ADMS Test Bed

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National Renewable Energy Laboratory

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Objectives and Outcomes

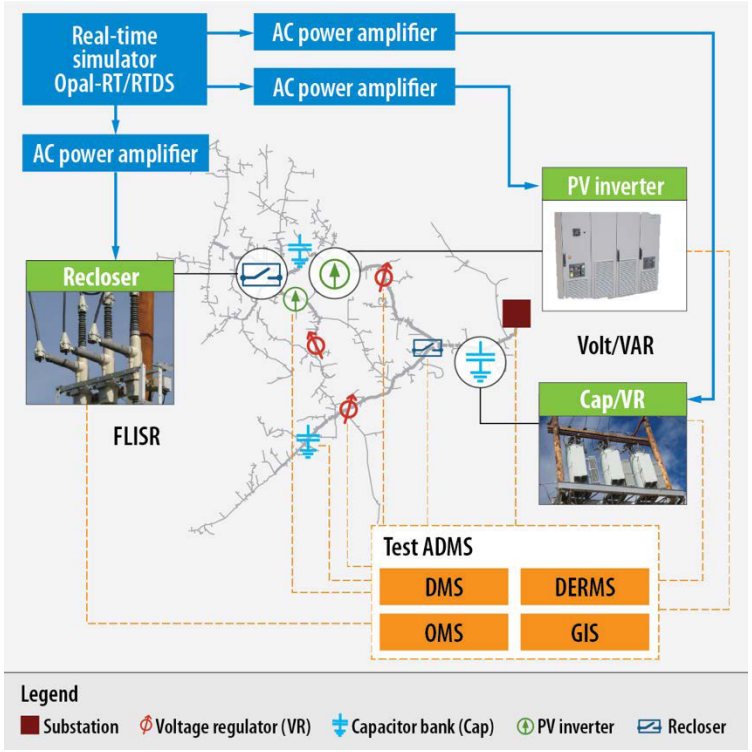
Objectives:

- Establish a national, vendor-neutral advanced distribution
- management system (ADMS) test bed
- Accelerate industry development
- Adopt ADMS capabilities.

Outcomes:

- Utility partners, vendors, and researchers
- Evaluation of existing and future ADMS applications and use cases
- Realistic laboratory test setting

  (including utility management systems and field equipment)
- Informing field deployment decisions.



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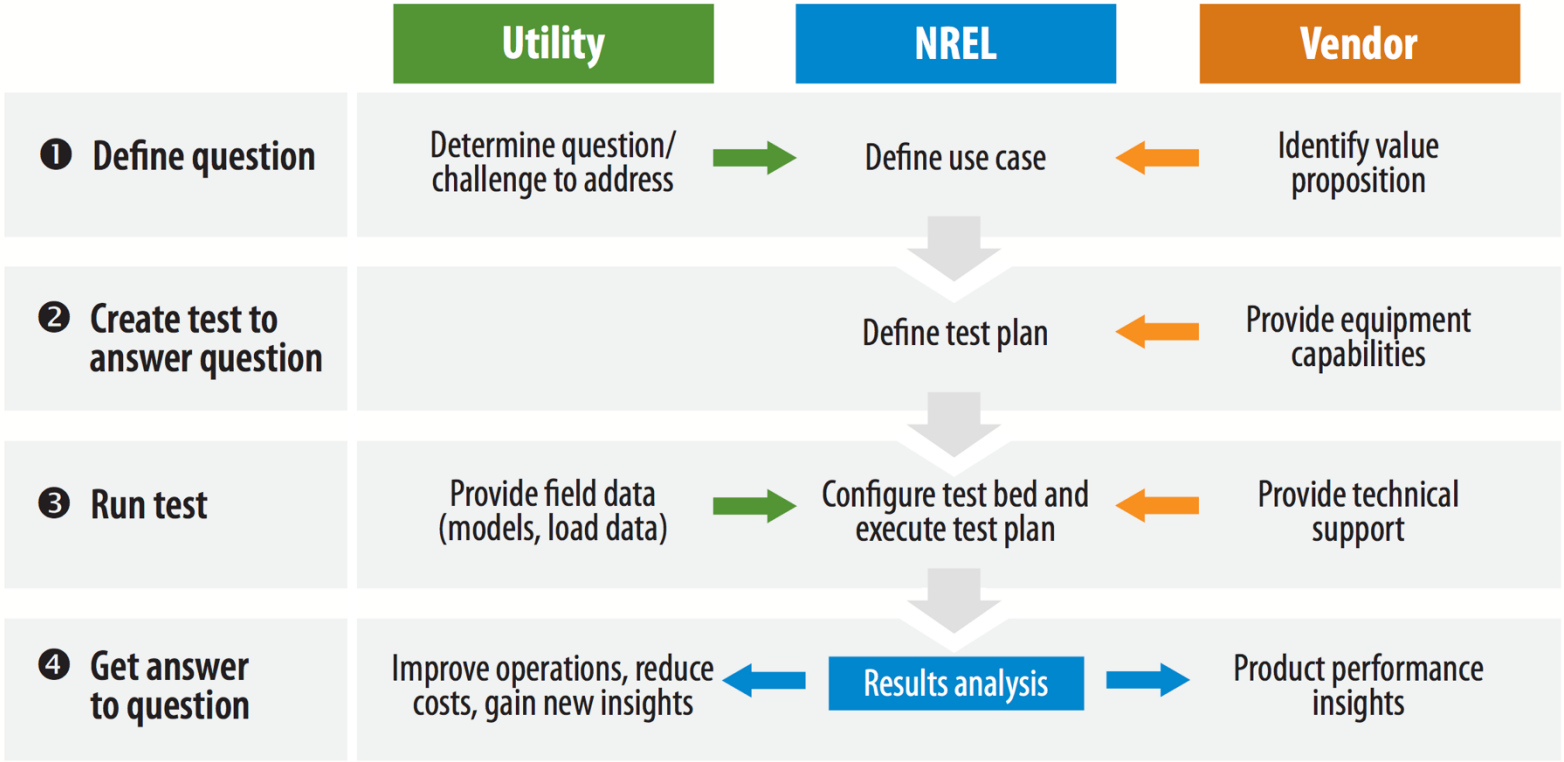
ADMS Test Bed Development



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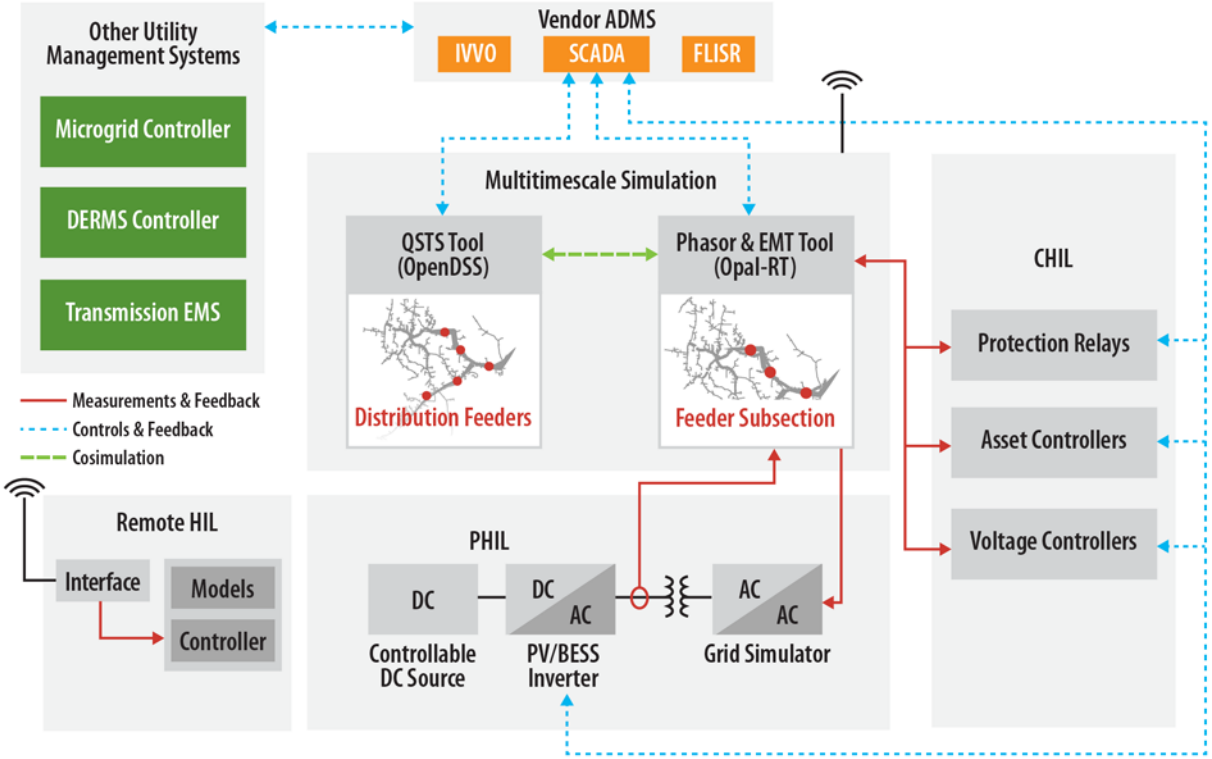
ADMS Test Bed Capabilities

Existing/Updated:

- Enabling tools for model conversion
- Controller hardware-in-the-loop (CHIL)
- Power hardware-in-the-loop (PHIL)
- Remote hardware-in-the-loop.

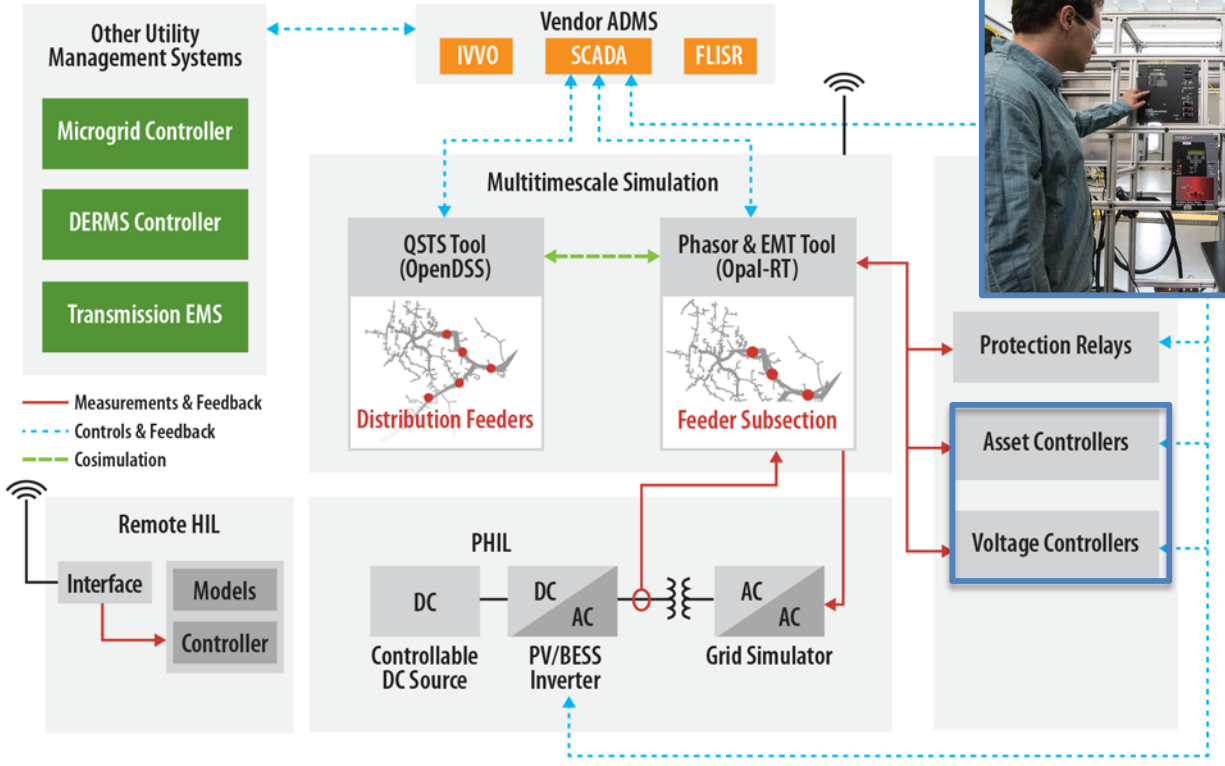
New:

- Multi-timescale simulations
- Integration of multi-vendor simulation platforms
- Integrated data collection and management system.



Controller Hardware

NREL 52749



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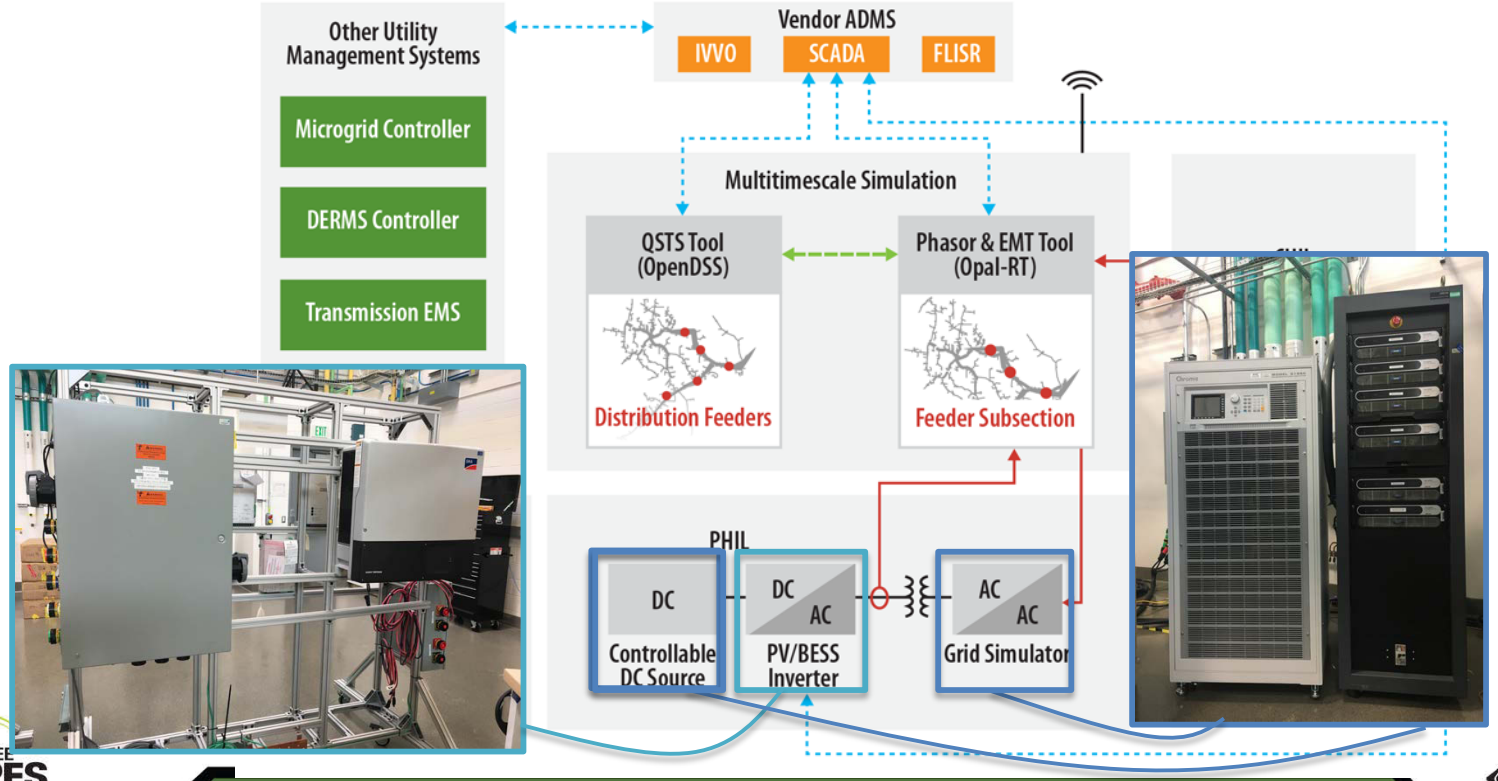
Power Hardware



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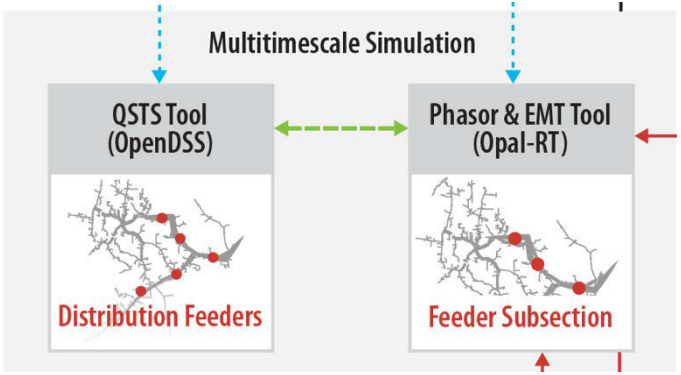
Remote Hardware

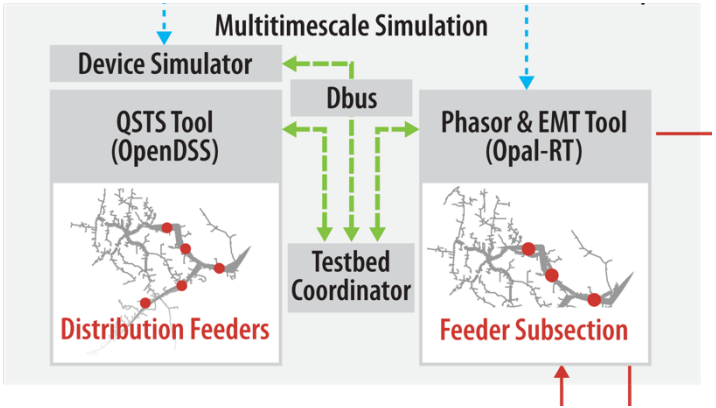
Multi-Timescale Simulation Capability

- 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 (EPRI)
    - Quasi-static time series (QSTS)
    - 1-s minimum time step; minutes typical.
  - ePHASORsim by OPAL-RT
    - Dynamic phasor
    - 1- to 10-ms time step.
- Can incorporate other simulators, e.g., RTDS.



Multi-Timescale Simulation Capability

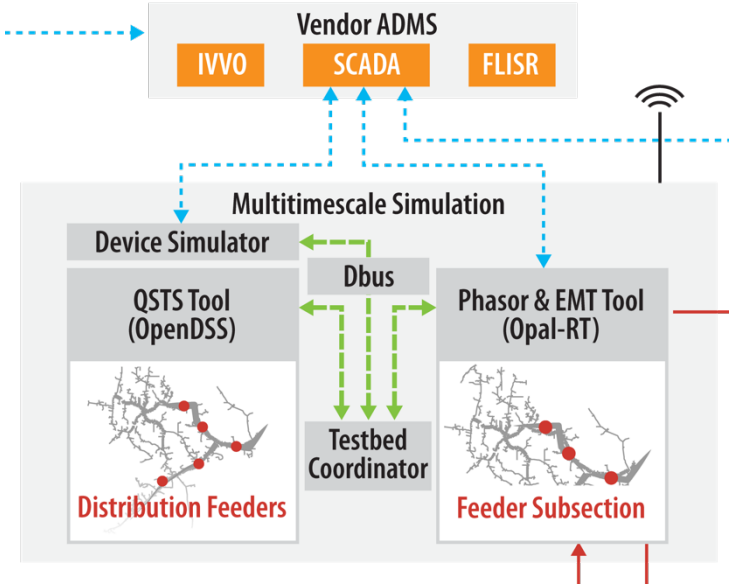
- Orchestrated by test bed coordinator software
  - Written in Python
  - Uses Hierarchical Engine for Large-Scale Infrastructure Co-Simulation (HELICS) framework.
    - U.S. Department of Energy investment through Grid Modernization Initiative www.helics.org.



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.



ADMS Test Bed Workshop

Workshop: Sept. 25, 2018, non-NREL attendees

Key inputs:

- Add communications simulation capability
- Interest in distributed energy resource management systems (DERMS) and microgrid integration.


NREL 53545


NREL 53536


NREL 53534


NREL 52525

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: Data remediation 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 DERMS
  - Holy Cross Energy and Survalent
  - *To be completed in 2019.*

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Use Case 1

Evaluate performance of the ADMS VVO application for different levels of model quality and different levels of measurement density

- Performance improvements from accurate model
- Offset model inaccuracies with additional telemetry
- Trade-off between model quality and telemetry density.

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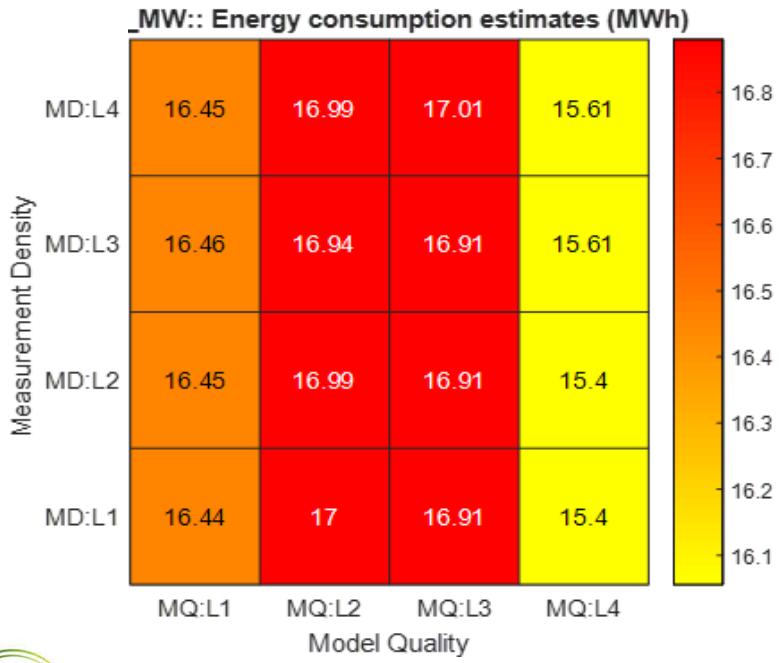
Use Case 1

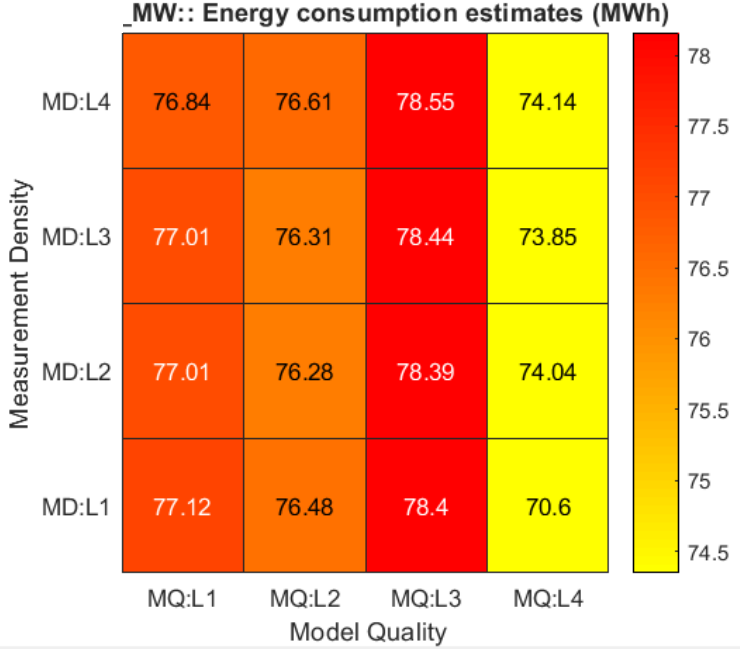
- Phase 1: evaluate using ADMS power flow
  - Six Xcel feeders with different characteristics
  - (4 model-quality levels) X (4 meter-density levels)
  - 16 combinations.
- Phase 2: evaluate using the ADMS test bed
  - Simulate two or three combinations for one feeder.

Phase 1 Result: Energy Savings

Low load



High load



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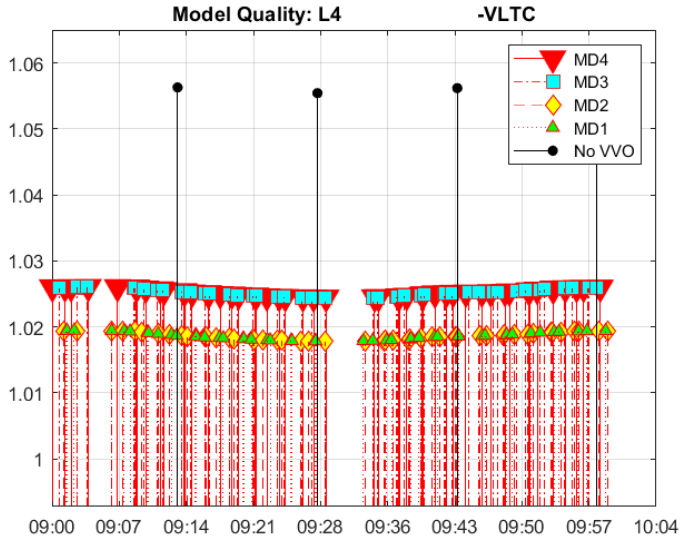
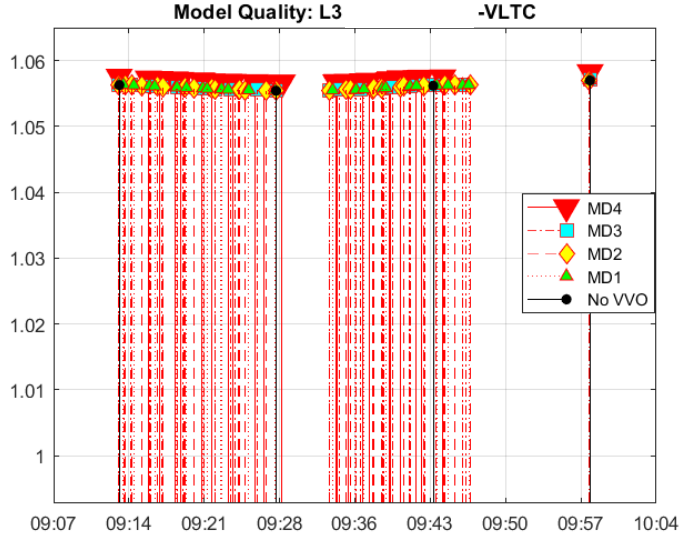
Phase 1 Result: End-of-Line Voltage

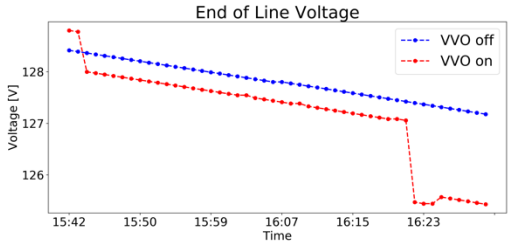


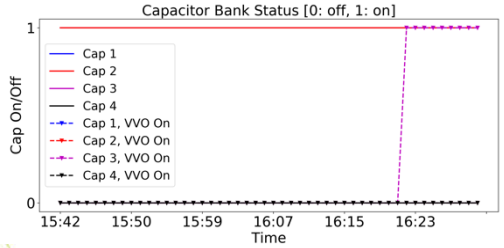


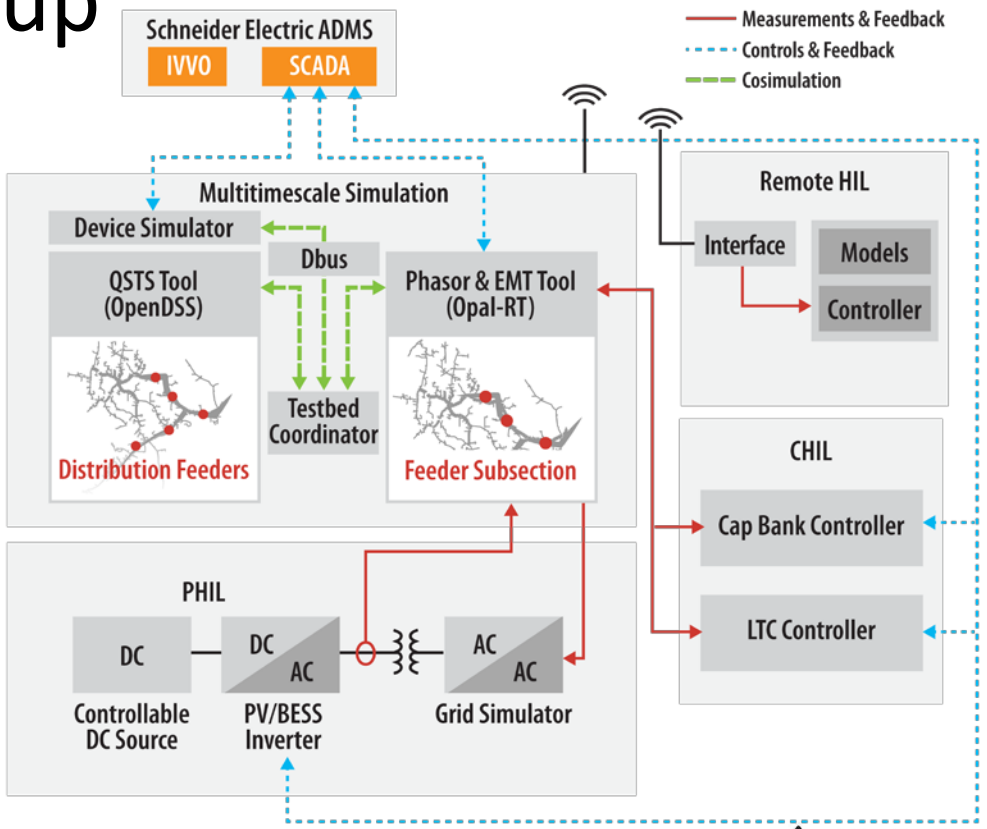
- Results vary significantly for different feeders.

Use Case 1 Setup

- Feeder from Xcel Energy
- ADMS: Schneider Electric
  - Four levels of remediation
  - Four levels of measurement density.







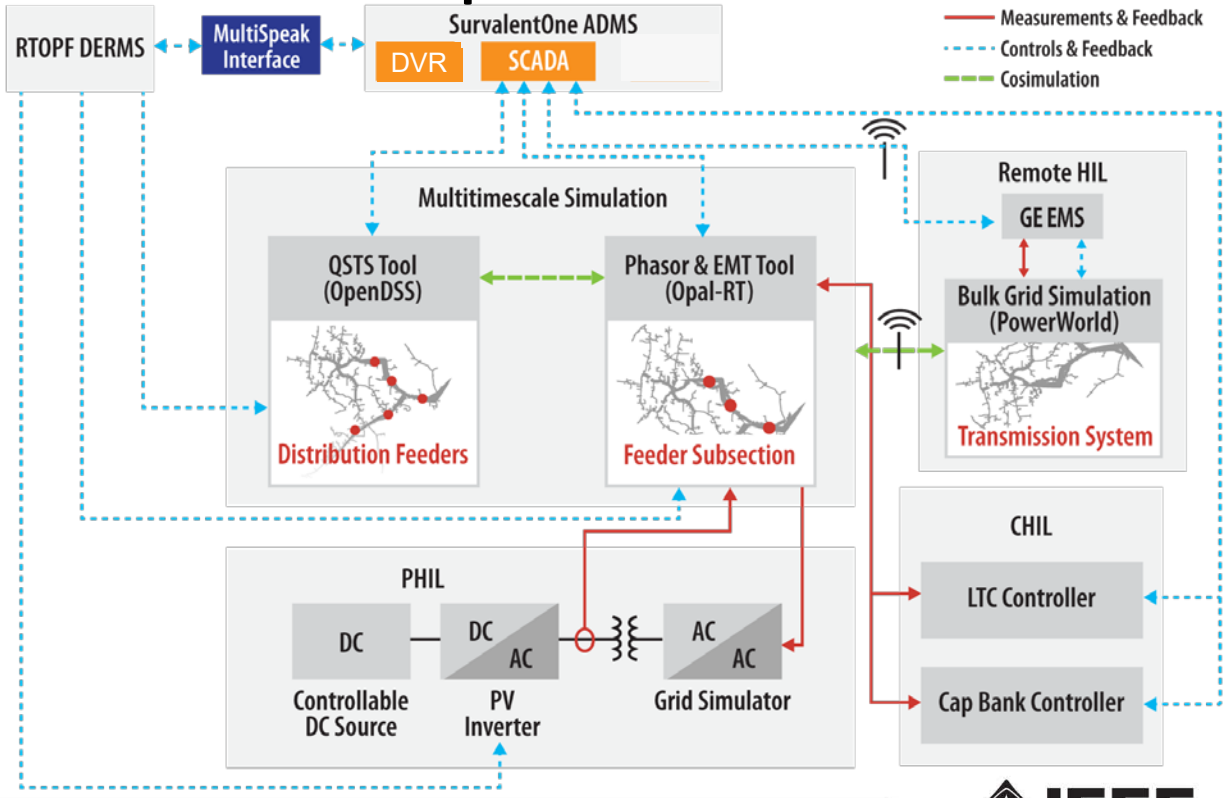
Use Case 2

Evaluate performance of peak load management coordinated across ADMS, DERMS, and energy management systems (EMS)

- Communications interface between ADMS and DERMS
- Effectiveness of DERMS in complementing ADMS operations
- Focus on municipal and cooperative utilities.

Use Case 2 Setup

- Feeder: Holy Cross Energy
- DERMS: NREL
- ADMS: SurvalentOne
- EMS: General Electric (at Pacific Northwest National Laboratory)



Projects Using ADMS Test Bed Capabilities

- Non-wires alternatives to grid modernization
  - ADMS + DERMS for behind-the-meter resources.
- Enabling Extreme Real-Time Grid Integration of Solar Energy (ENERGISE) ECO-IDEA
  - ADMS + Varentec devices + DERMS for photovoltaics
- Evaluating a wireless communications system for utility applications
- Grid Modernization Laboratory Consortium controls coordination between centralized and distributed FLISR.

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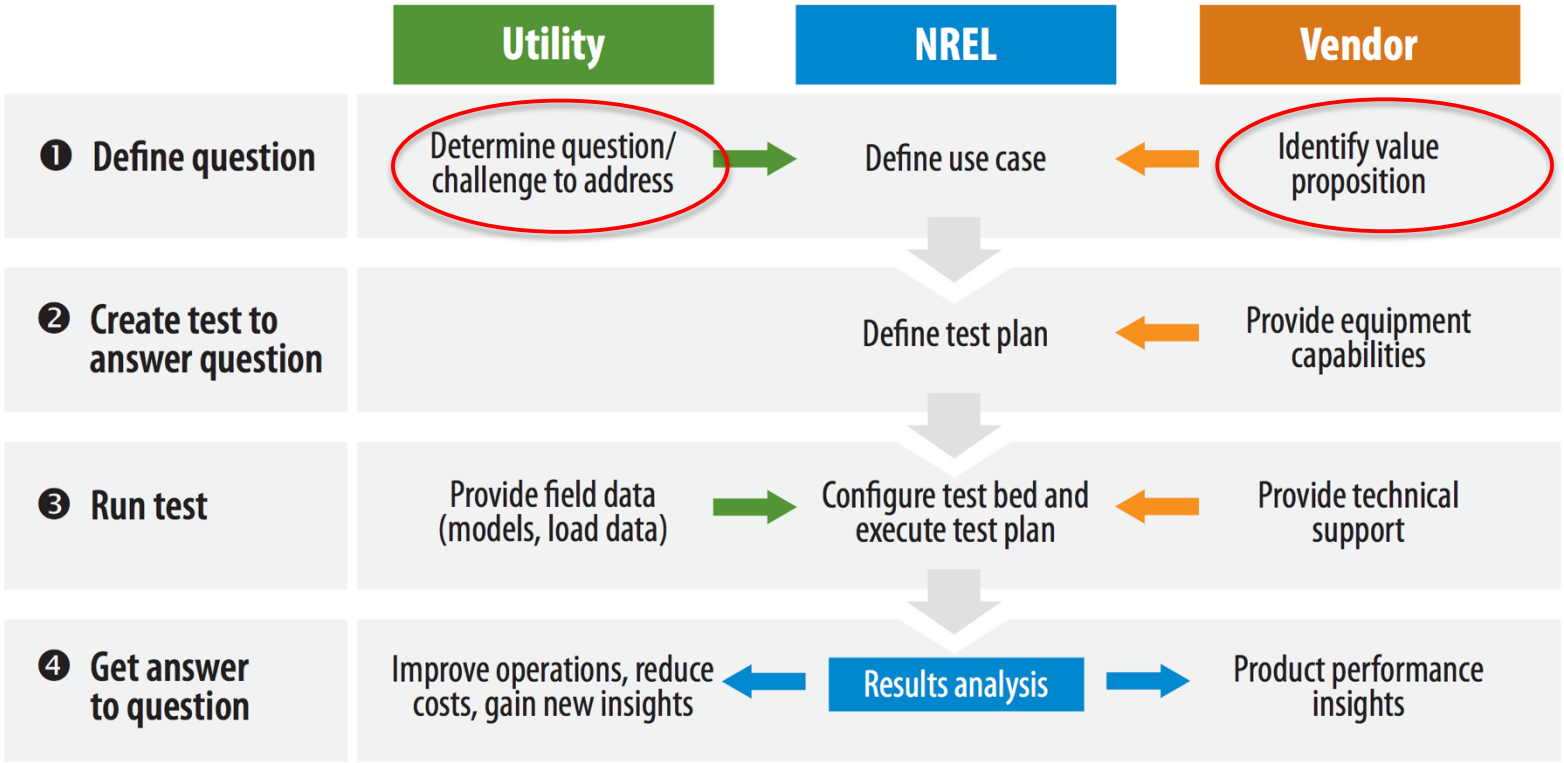
ADMS Test Bed Engagement



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Thank you

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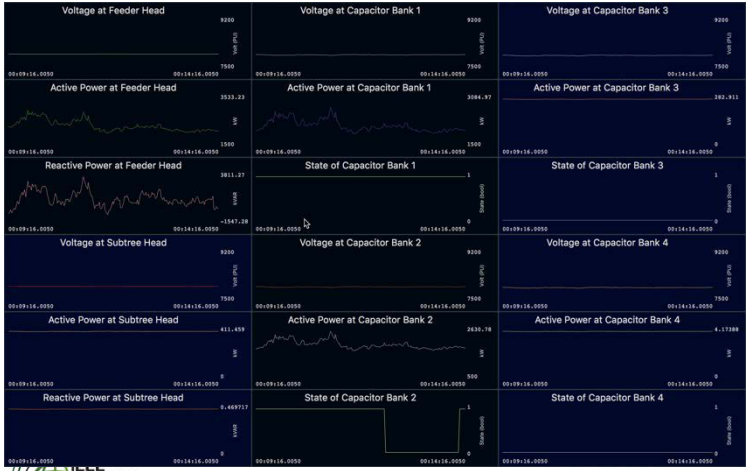
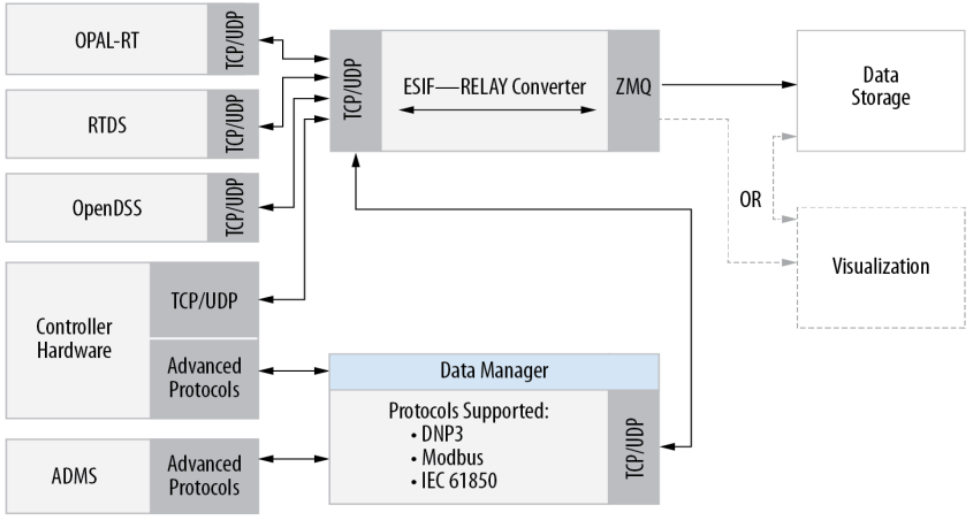
Integrated Data Collection/Management

- Architected and implemented data management tools
- Real-time visualization capability
- Code available on GitHub
- Adding 3-D visualization.

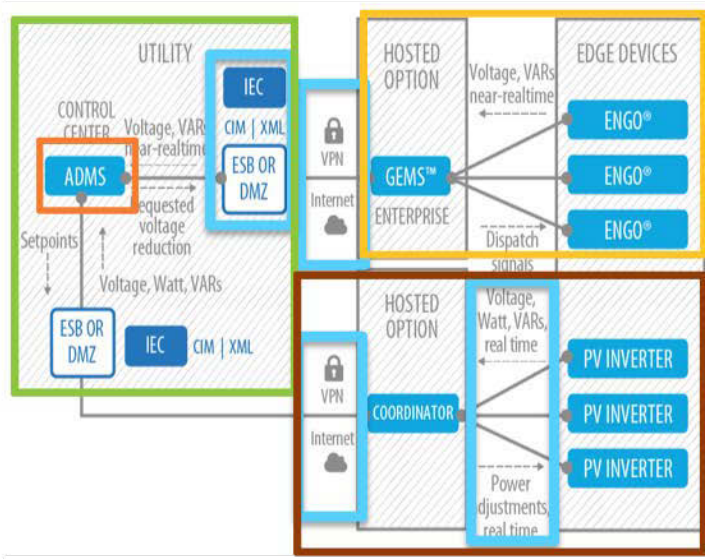




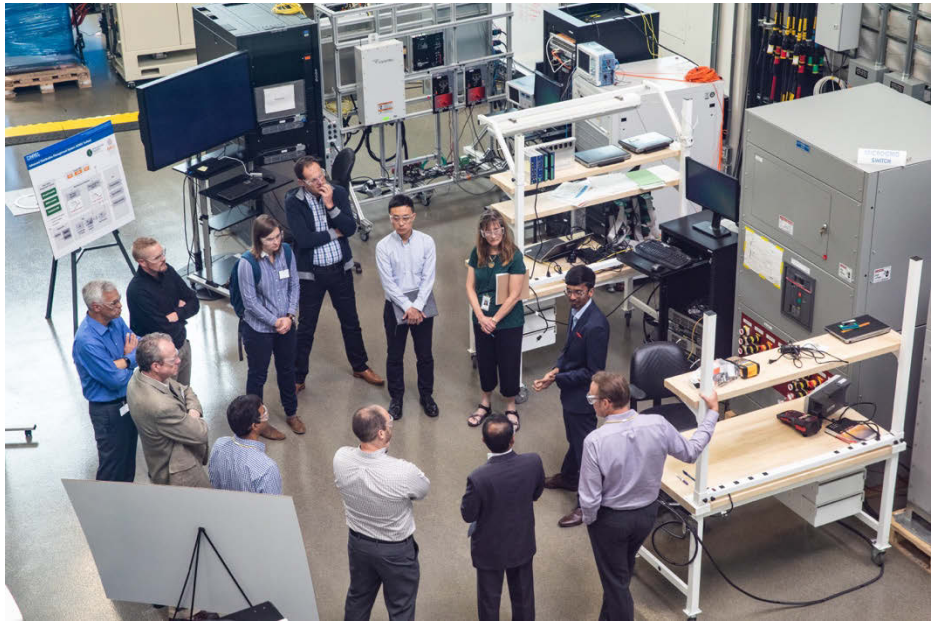
ECO-IDEA Project

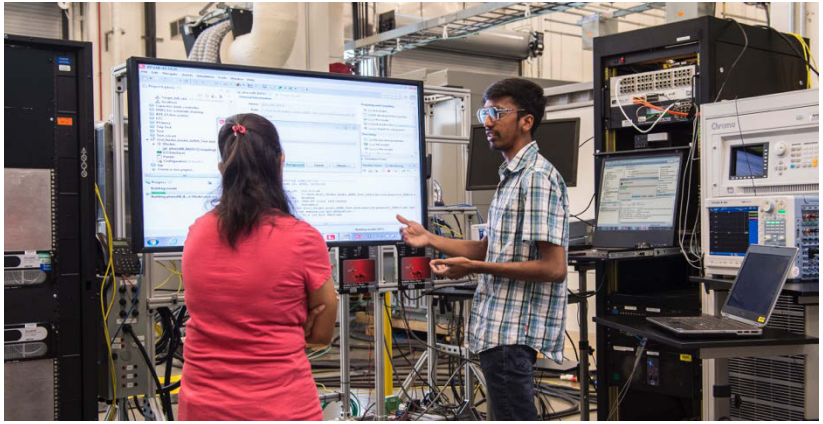
Unified solution to tackle the critical challenges associated with integration of centralized and distributed controls for VVO

- Utility enterprise
- Varentec ENGO® devices
- Real-time optimal power flow
- State estimation, forecasting
- Cybersecurity and interoperability

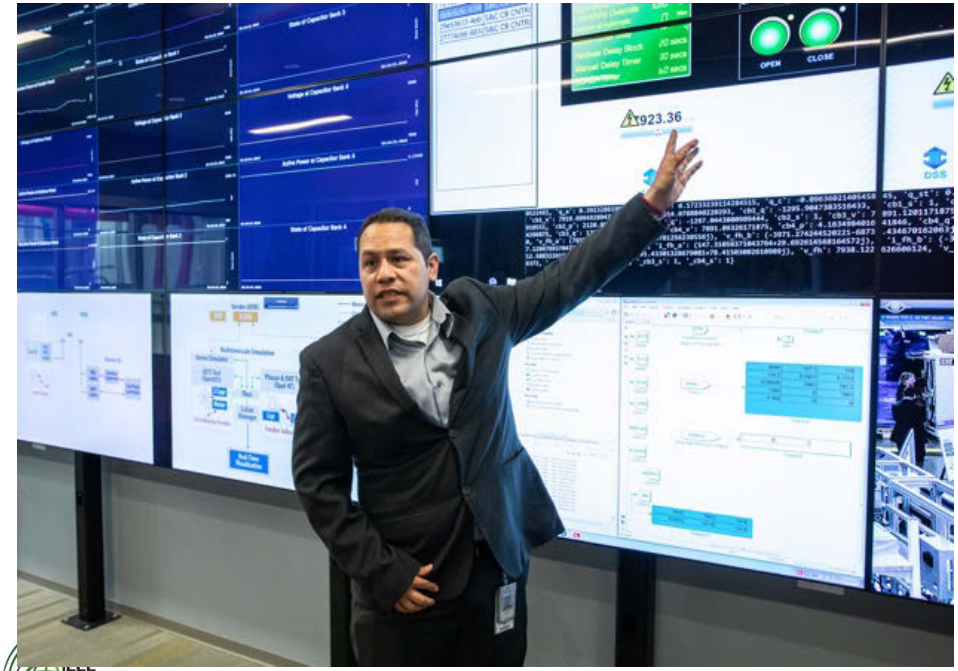


ADMS Test Bed





ADMS Test Bed



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Use Case Setup

Levels of Model Quality

Level 1 – Base-level geographic information system data

Level 2 – Field verification at select locations

Level 3 – Tap-phase verifications

Level 4 – Field confirming each primary pole line.

Levels of Measurement Density

Level 1 – Feeder head

Level 2 – Level 1 + utility assets + 1 tail-end advanced metering infrastructure (AMI) sensor

Level 3 – Level 2 + additional 9 AMI sensors

Level 4 – Level 3 + additional 20 AMI sensors.