ADMS Test Bed Capabilities

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DOE ADMS and DERMS Core Development

*Transform utility electric distribution management systems to enable the integration and management of all assets and functions across the utility enterprise regardless of vendor or technology.*

Today
Closed, proprietary, vendor specific

Future
Open architecture, standards-based data exchange

Four program areas:
- **Platform:** Develop open-source platform; evaluate advanced applications.
- **Test bed:** Build a vendor-neutral test bed to evaluate existing and future advanced distribution management system (ADMS) functionalities in a realistic setting.
- **Applications:** Develop an initial suite of ADMS applications.
- **Advanced control:** Develop new integrated optimization and control solutions.
ADMS Test Bed Overview

Project description:

• Model large-scale distribution systems for evaluating ADMS applications.

• Integrate distribution system hardware in the Energy Systems Integration Facility for hardware-in-the-loop experiments.

• Develop advanced visualization capability for mock utility distribution system operator’s control room.
ADMS Test Bed Use Case Development

1. Define question
   - Determine question/challenge to address
   - Define use case
   - Identify value proposition

2. Create test to answer question
   - Define test plan
   - Provide equipment capabilities

3. Run test
   - Provide field data (models, load data)
   - Configure test bed and execute test plan
   - Provide technical support

4. Get answer to question
   - Improve operations, reduce costs, gain new insights
   - Results analysis
   - Product performance insights
ADMS Test Bed Capabilities

Existing/updated:
• Enabling tools for model conversion
• Controller hardware-in-the-loop (CHIL)
• Power hardware-in-the-loop (PHIL)
• Remote hardware-in-the-loop.

New:
• Multi-timescale simulations
• Integration of multi-vendor simulation platforms
• Integrated data collection and management system.
Model Conversion Tools

Also used NREL’s DiTTo tool, providing an open-source framework to convert various distribution systems modeling formats: [https://github.com/NREL/ditto](https://github.com/NREL/ditto).
1. Reduced voltage error by using a closed-loop voltage control filter.

2. Used reduced-order feeder model (100 µs) to interface slow (15-min) large-scale quasi-static time series (QSTS) with power hardware.

Multi-Timescale Simulation Capability

- Can select one or more simulators to fit use case.
- Can run parts of feeder in different simulators.
- Currently using:
  - OpenDSS by Electric Power Research Institute:
    - QSTS
    - 1-s minimum time step; minutes typical.
  - ePHASORSIM by OPAL-RT:
    - Dynamic phasor
    - 1- to 10-ms time step
    - Developed LTC, capacitor bank, and VR models for CHIL
    - Developed photovoltaic model for PHIL.
- Can incorporate other simulators, e.g., RTDS.
Multi-Timescale Simulation Capability

- Orchestrated by test bed coordinator software
- Written in Python
- Uses Hierarchical Engine for Large-Scale Infrastructure Co-Simulation (HELICS) framework:
  - U.S. Department of Energy (DOE) investment through Grid Modernization Initiative
  - www.helics.org.
Integration of Multi-Vendor Platforms

- ADMS to OpenDSS:
  - Device simulator developed to provide communications interface
  - Interfaces through Dbus
    - Low overhead data exchange based on TCP.

- ADMS to Opal-RT:
  - DNP3 drivers available.
Architected and implemented data management tools

Started with JavaScript-based code; moved to C++ for better performance and scaling


3-D visualization under development.
ADMS Test Bed Use Cases

• Use Case 0: Centralized and distributed volt/volt-ampere reactive (VAR) optimization (VVO):
  – Duke Energy and General Electric
  – Completed in 2017 using ADMS power flow.

• Use Case 1: Model quality impacts on VVO:
  – Xcel Energy and Schneider Electric
  – ADMS test bed currently set up for this use case.

• Use Case 2: Peak load management with ADMS + distributed energy resource management systems (DERMS):
  – Holy Cross Energy and Survalent
  – To be completed in early 2020.
ADMS Test Bed Capability Development

Use Case 0
- GE DMS
  - VVO
  - SE
  - SCADA
- Internal Powerflow
- eMEGASIM
- Power hardware

Use Case 1
- SE ADMS
  - VVO
  - SE
  - SCADA
- OpenDSS
- ePHASORSIM
- Controller hardware
- Power hardware
- Remote hardware

Use Case 2
- NREL RTOPF DERMS Coord Local
- Survalent ADMS DVR SCADA
- Remote GE EMS
- OpenDSS
- eMEGASIM
- Controller hardware
- Power hardware
- Remote PowerWorld

Remote hardware
Projects Using Test Bed Capabilities

- Grid modernization via control and optimization using distributed energy resources: ADMS + DERMS
- Evaluating Anterix wireless communications system for utility applications.
Enabling Extreme Real-Time Grid Integration of Solar Energy (ENERGISE) ECO-IDEA:

- ADMS + DERMS for photovoltaics + Varentec devices.
Thank you

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