# WEST VIRGINIA SUPER CIRCUIT (WVSC)

International Microgrid Symposium,
San Diego, CA
17-18 September, 2009

Hakan INAN
Science Applications International Corporation (SAIC)

# Outline

- WVSC Project Overview
- Project Objectives
- Morgantown Developmental Field Test
- WVSC Project Technologies
- Technical Challenges
- Project Benefits

# WVSC Project Overview

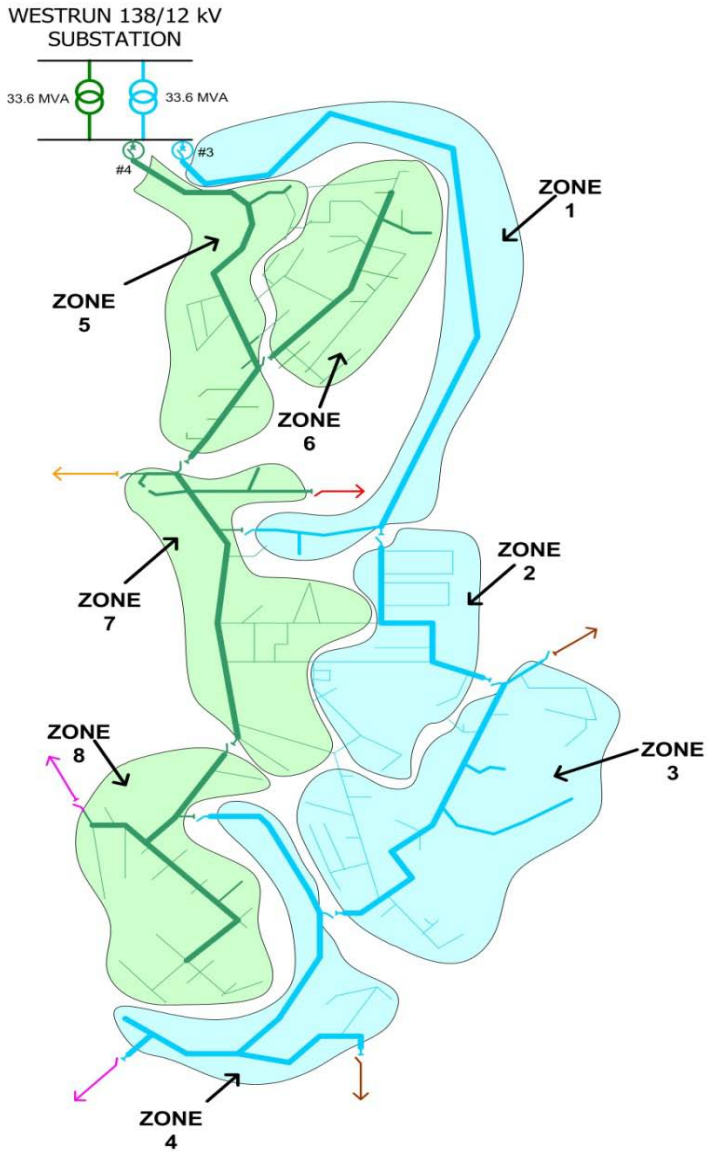
- Team Members
  - Allegheny Power – PM
  - Science Applications International Corporation (SAIC) – Systems integrator, design, testing
  - West Virginia University (WVU) Research Park – Distributed generation
  - WVU Advanced Power and Electricity Research Center – Agent based controls development, modeling & simulation,
  - North Carolina State University – Fault location, fault prediction
  - Augusta Systems, Inc. – Communications network
  - Tollgrade Communications – Advanced sensors
- Current Status
  - Negotiations between NETL/Allegheny Power. Expected project kick-off October, 2009

# Project Objectives

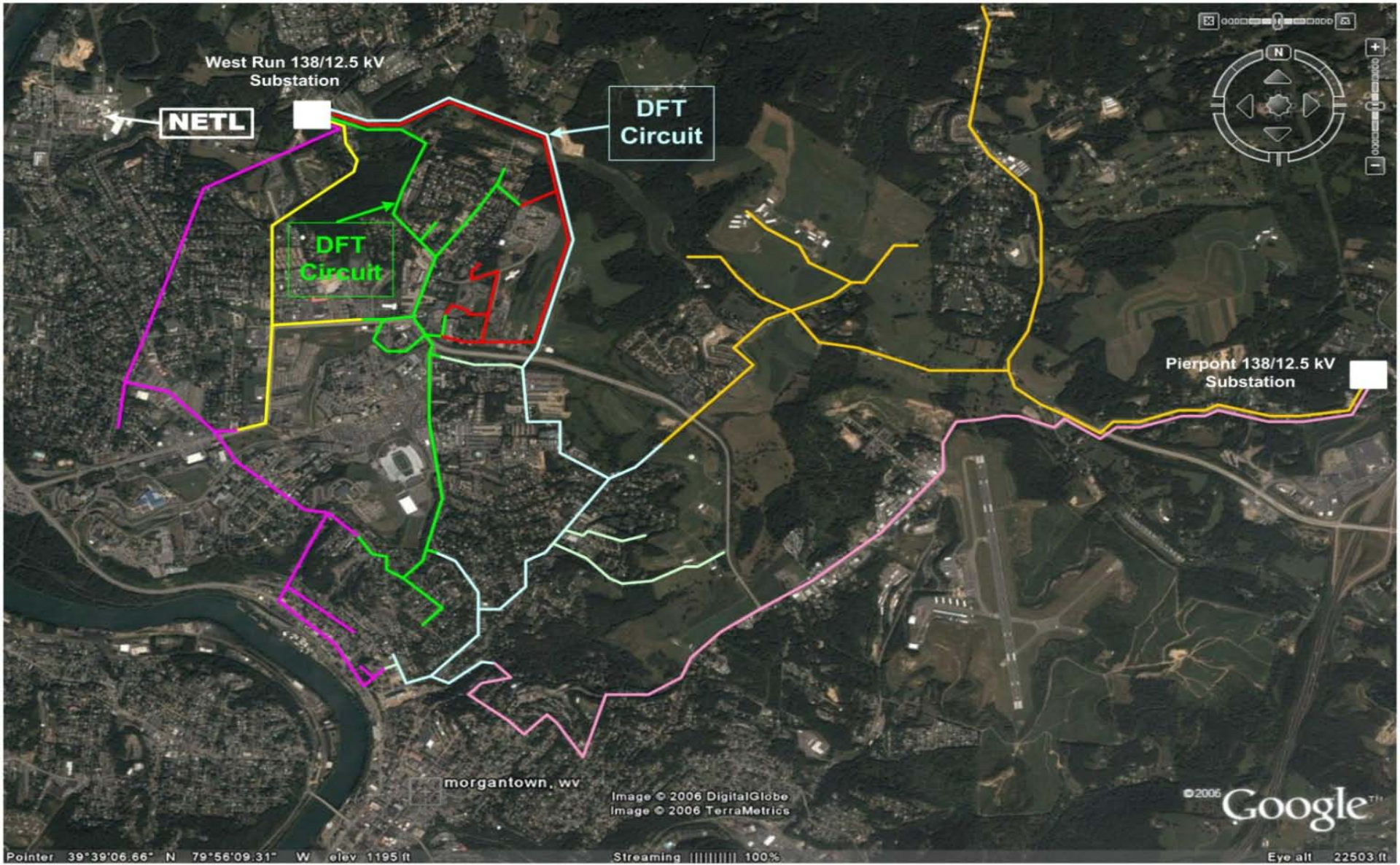
- Achieve >15% peak power reduction; demonstrate that this can be done at a cost competitive with capacity upgrades
- Demonstrate the viability of advanced circuit control through multi-agent technologies
- Demonstrate the benefits of the integrated operation of rotary and inverter-based distributed generation (DG), energy storage, Automated Load Control (ALC), advanced wireless communications, and advanced system control technologies
- Use advanced operational strategies such as dynamic islanding and micro-grids to serve priority loads through the integration of ALC with advanced system control
- Demonstrate the reliability benefits of Dynamic Feeder Reconfiguration (DFR) across two adjacent feeders
- Leverage advanced wireless communications to address interoperability issues between control and protection systems and distributed energy resources (DERs)

# Morgantown Developmental Field Test (DFT)

- Cost-shared demonstration project between DOE/NETL and Allegheny Power
- Goal: Major improvement in reliability, minimize labor cost associated with fault restoration
- Scope: Dynamic Feeder Reconfiguration System
  - Locate & isolate the feeder fault, restore service from adjacent feeders
  - 5,000 customers, two 138/12.5 kV substations, 668 distribution transformers, 29 MVA of installed capacity in two circuits
- Real-time monitoring of distribution circuits, remote control of automated switchgear
- Wi-Fi mesh communications network
- Site Acceptance Test completed in August, 2009
- West Virginia Super Circuit will build on one of the two DFT circuits

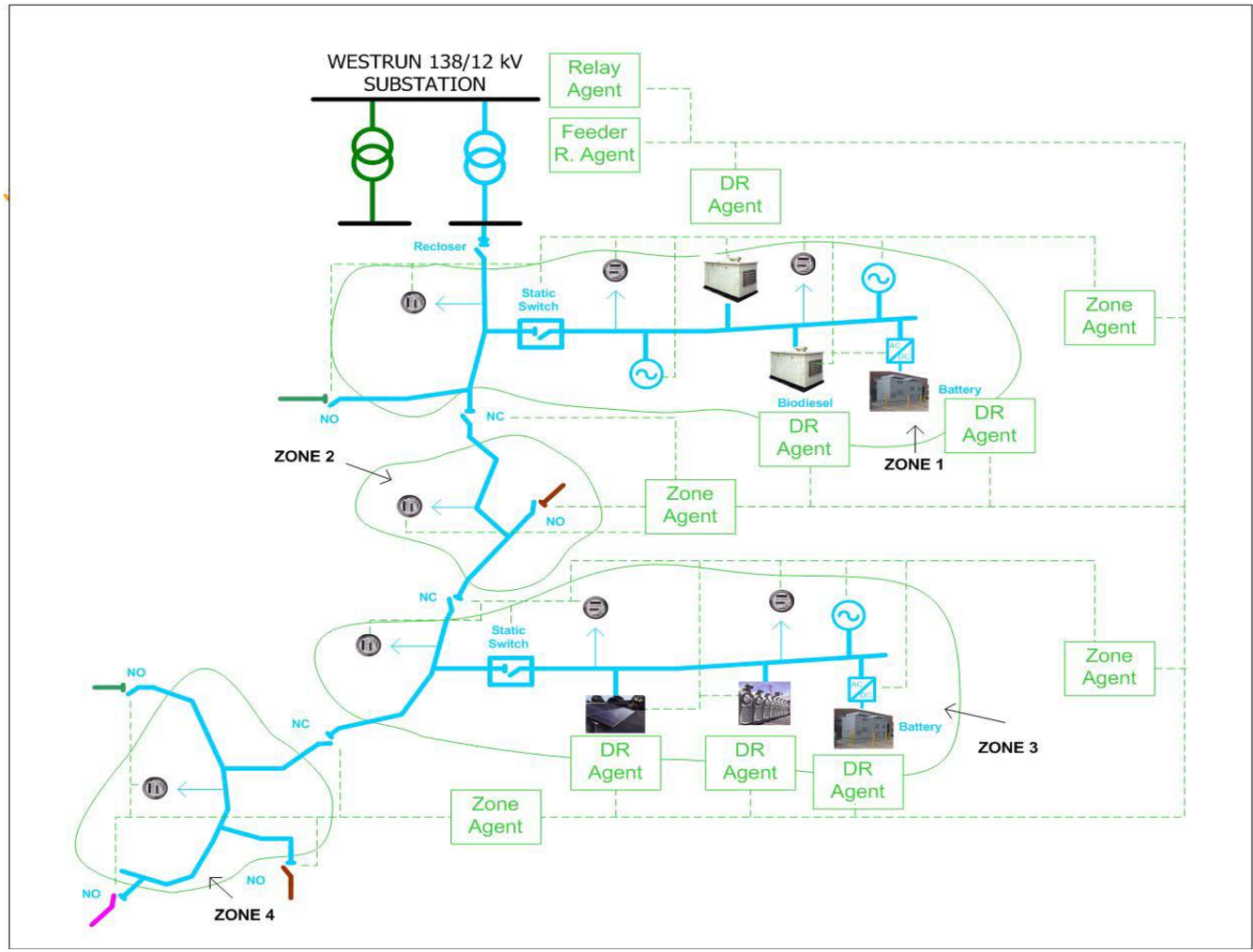


# WVSC Demonstration Site



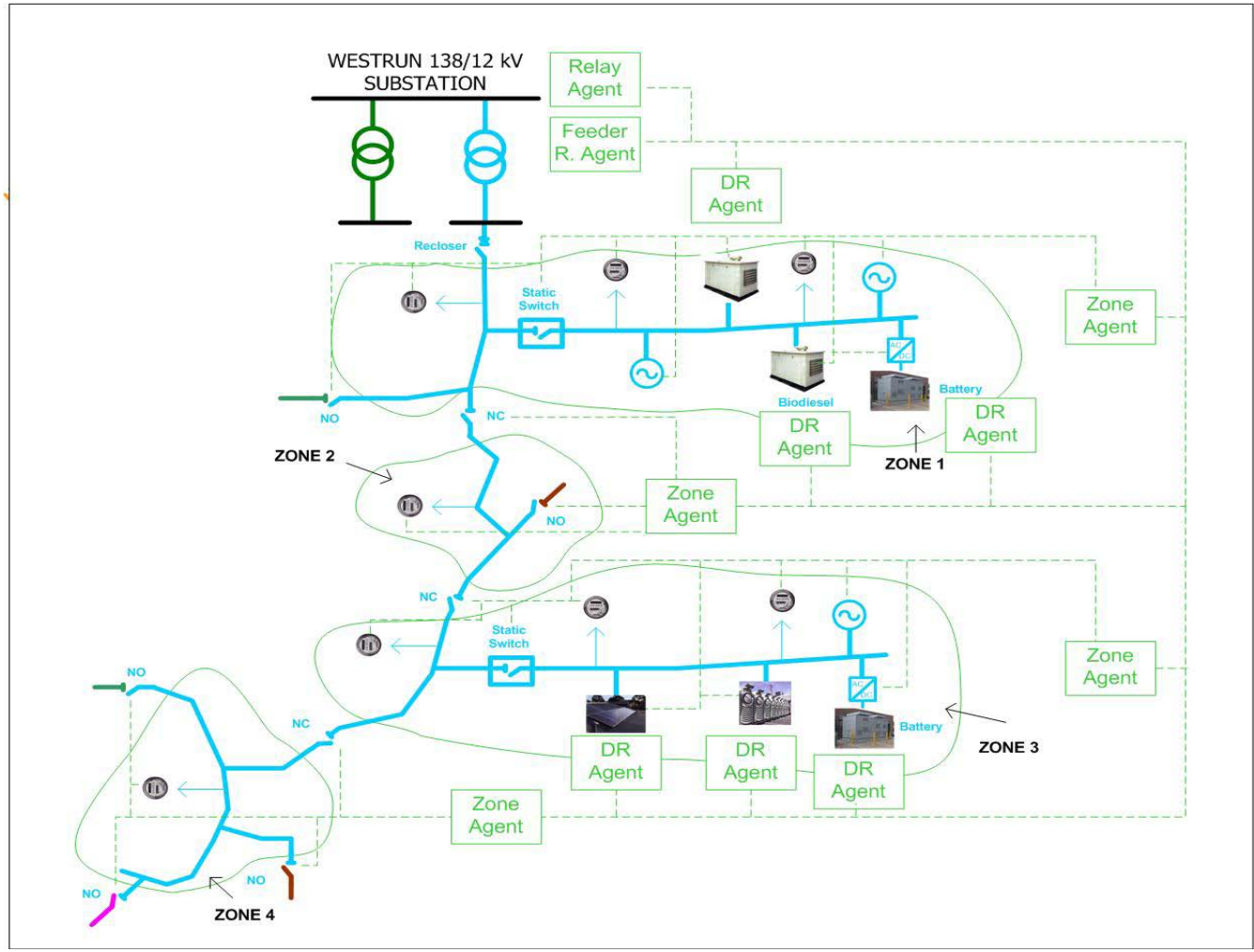
# Project Technologies

- **Distributed Energy Resources**
  - 1.2 MW (3x400 kW) Biodiesel Internal Combustion Engines (ICE)
  - 250 kW Micro-turbine
  - 100 kW Solar Photovoltaic (PV) System
  - 500 kW (2x250 kW), 8 hrs Energy Storage



# Project Technologies

- **Multi-Agent Grid Management (MGM) System**
  - West Virginia University/APERC will develop the algorithms for Multi-Agent Grid Management Systems.
  - Autonomous controls
  - The integrated operation of distributed resources, ALC and other intelligent electronic devices
- **Demand Response and Automated Load Control**
  - DR/ALC will be deployed to participating customers on the WR-3 circuit.
  - The system will allow AP to control customer loads (A/C, water heater, etc) via advanced system automation



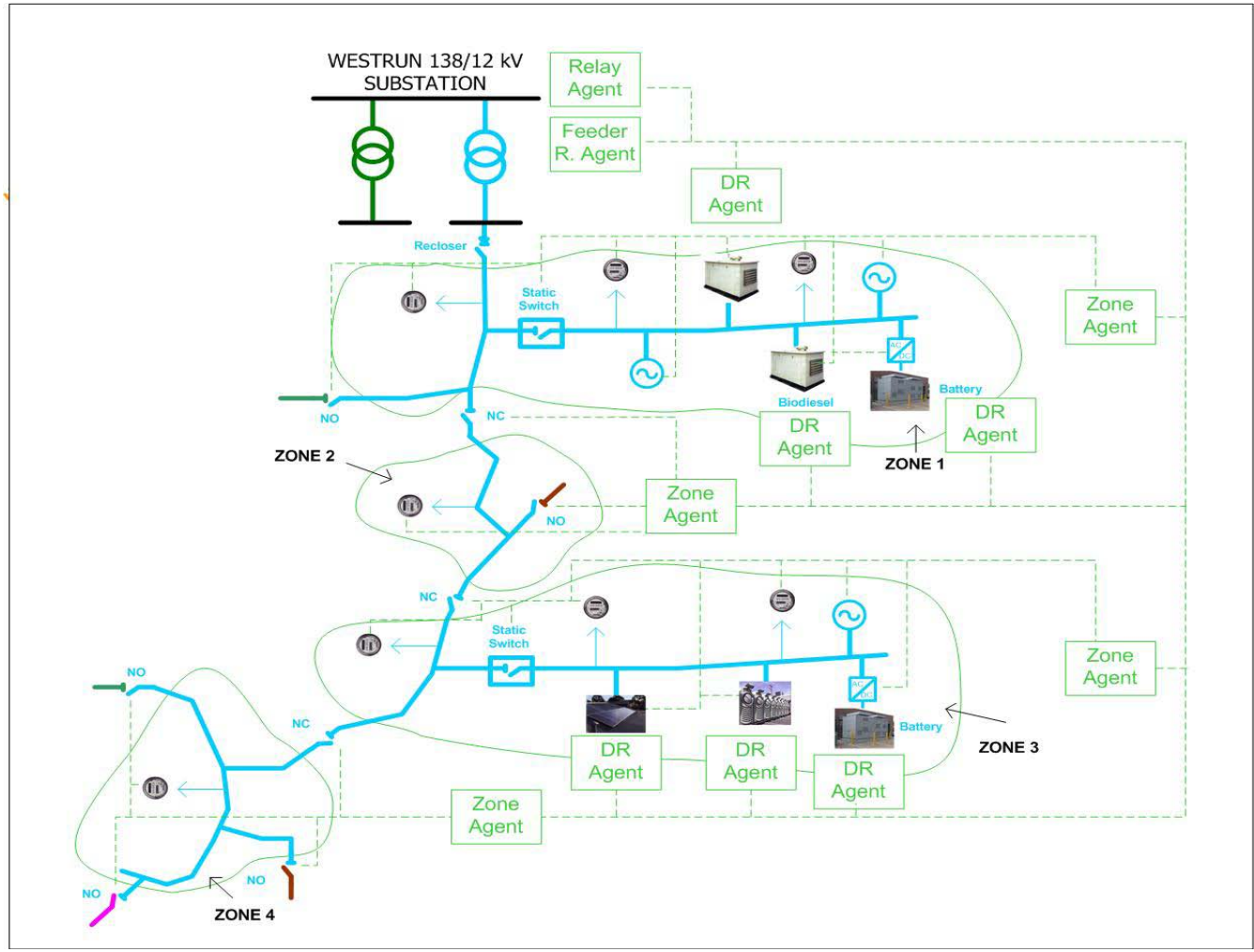
# Project Technologies

- **Low-Cost Distribution Sensors**
  - Nominal current,
  - Surge and fault current,
  - Relative voltage,
  - Wire temperature
  - Clamps to medium voltage lines via a standard hot stick
  - Inductively coupled

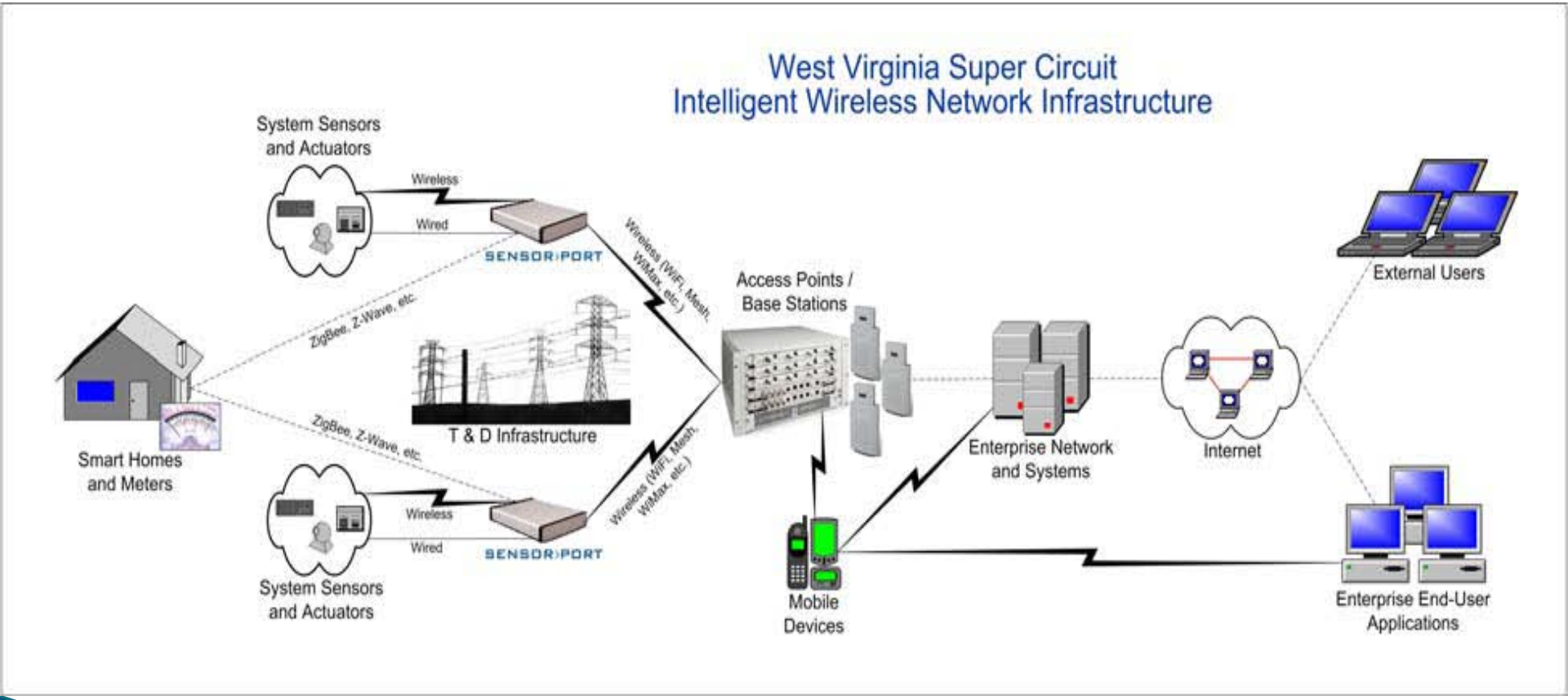
- **Fault Location & Prediction**
  - North Carolina State University will develop the algorithms
  - Analyze voltage and current signatures of many typical circuit disturbances that are intermittent in nature
  - Identify circuit components that are beginning to fail
  - Determine exact location of the disturbance

# Project Technologies

- **Dynamic Feeder Reconfiguration**
  - Expand the DFR system to 2 additional feeders (WR-5/WR-8)



# Project Technologies



# Technical Challenges

- Microgrid Operation Challenges
  - Seamless transition
  - Stability issues
- Optimal Placement and Sizing of DERs
  - Loss minimization
  - Recloser-fuse coordination
- Protective System Challenges
  - Bi-directional currents
  - Limited fault current magnitudes due to Power-Electronics
- Interoperability
- Cyber Security
- Wireless Communication Network Challenges
- Personnel Safety

# Project Benefits

| Metric | Multi-Agent Grid Management (MGM) | Dynamic Feeder Reconfiguration (DFR) | Demand Response (DR) & Automated Load Control (ALC) | Fault Location & Prediction (FLP) | Total |
|---|---|---|---|---|---|
| Peak Load Reduction | **20%** | | **10%** | | **30%** |
| Deferment of Capital Investment | **600K** | | **200K** | | |
| CAIDI | **20%** | **20%** | **5%** | **5%** | **50%** |
| SAIFI | **20%** | **20%** | **5%** | **5%** | **50%** |
| Loss Reduction | **30%** | | | | |
| Labor savings (assoc. w/fault location) | | **75%** | | **15%** | **90%** |
| PQ event reduction | **30%** | | | | **30%** |
| Capacity utilization of DER | **50%** | | | | **50%** |
| Capacity utilization of feeder | **25%** | | | | **25%** |
| NOx-Sox emissions reduction | **10%** | | **5%** | | **10%** |

- Thank you!