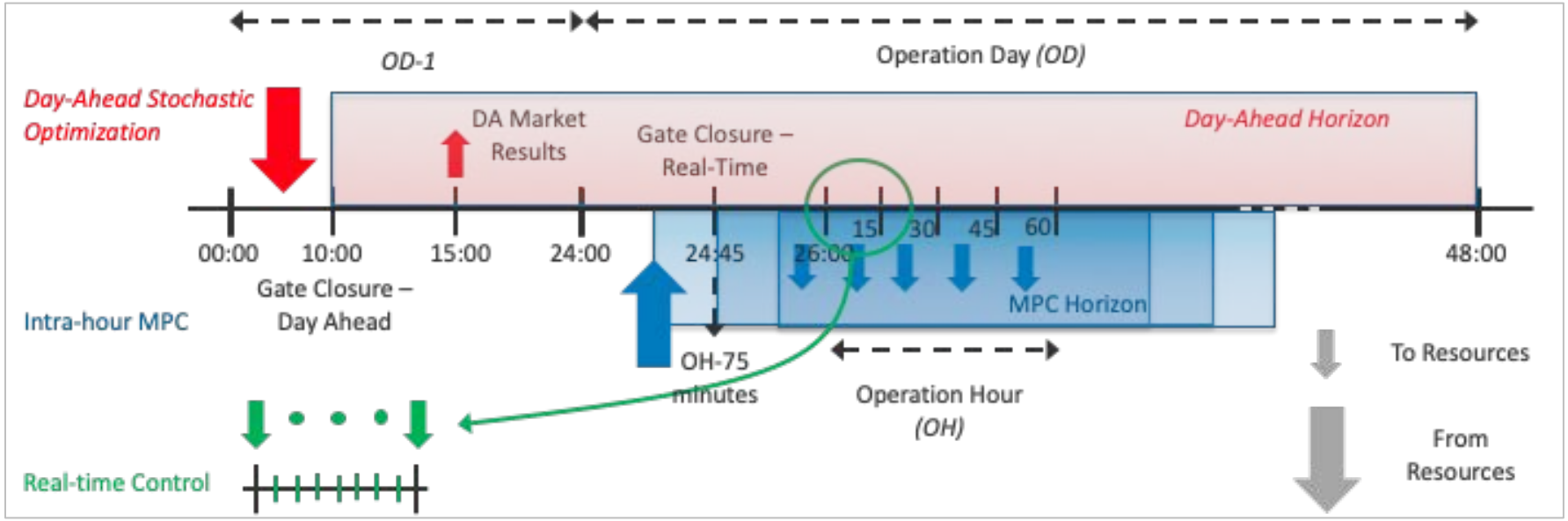
- Total DSO approach
- Network-aware stochastic optimization
- Distributed intelligence at substations
- Manage net power flow at substations.



Coordination and Control

Via the Flexible Resource Scheduler (FRS)

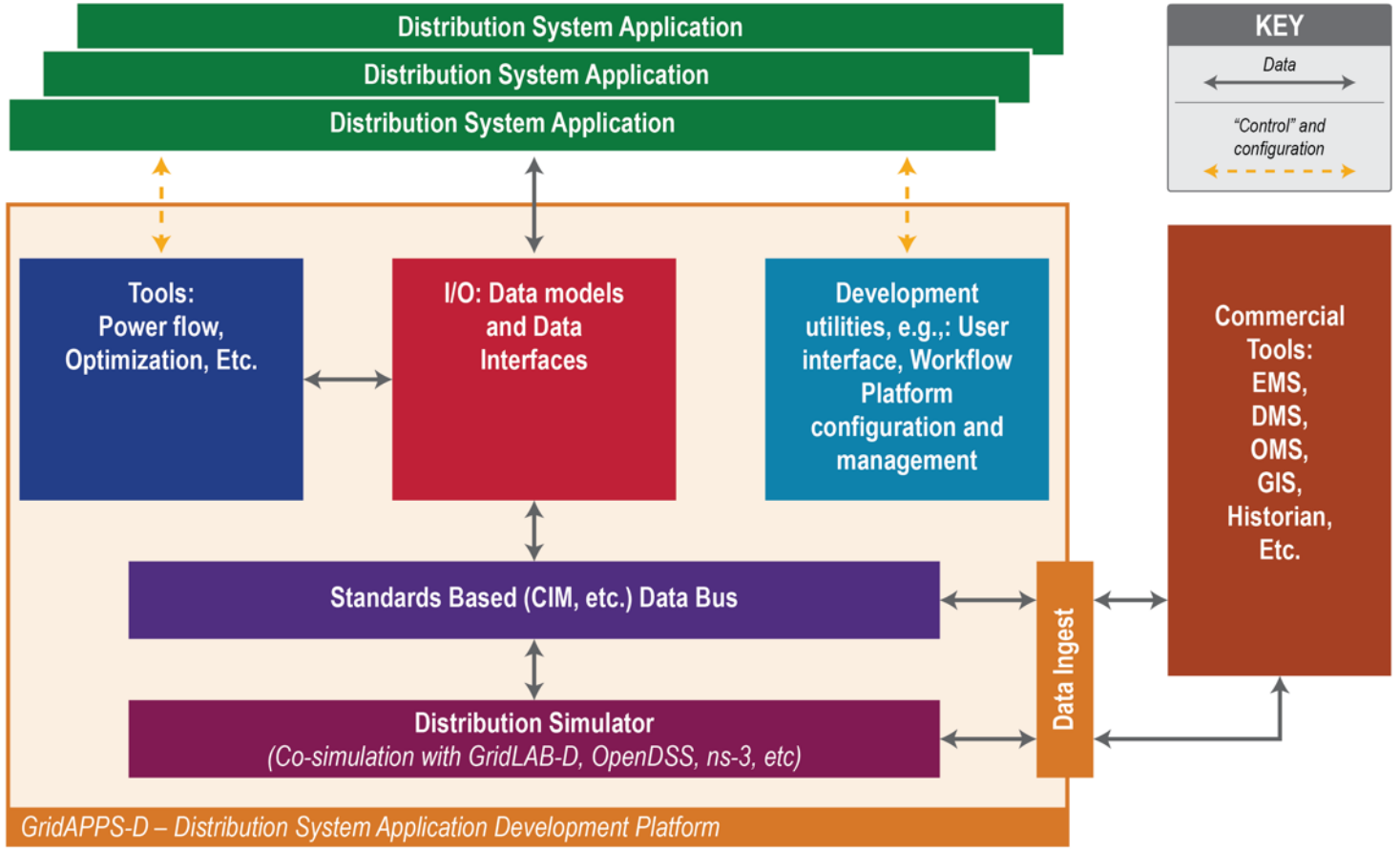
- Simultaneous distribution management and transmission service provision
- Temporal hierarchy of coordination and control via the FRS:
  - **Day-ahead** stochastic optimal power flow for wholesale market bidding
  - **Intra-hour** model predictive control for DER management and response allocation
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



Implementation and Evaluation

GridAPPS-D Overview

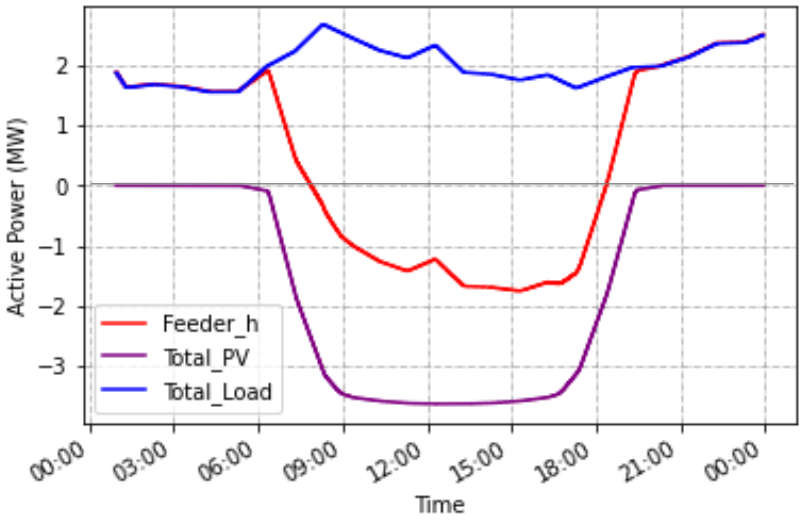
- An open-source platform for advanced distribution management system (ADMS) application development
- Built-in distribution simulator, cosimulation, and common services for developers and applications
- Can integrate with external software systems using standard communications (e.g., IEEE Std. 2030.5, DNP3).



Implementation and Evaluation

GridAPPS-D Day-Ahead Results

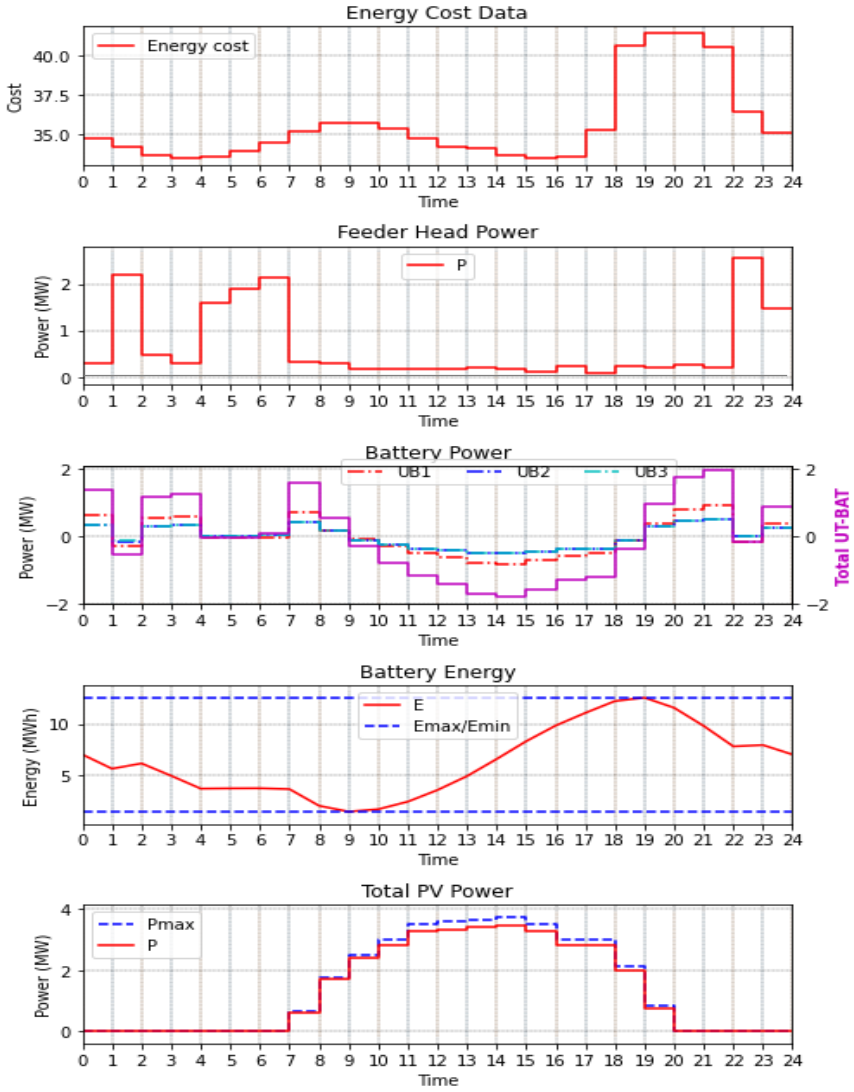
Southern Company feeder: light load and high PV day—baseline:



Added utility-scale battery systems to model to address reverse power flow.

Day-ahead FRS stochastic optimization:

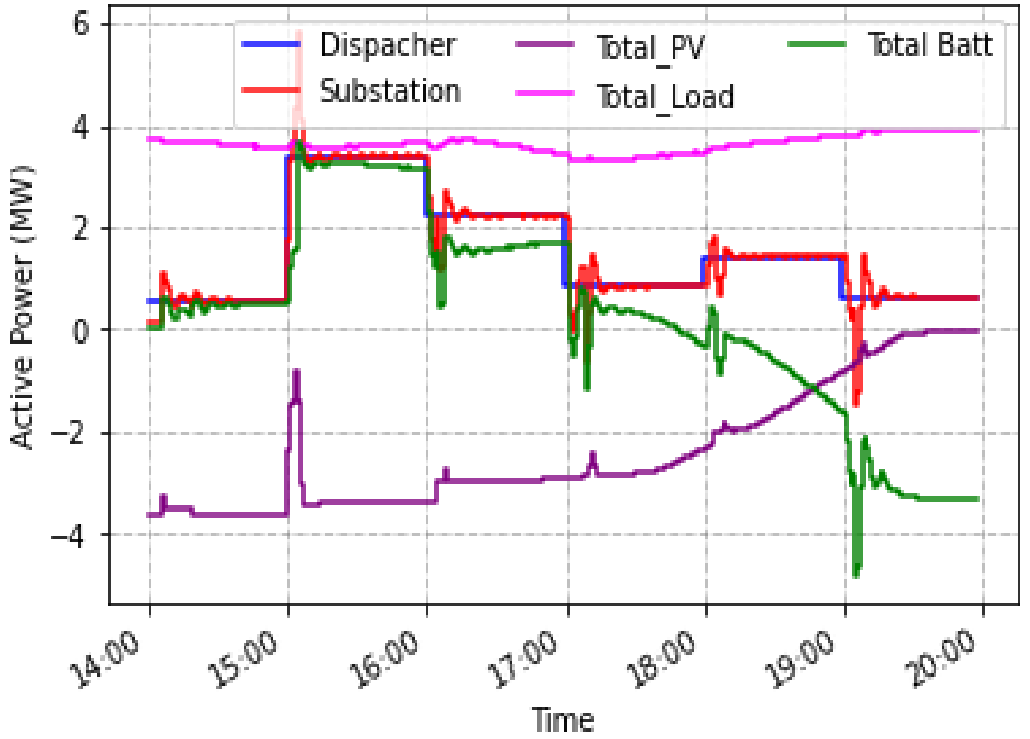
- Objective is to minimize cost, subject to network constraints
- No reverse power flow allowed (per use case)
- Performs energy arbitrage using battery
- Limited PV curtailment.



Implementation and Evaluation

GridAPPS-D Real-Time Results

- Model predictive control:
  - Operates over 4-hour horizon
  - Updated every 15 minutes.
- Real-time control:
  - PID controller
  - Time step of 1 minute.
- Continuing work to reduce overshoot.



Implementation and Evaluation

Advanced Distribution Management System Test Bed

- A vendor-neutral test bed to evaluate existing and ADMS functionalities in a realistic laboratory setting
- Real-time software simulation and distribution system hardware.

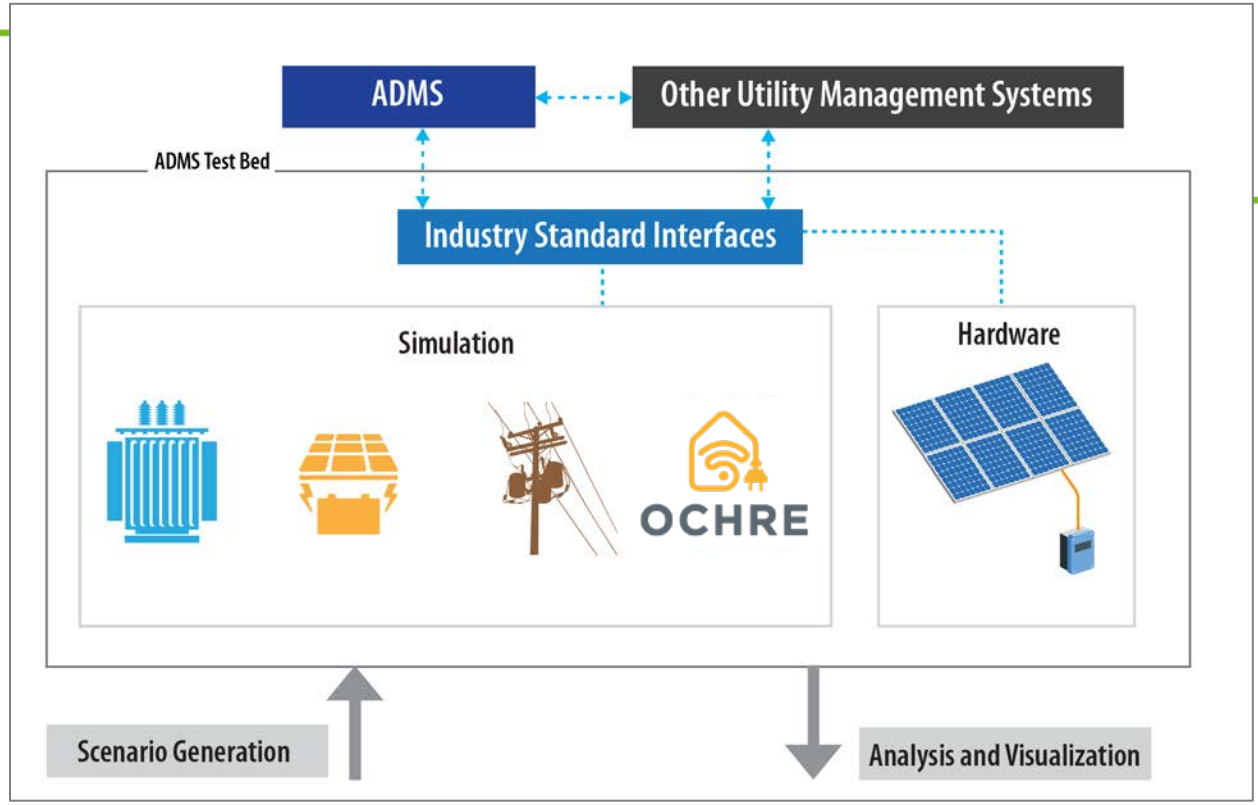


Photo by NREL

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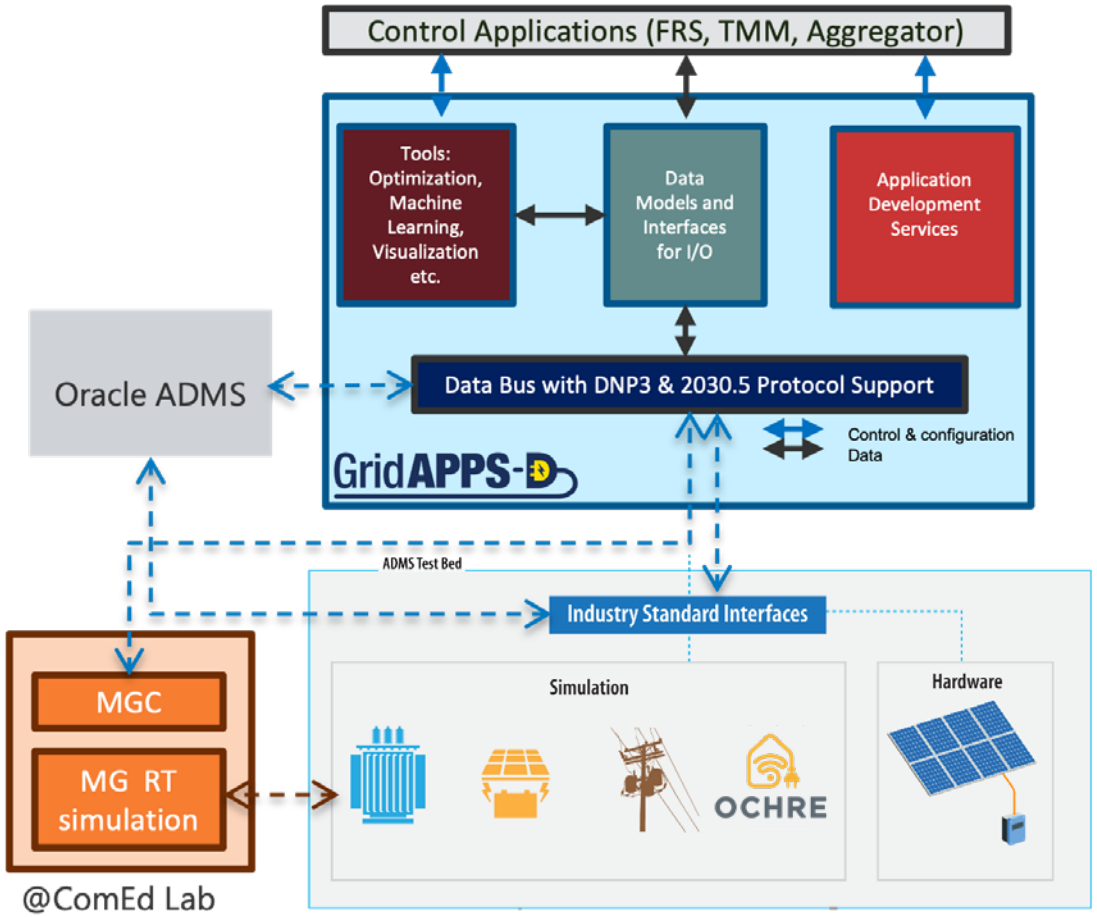
ADMS Test Bed and GridAPPS-D

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 mid 2024.



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 & Electric Company
- Electric Power Research Institute
- Southern Company
- New York Power Authority
- Oracle
- GridBright
- Iowa State University
- University of North Carolina at Charlotte

Thank you

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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_FAST%20DERMS.pdf