Integration of Microgrids, DER Aggregators, and DERMS with ADMS

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

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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.

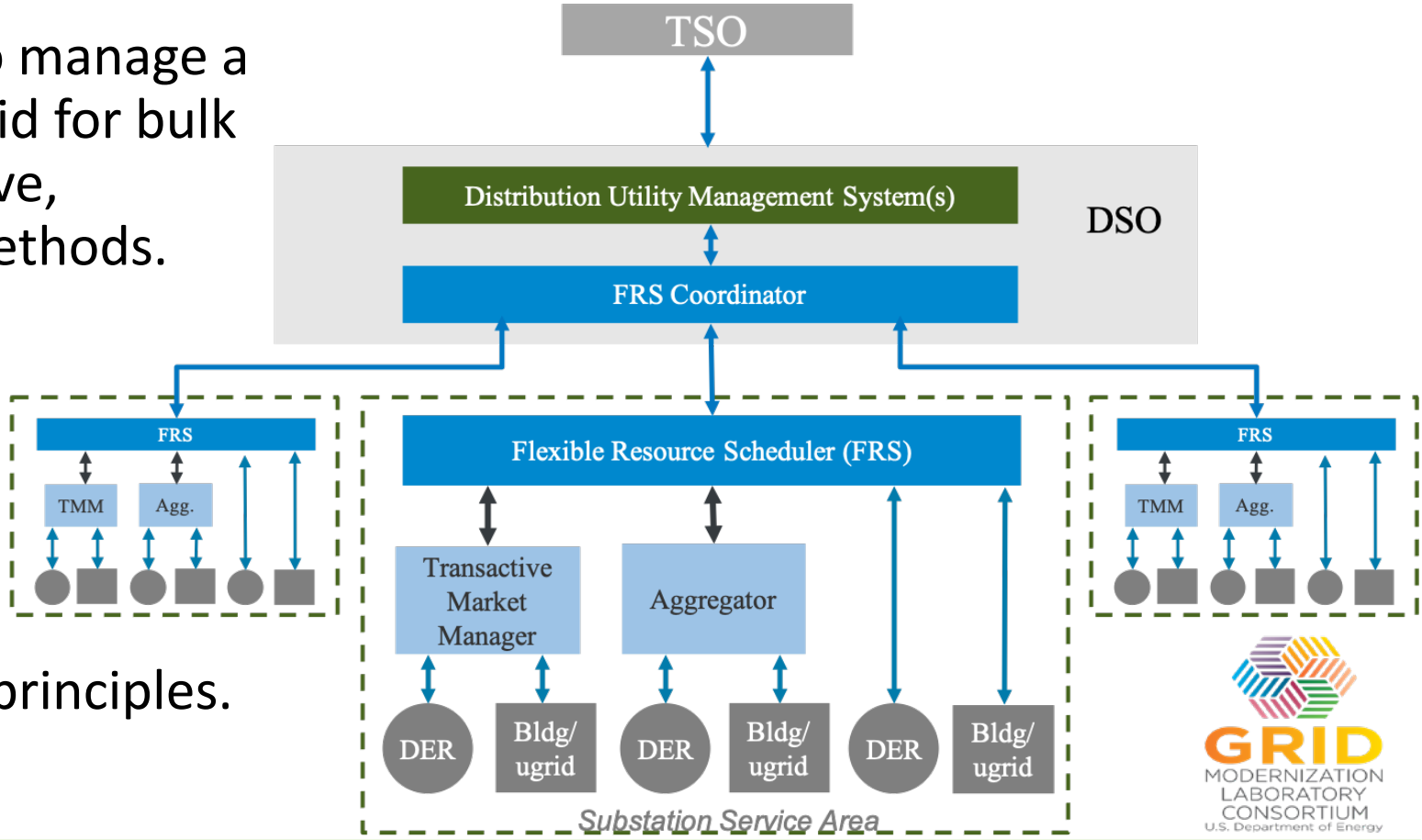
Objective: Develop and demonstrate an architecture that:

- 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.



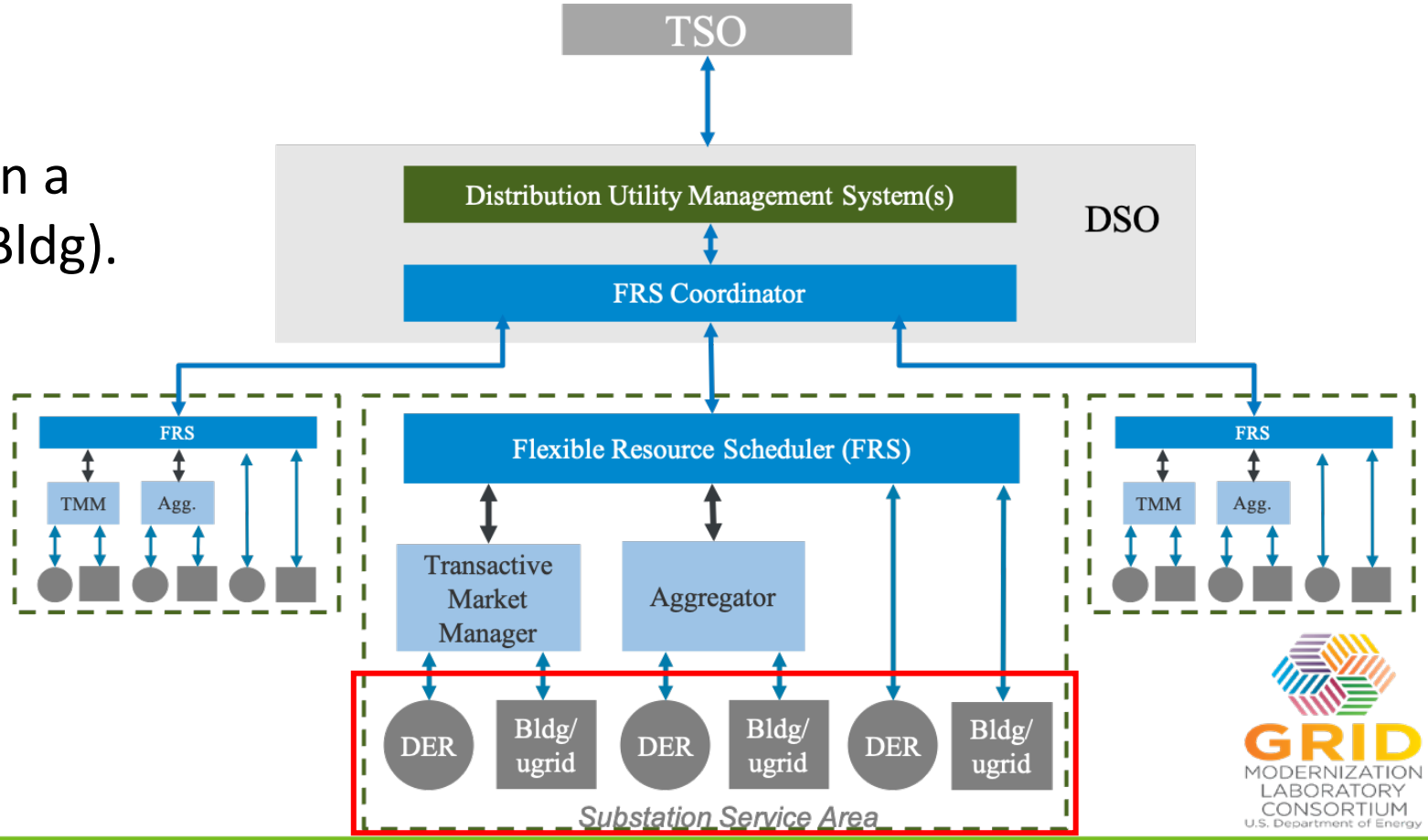
Key architecture features:

- 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

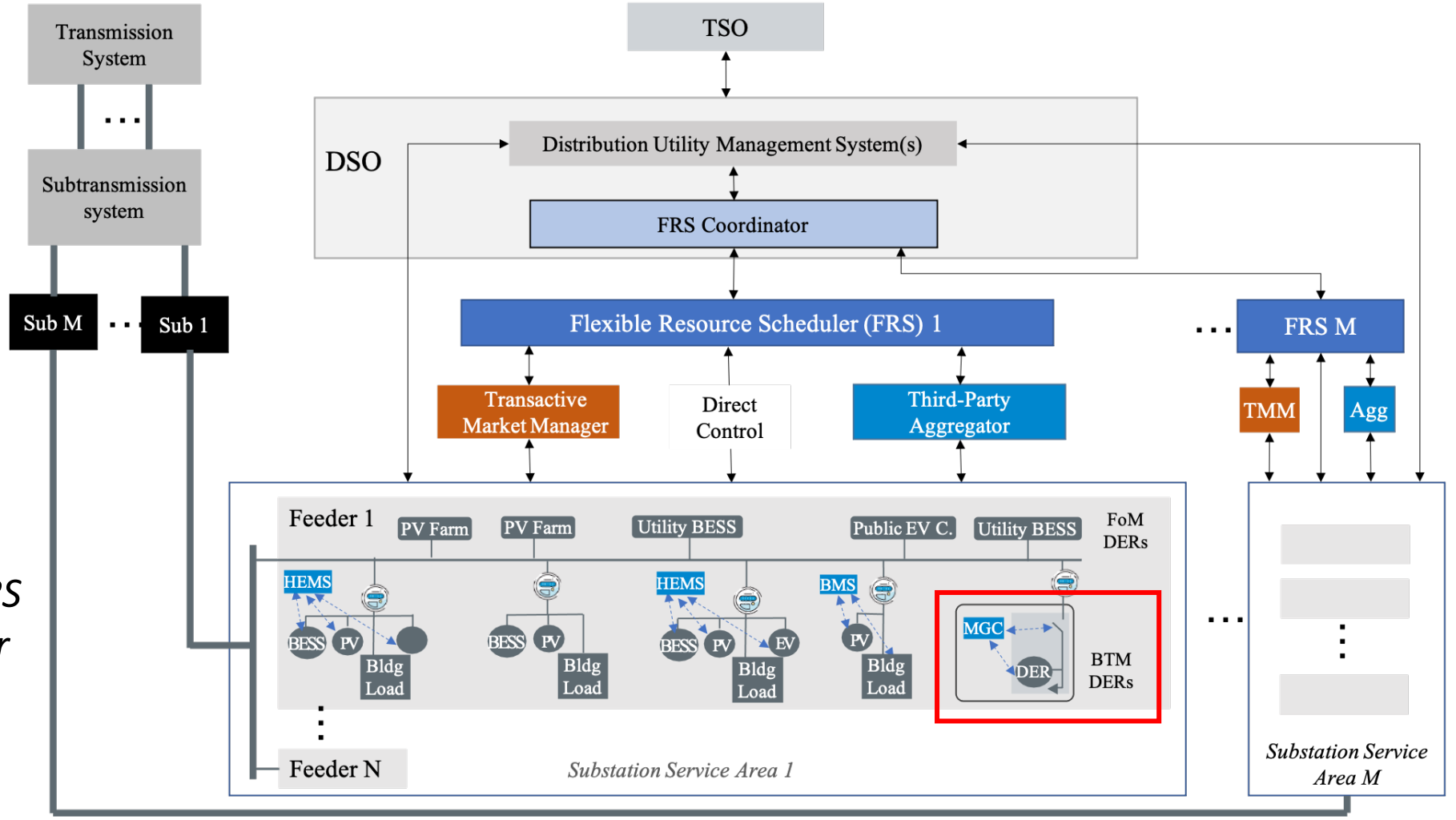
Encompasses DERs aggregated in a microgrid (ugrid) or a building (Bldg).



The DSO aggregates and controls individual DERs to provide **transmission services defined and measured at the transmission-and-distribution interface.**

Distribution substation: point of aggregation

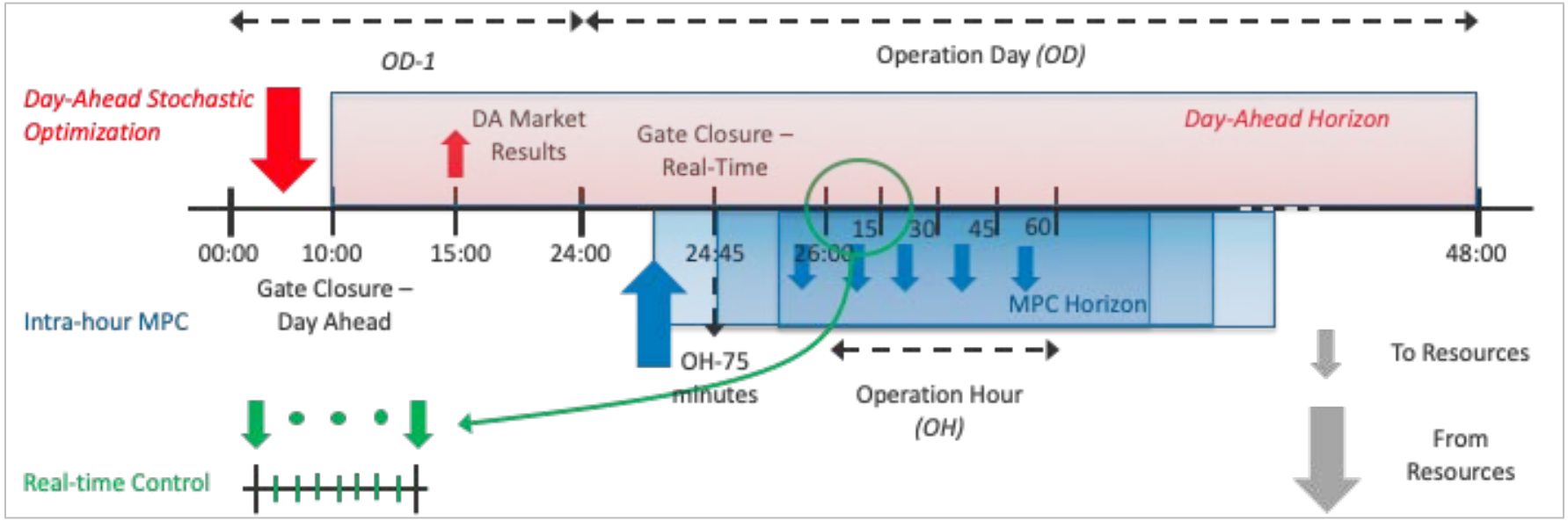
Microgrids can be managed directly by a FRS or through an aggregator or transactive market.



Coordination and Control via the FRS

- Simultaneous distribution management and transmission service provision
- Temporal hierarchy of coordination and control via the FRS:

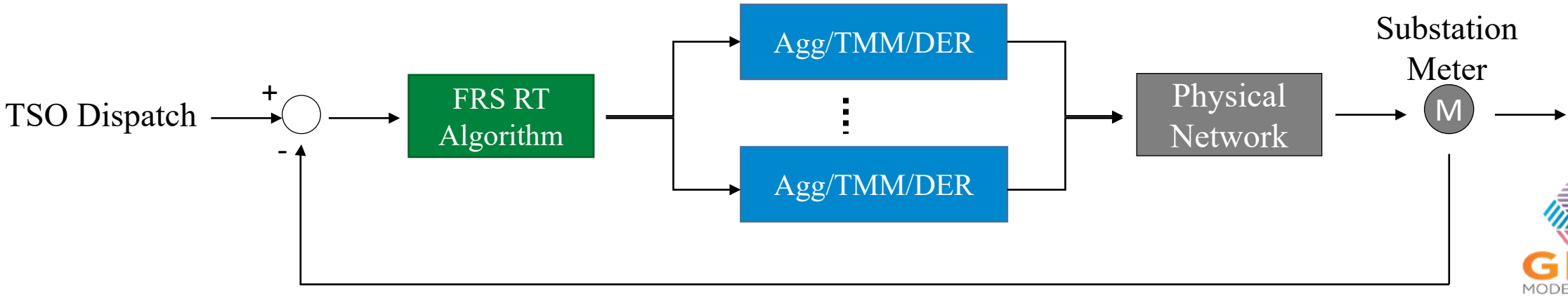
- **Day-ahead** stochastic optimal power flow-based for wholesale market bidding
- **Intra-hour** stochastic model predictive control (MPC) for DER management and response allocation
- **Real-time** signal disaggregation for distributed control.



Real-Time Control in the FRS

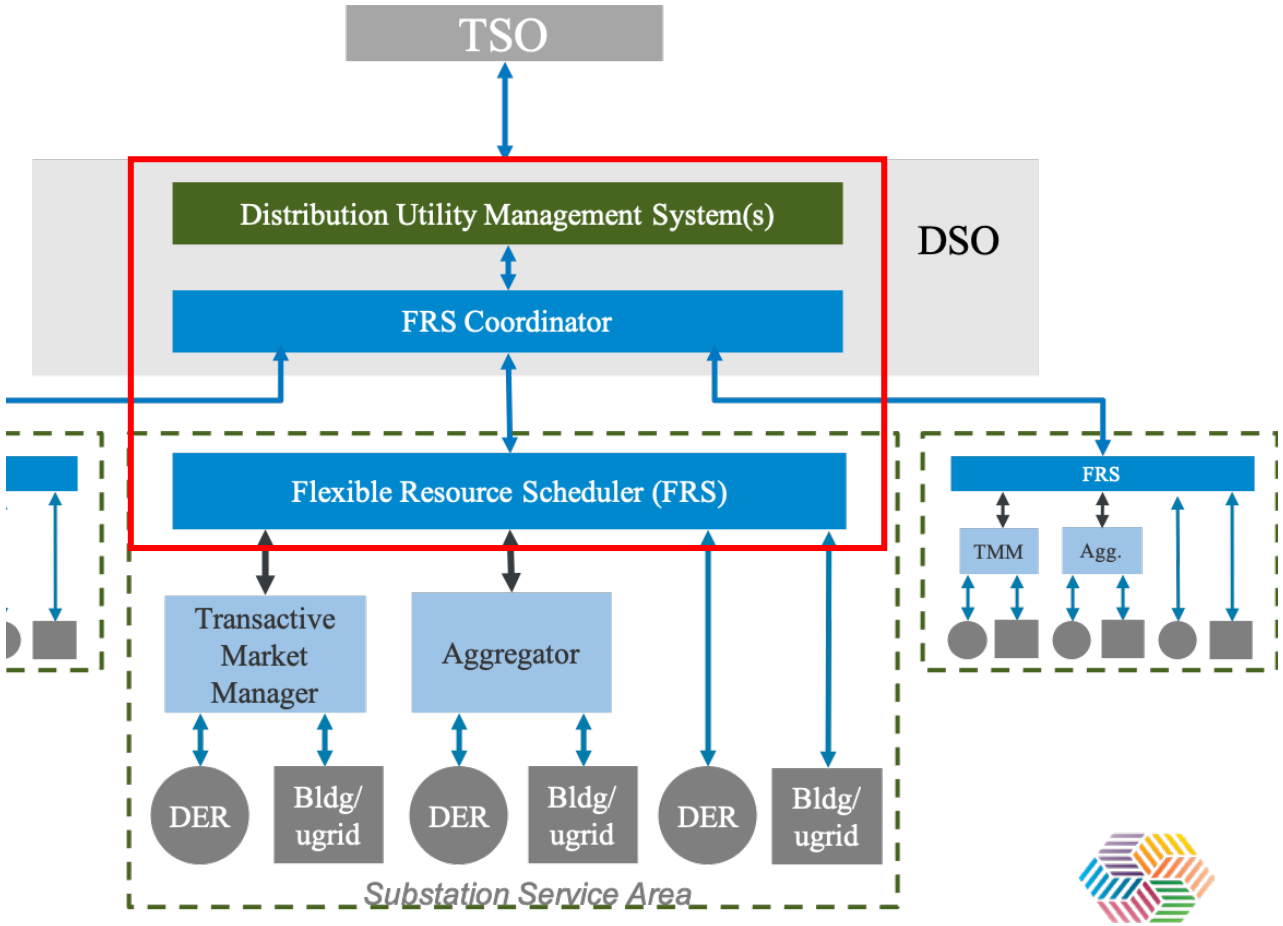
Goal: Minimize the difference between the transmission system operator (TSO) dispatch signal and the measured output at the substation:

- 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.



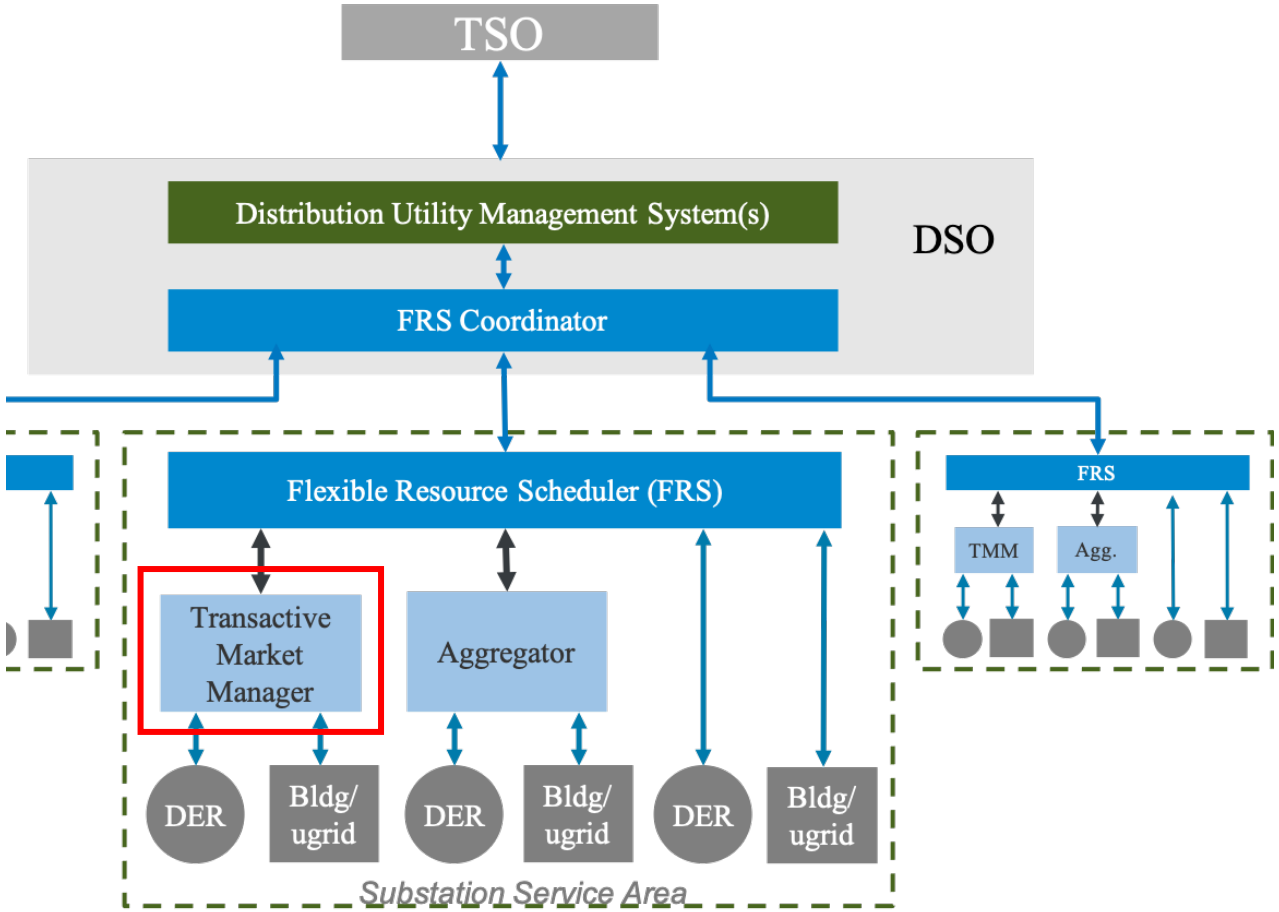
Coordination with Existing Utility Management Systems

- 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

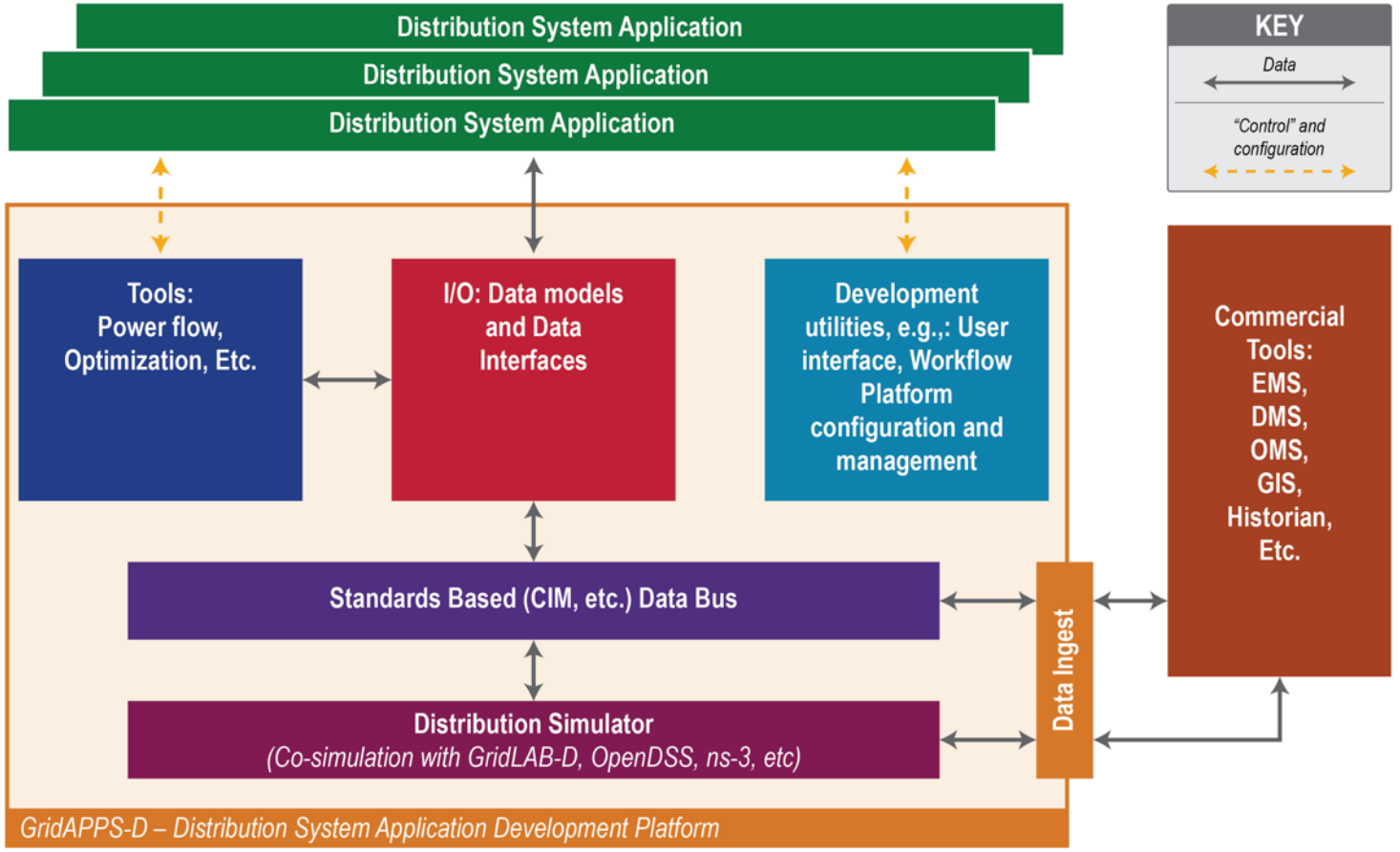
- The FRS will connect with a transactive market manager (TMM).
- The TMM will aggregate the transactive resources.
- The project team is evaluating two transactive methods differentiated by the level, or sophistication, of communication.



Implementation and Evaluation

GridAPPS-D Overview

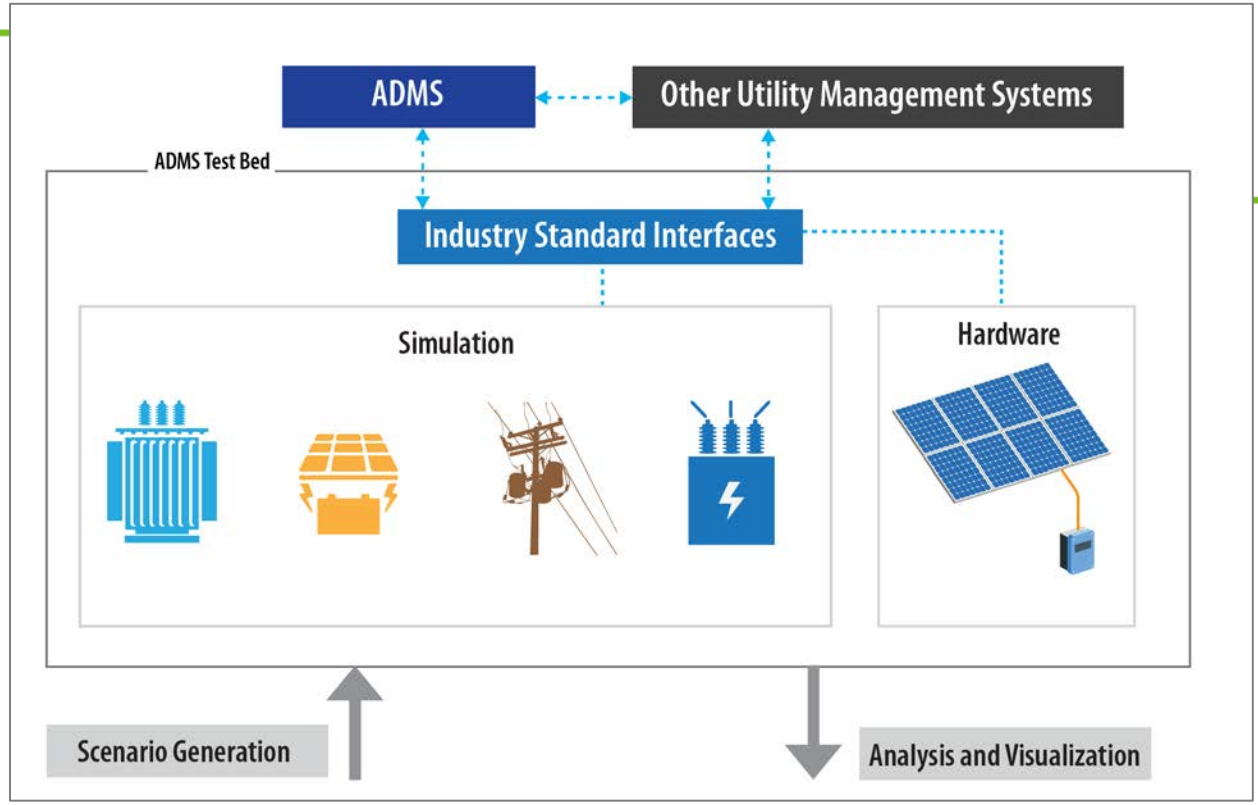
- An open-source platform for ADMS application development
- Built-in distribution simulator, cosimulation, and common services for developers and applications
- Can integrate with external software systems using standard communications (e.g., DNP3).



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.



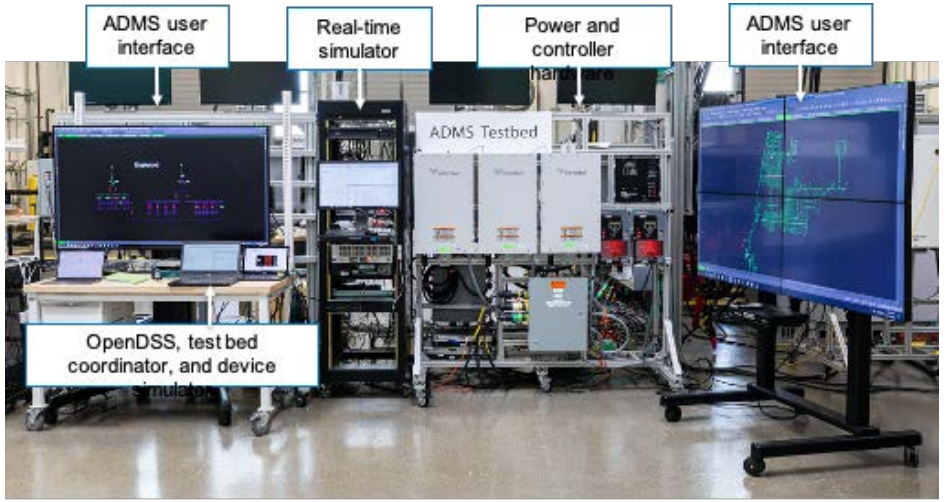
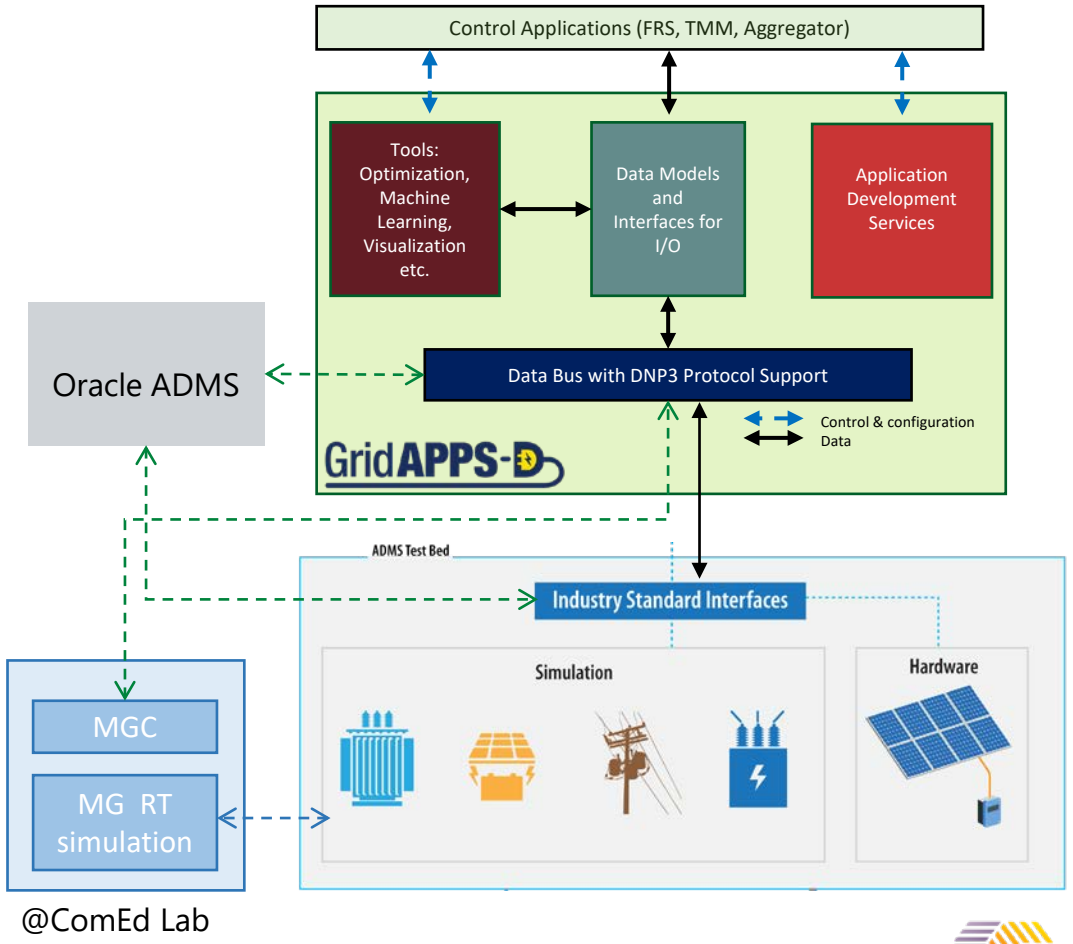


Photo by NREL

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_FAST%20DERMS.pdf

Thank you

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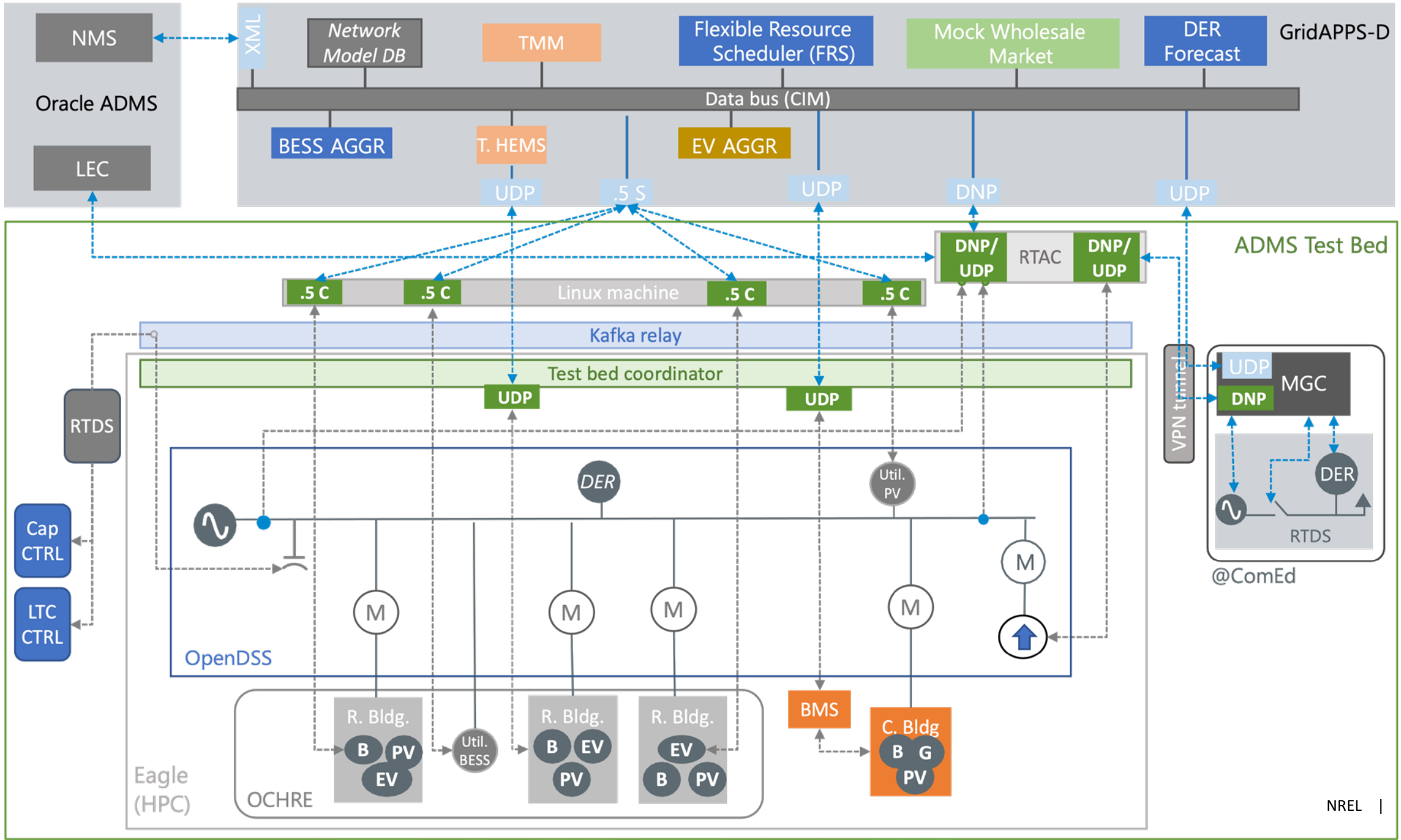
NMS
Oracle ADMS
LEC
XML
Network Model DB
TMM
Flexible Resource Scheduler (FRS)
Mock Wholesale Market
DER Forecast
GridAPPS-D
Data bus (CIM)
BESS AGGR
T. HEMS
EV AGGR
UDP
.5 S
UDP
DNP
UDP
ADMS Test Bed
DNP/ UDP
RTAC
DNP/ UDP
.5 C
.5 C
Linux machine
.5 C
.5 C
Kafka relay
Test bed coordinator
UDP
UDP
RTDS
VPN tunnel
UDP
DNP
MGC
DER
RTDS
@ComEd
Cap CTRL
LTC CTRL
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Communications Architecture