

# Power and Energy Program at UNM

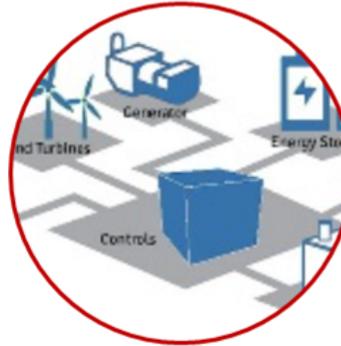
A multidisciplinary research program working on multiple aspects of society's energy needs and networked systems:

- power system control and protection,
- microgrid and smart grid design and operation,
- integration of distributed energy resources, Power Electronics, Storage and Electric Vehicles,
- novel photovoltaics (PV) materials for better solar cells.



## Renewable Energy Systems

- Grid Integration
- Impact Studies
- Control System Design



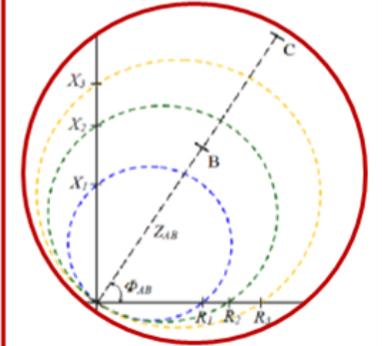
## Microgrid and Smartgrid

- Control
- Feasibility Studies
- DC and AC/DC Microgrids



## Grid Modernization

- Modern Control Systems
- Automation
- Market Analysis
- Resilience



## Protection

- Adaptive Protection
- Automated Coordination Studies
- Microgrid Protection



# Microgrid/Smart grid Introduction

Smartgrid refers to a class of technology that modernizes utility electricity delivery systems using computer-based remote control and automation.

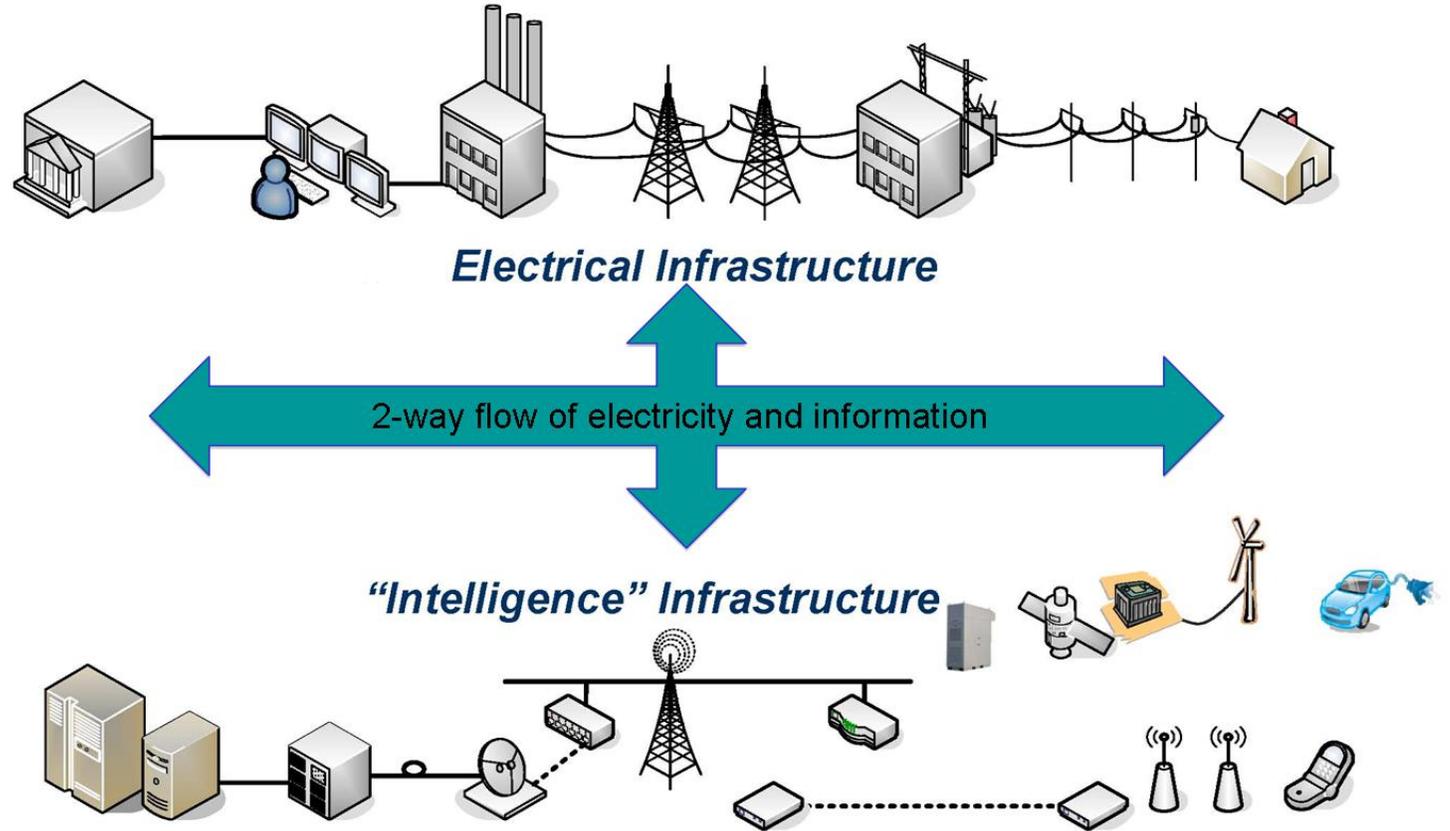
**Reliability**



**Sustainability**



**Efficiency**



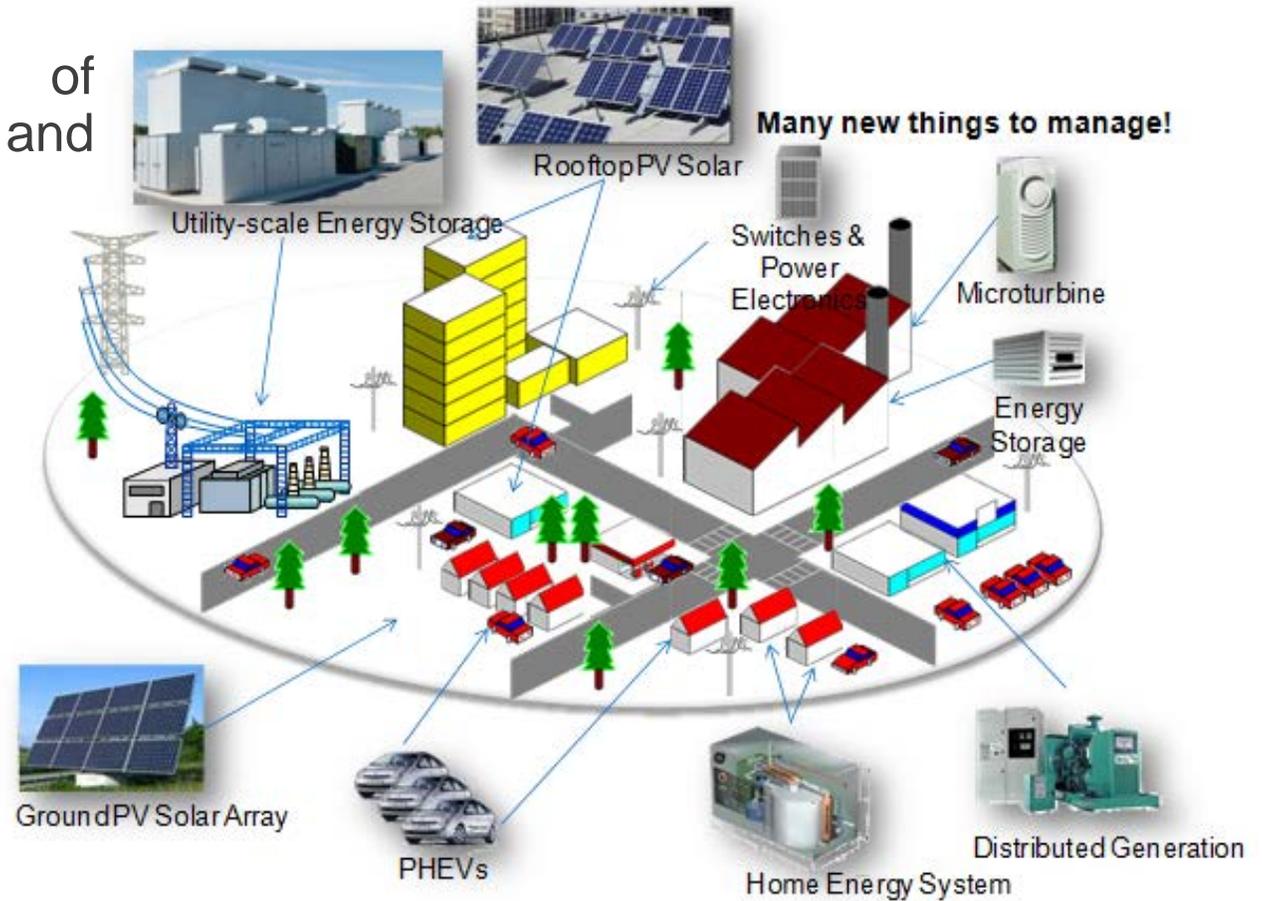
# Microgrid/Smart grid Introduction

## Department of Energy:

- Microgrid, as the main building block of smartgrids, is a group of interconnected loads and distributed energy resources.
- Microgrid has the ability to work in
  - grid-connected
  - islanded modes.

## Microgrid applications:

- Rural plants.
- Business buildings, hospitals, and factories
- Forward operating bases



# UNM Mesa del Sol Microgrid



- PV system (50kW)
- Lead-acid battery energy storage system (50kW/90kWh)
- Natural Gas generator (240kW)
- Fuel Cell (80kW)
- hot and cold thermal storage, and an adsorption chiller.



# UNM Mesa del Sol Microgrid - History

- \$15 M equipment and infrastructure.
- History: Built by Japan's New Energy and Industrial Technology Development Organization (NEDO)
- Equipment from Japanese companies including Shimizu, Toshiba, Tokyo Gas, Mitsubishi, Fuji Electric, Furukawa Battery, and others.
- Under NEDO's agreement, the microgrid was turned over to UNM in 2014.



# UNM Mesa del Sol Microgrid - Benefits

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➤ ***Economic development***

➤ ***Outreach activities***

➤ ***Research activities***

# UNM Mesa del Sol Microgrid - Benefits

## ➤ ***Economic development:***

- Directly impacting the local MDS entities (e.g., Aperture Center, Netflix, ...) by providing a resilient source of power and minimizing the electric utility bills.
- Opens a new avenue to bring world renowned electric power industry players (e.g., Siemens, Emera) to New Mexico.
- Local workforce training in the area of renewable energy systems, building energy management, and microgrid operation.

Mesa del Sol

SIEMENS



NETFLIX

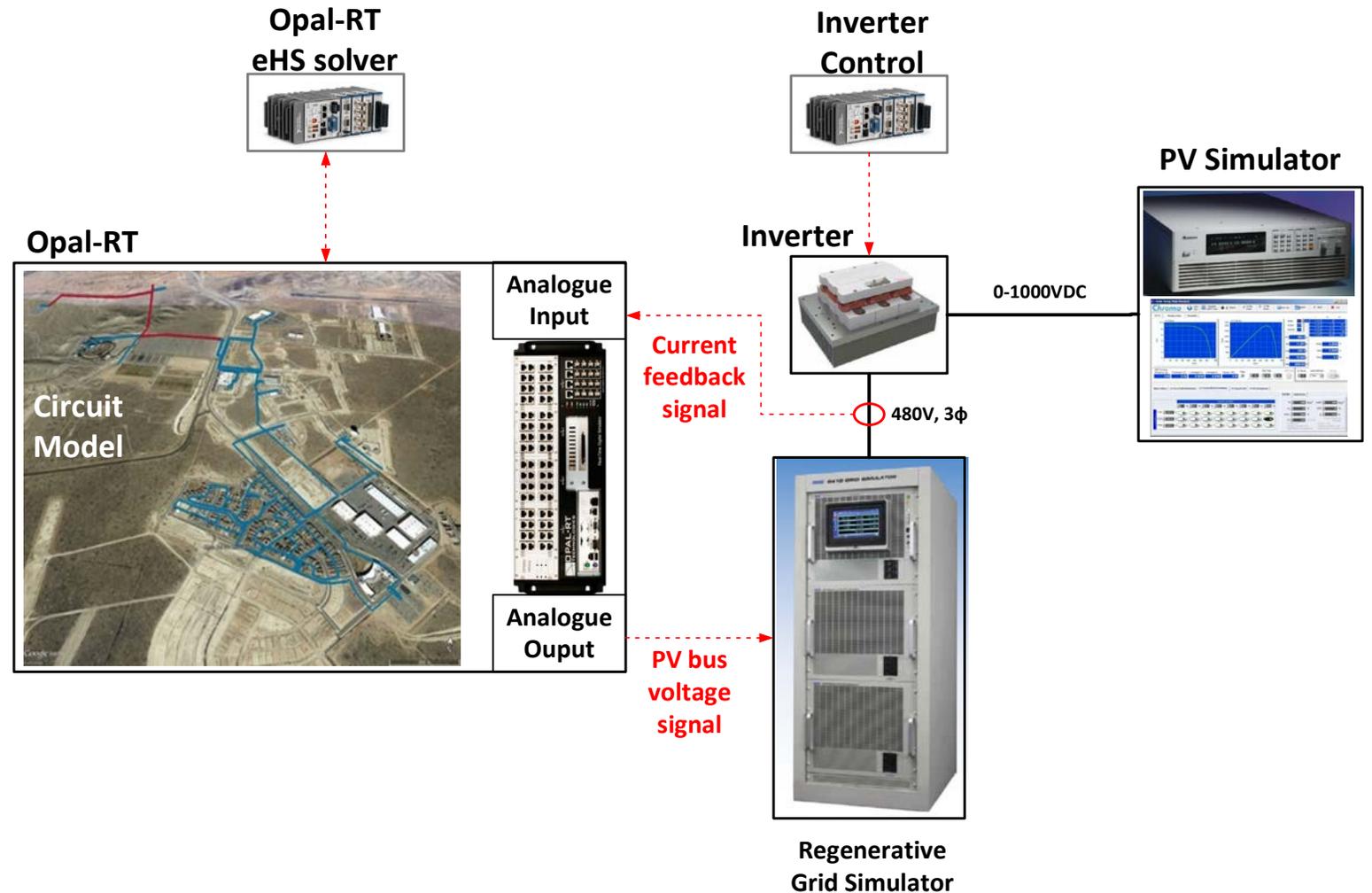
# UNM Mesa del Sol Microgrid - Benefits

- Outreach Activities:
  - Workforce training
  - Collaboration with SIPI
  - Collaboration with Explora
  - Educational outreach for high school teachers (Engineering Student Success Center)



# UNM Mesa del Sol Microgrid - Benefits

**Power and Control Hardware-in-the-Loop Laboratory:** A laboratory testbed that facilitates the real-time simulation of large electric power systems while integrating actual power system equipment to the simulation model.



# NM SMART Grid Center

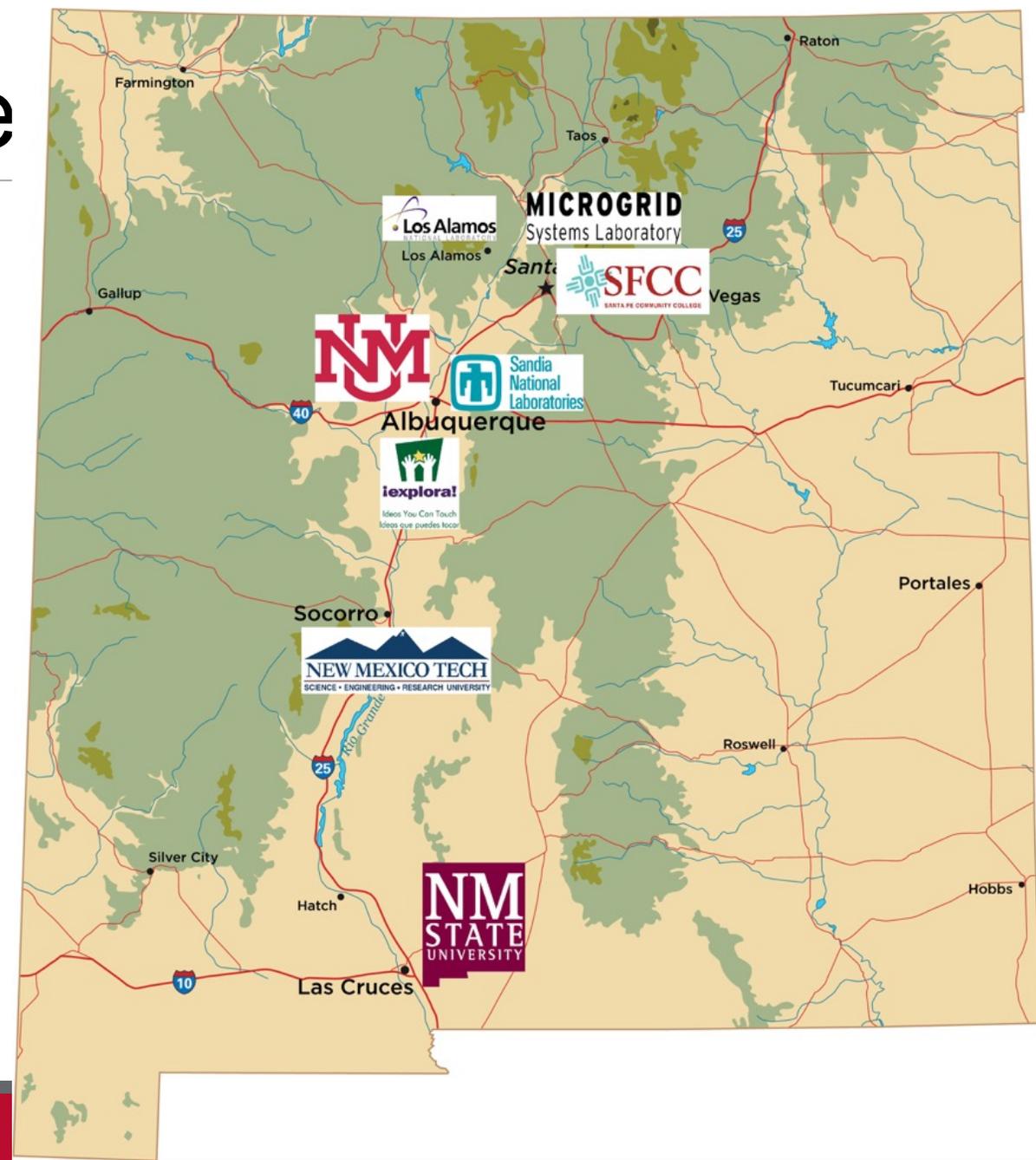
- Sponsored by NSF EPSCoR (\$24 M)
- “SMART:”
  - Sustainable
  - Modular
  - Adaptive (using Artificial Intelligence and Machine Learning)
  - Resilient
  - Transactive
- Develop a modern electric grid that will account for:
  - renewable distributed resources
  - electricity-based transportation
  - human activities
  - rapid integration to existing infrastructures



# NM SMART Grid Cente

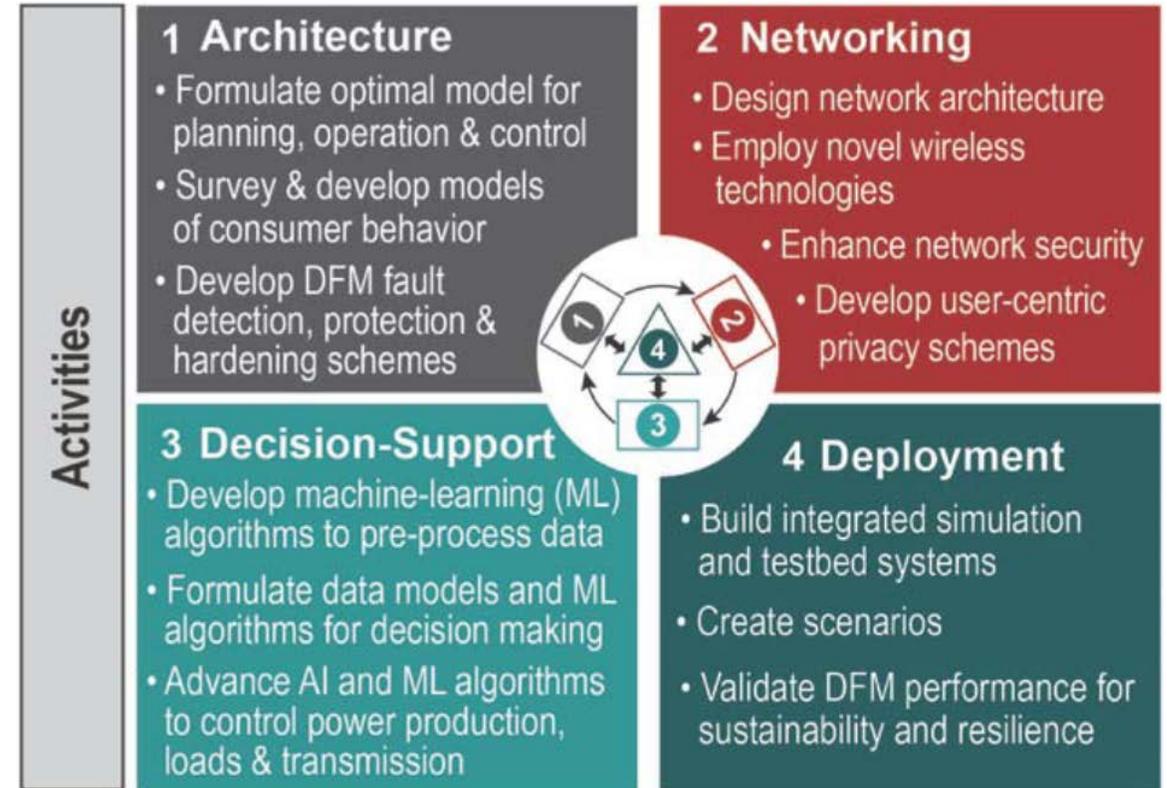
## Participating Institutions

- 3 research universities
- 1 community college
- 2 national laboratories
- 1 museum
- 1 non-profit
- Industry partners



# NSF EPSCoR “SMART” Project Goals

- Optimal Architecture for planning, operation and control of Distribution Feeder Microgrids
- Design a network architecture for Distribution Feeder Microgrid Infrastructure
- Create data-driven adaptive decision-making strategies for power control and resiliency using AI and Machine Learning
- Integrate and verify Distribution Feeder Microgrids in multi-scale testbeds

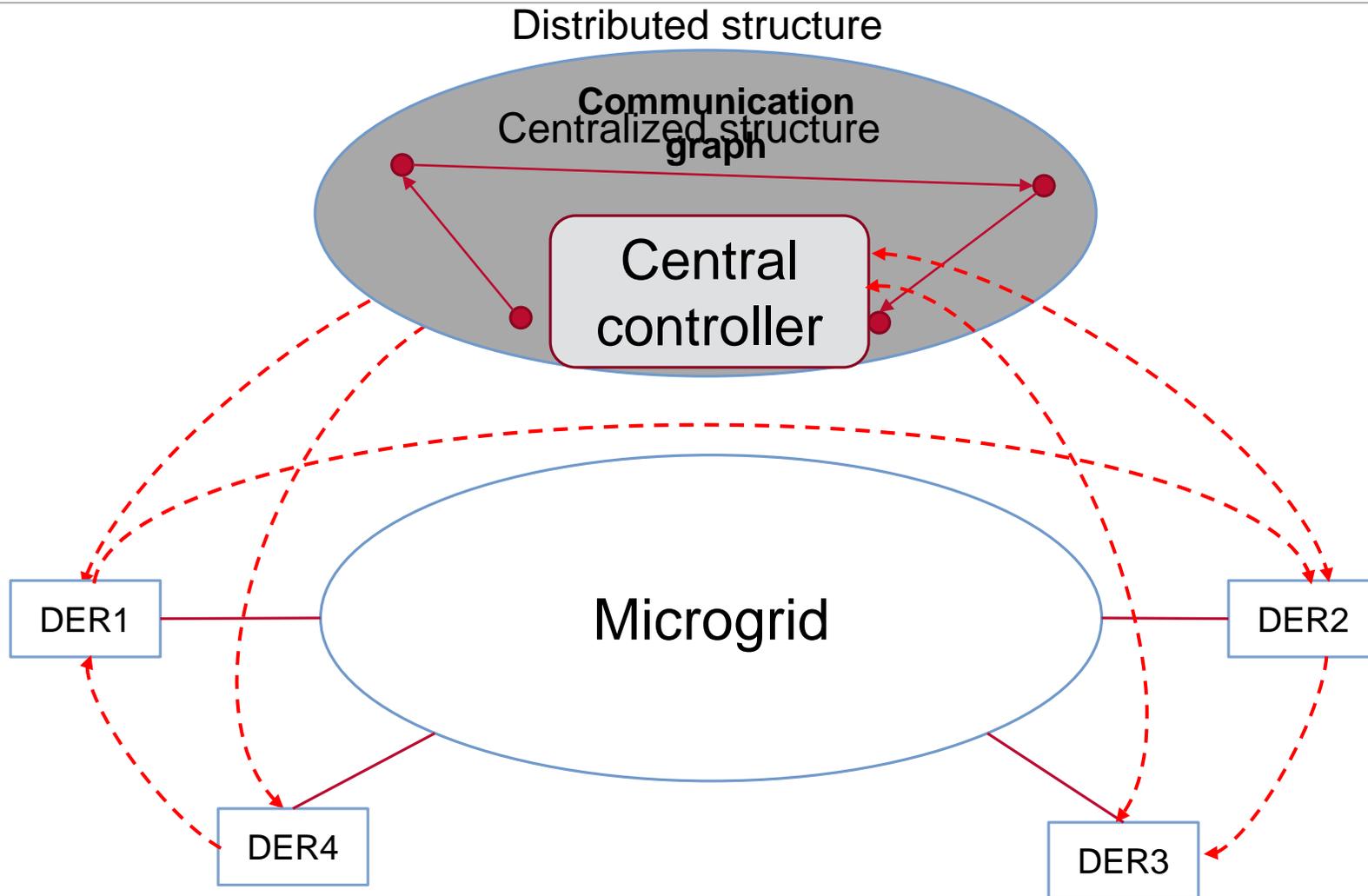


# Ongoing Microgrid Research at UNM

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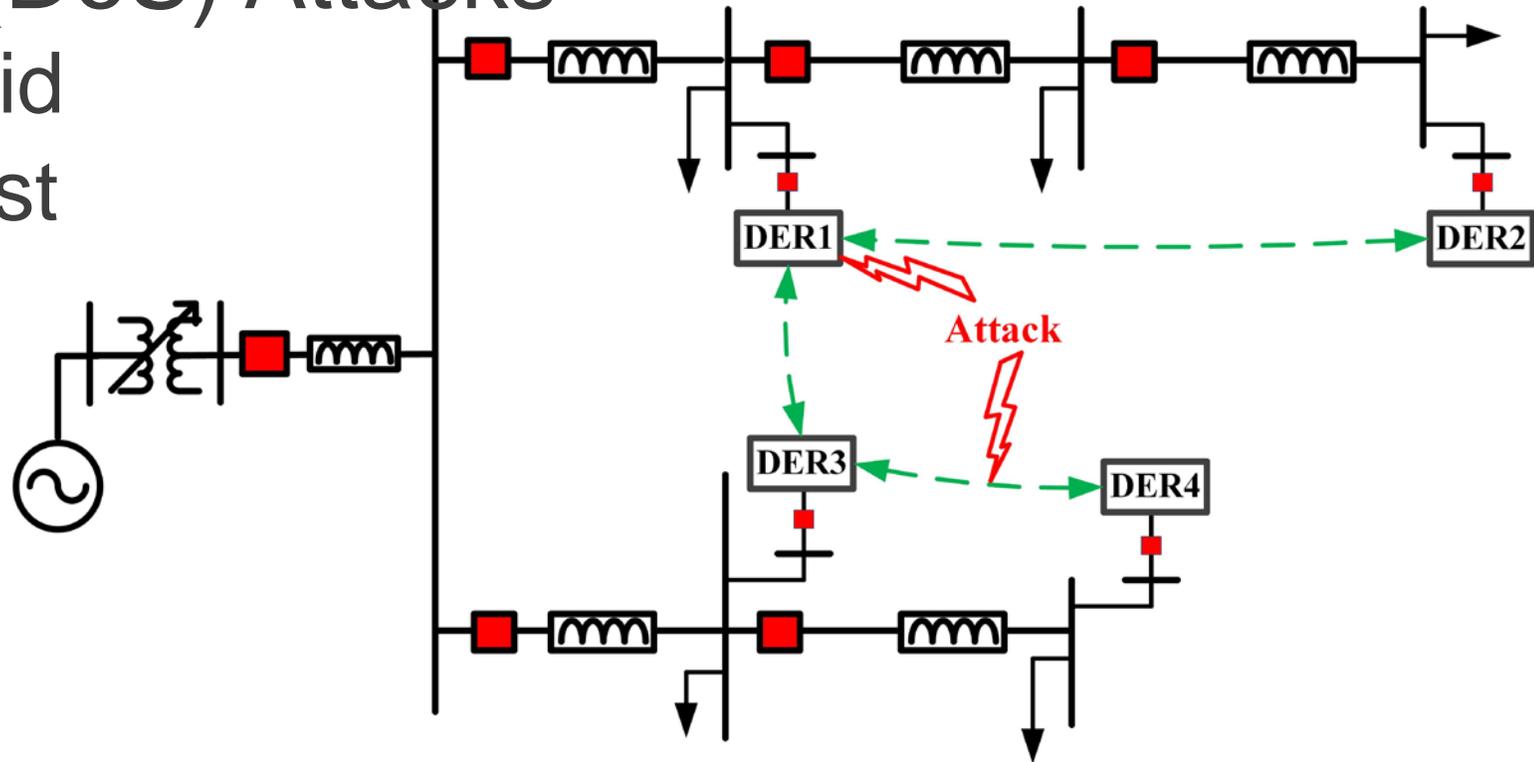
- Distributed control of microgrids
- Microgrid cybersecurity
- Adaptive protection systems
- Microgrid clustering for improving grid resilience

# Microgrid distributed control

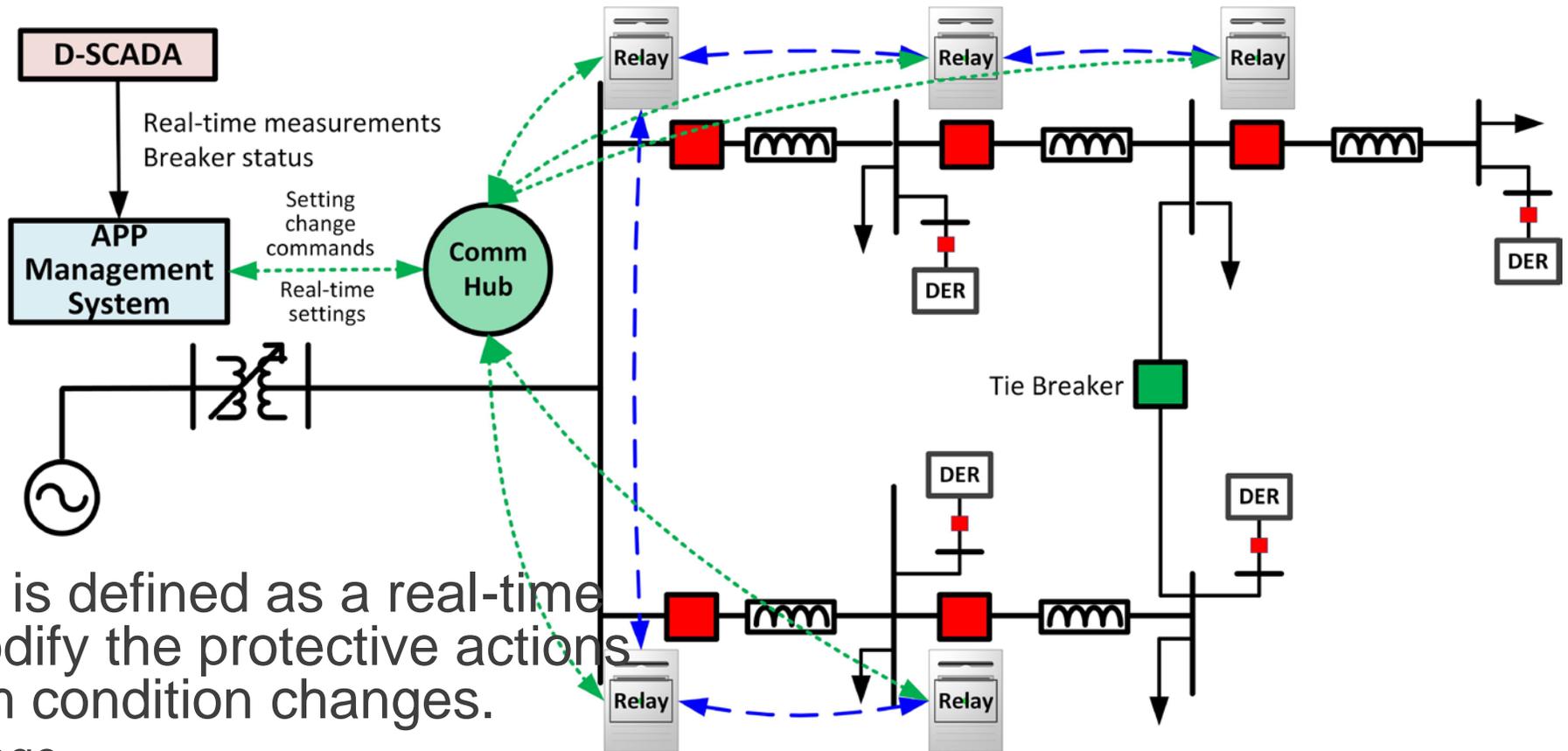


# Cybersecurity of microgrids

- False Data Injection Attacks (FDI)
- Denial of Service (DoS) Attacks
  - Ukrainian Power Grid
  - Aurora generator test



# Adaptive Protection Systems



Adaptive protection is defined as a real-time system that can modify the protective actions according to system condition changes.

- Circuit topology change
- DER generation level change