

NETL MGS – Smart Grid Field Trials

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Role of the Modern Grid Strategy

- **Define a vision for the Smart Grid**
- **Reach out to stakeholders for input**
- **Assist in the identification of benefits and barriers**
- **Facilitate resolution of issues**
- **Communicate and educate stakeholders**
- **Promote testing of integrated suites of technologies**

MGS is an “Independent Broker” for the Smart Grid

Powering the 21st Century Economy



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Developmental Field Tests (DFT)

- **Morgantown DFT**
 - Dynamic Feeder Reconfiguration (DFR) System
 - “Weak tie” concept
 - NETL / Allegheny Power

- **BPL DFT**
 - Broadband Over Power Lines at 69 kV
 - NETL / AEP



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- **Dynamic Feeder Reconfiguration System**
 - Find fault location and isolate
 - Check adjacent circuit capacities
 - Connect if adequate capacity exists
 - Monitor feeder loadings in real-time

- **Circuit Characteristics**
 - Two 12.5 kV radially operated
 - Multiple switches to adjacent circuits
 - 5,000 customers - 93% residential
 - Poor reliability performance



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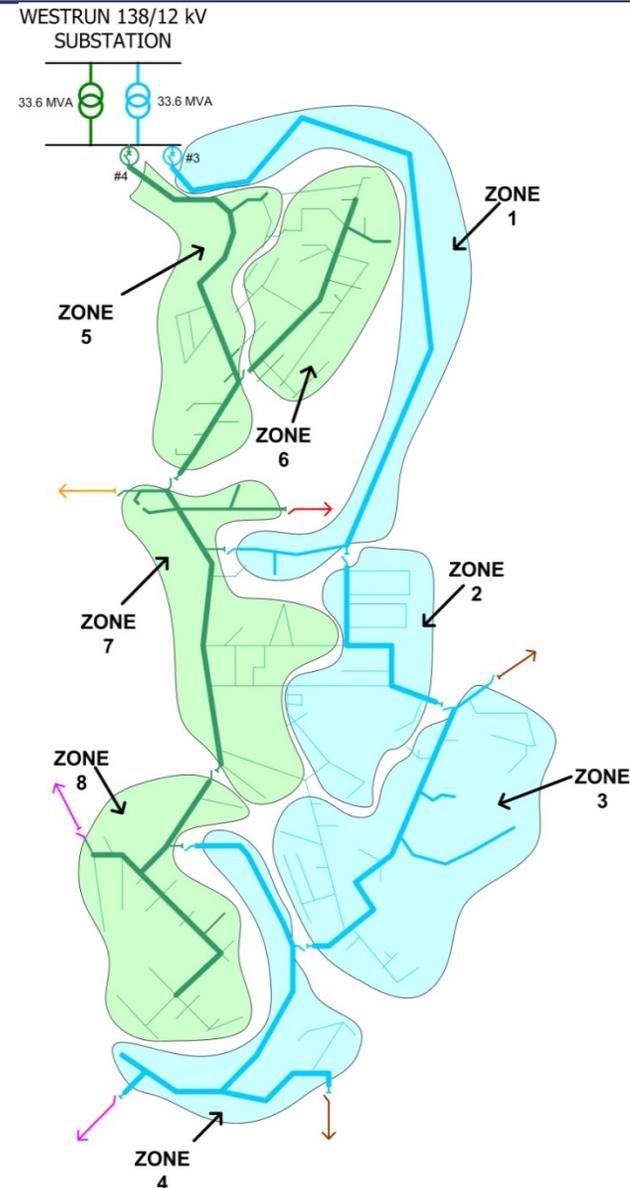
Morgantown Goals & Objectives

- **Significantly improve reliability (CAIDI)**
- **Demonstrate feasibility of “weak tie” concept**
- **Reduce labor cost associated with fault location**
- **Demonstrate integrated communication system that will support both smart meters and advanced distribution operations**
- **Create a design concept that can be transferred to utilities nationwide**
- **Provide test results for extrapolation at regional / national level**
- **Expect to be operational April, 2009**

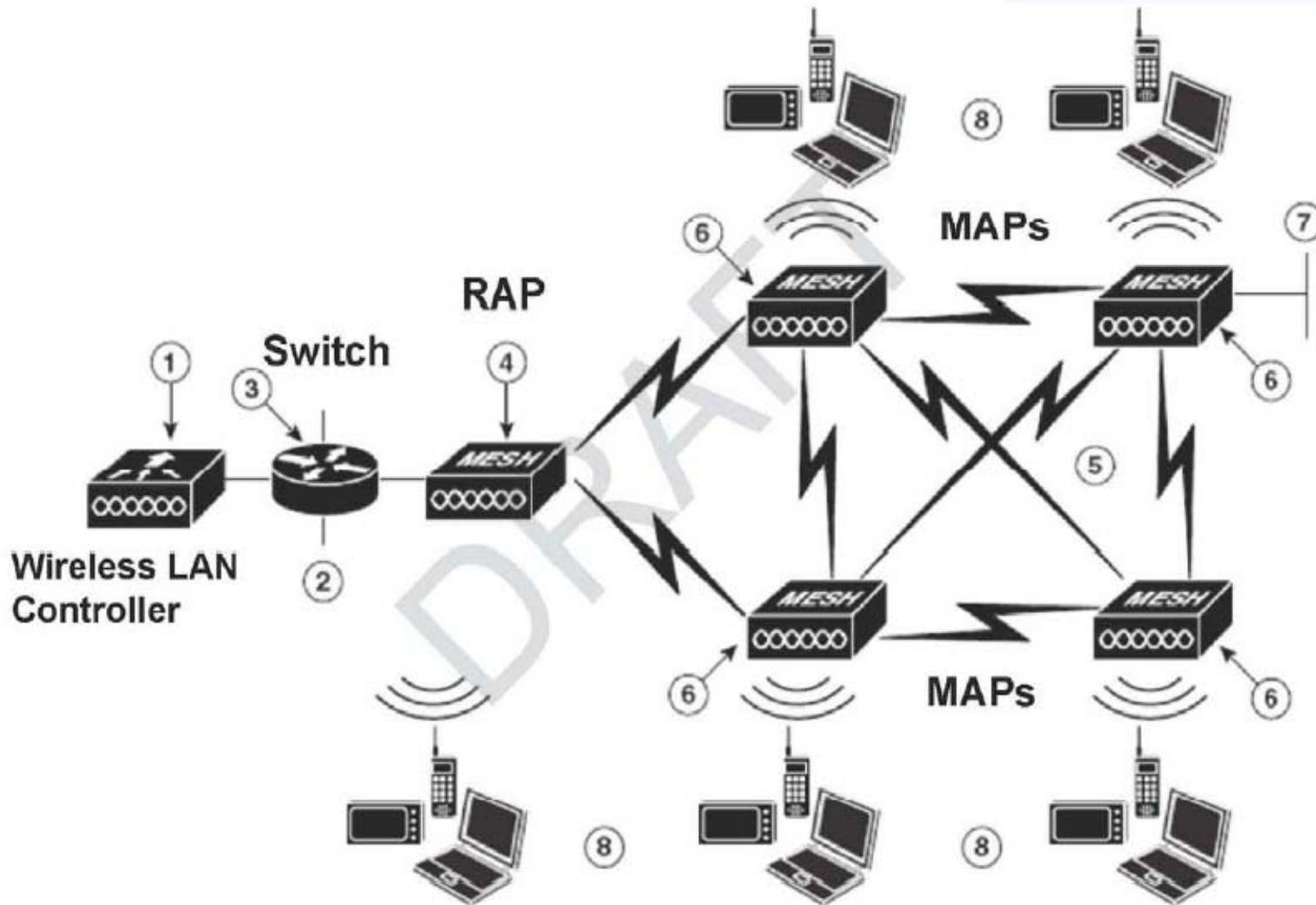


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- **Patrick Energy Services**
 - GE – Human Machine Interface (HMI) software provider (ENMAC)
 - Microsol – Remote Terminal Unit (RTU) provider
- **Fault Location, Isolation Restoration**
 - Restoration based on real-time loadings
 - Intelligence at the substation
 - Back-to-normal topology with one click
 - Open architecture



System Specifications – Access Points



Modified Cisco Diagram

Reclosers at the Substation

- **West Run Substation**
- **Cooper Electronic Reclosers 560A, 15.5 kV**
- **Form 6 Controllers**

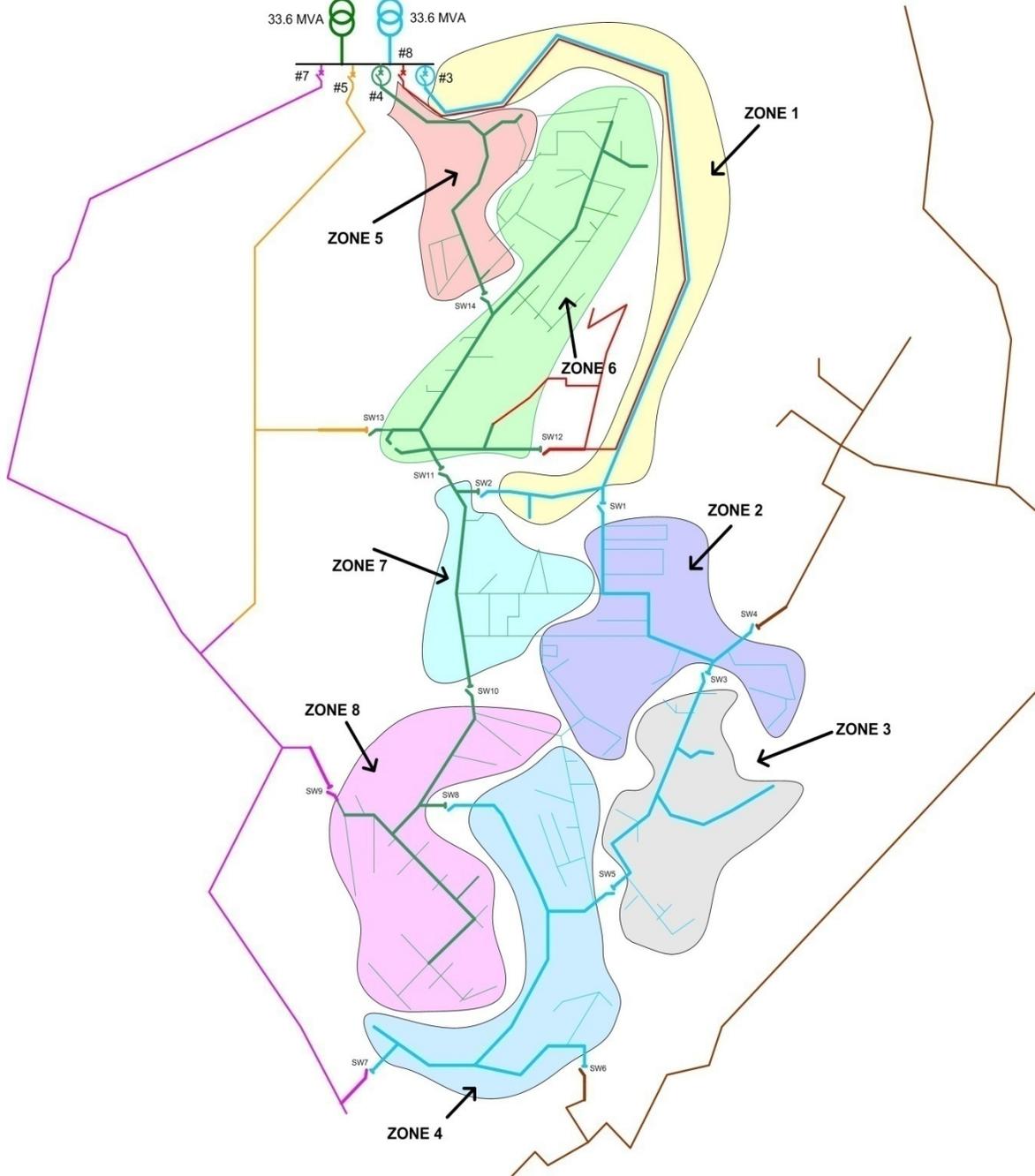
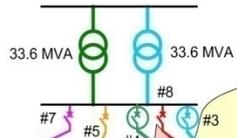


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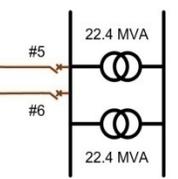


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WESTRUN 138/12 kV
SUBSTATION



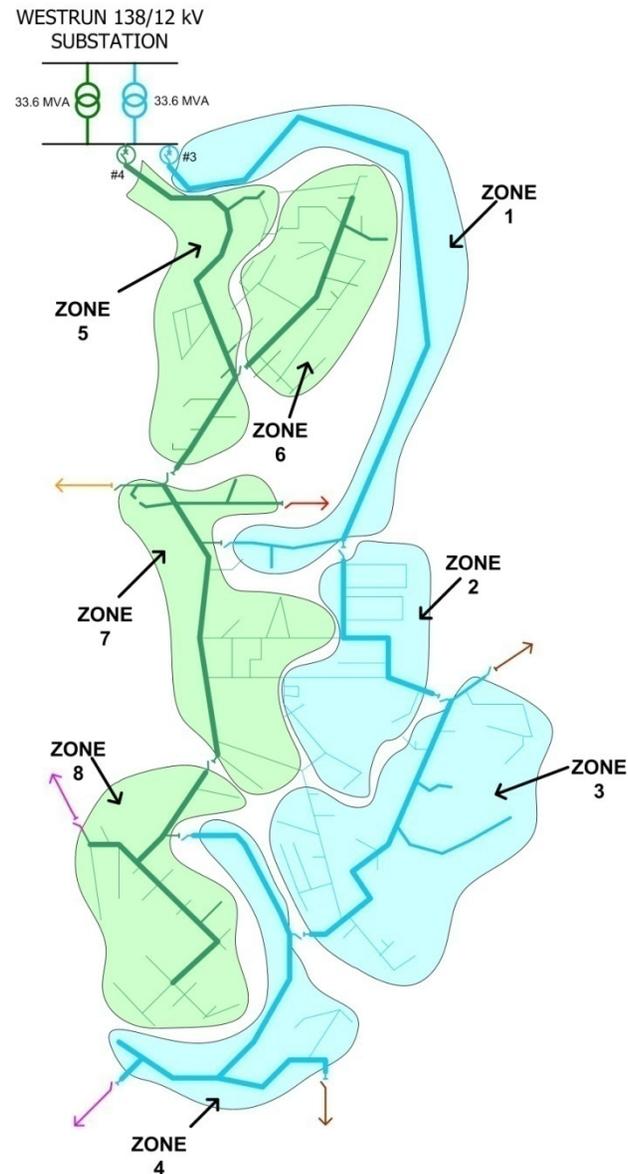
PIERPONT 138/12 kV
SUBSTATION



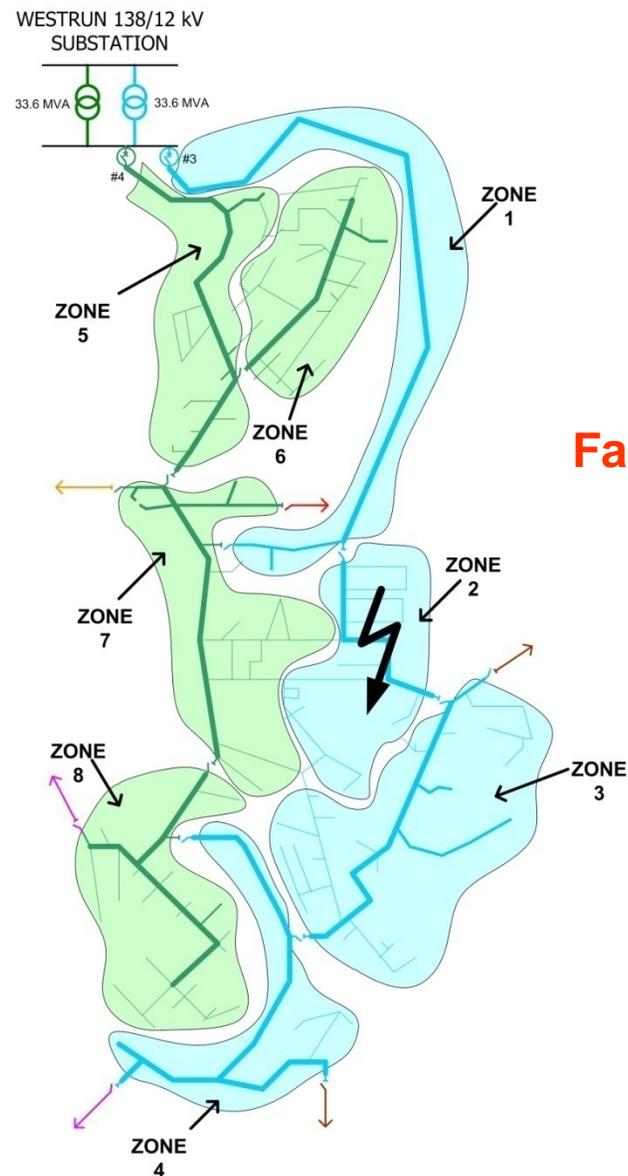
LEGEND

-  Recloser with Electronic Controls (New Installation)
-  Recloser with Electronic Controls (Retrofitted)
-  Intelligent Loadbreak Switch (New Installation)
-  3-Phase Line
-  Single Phase Line

Autonomous Dynamic Feeder Reconfiguration



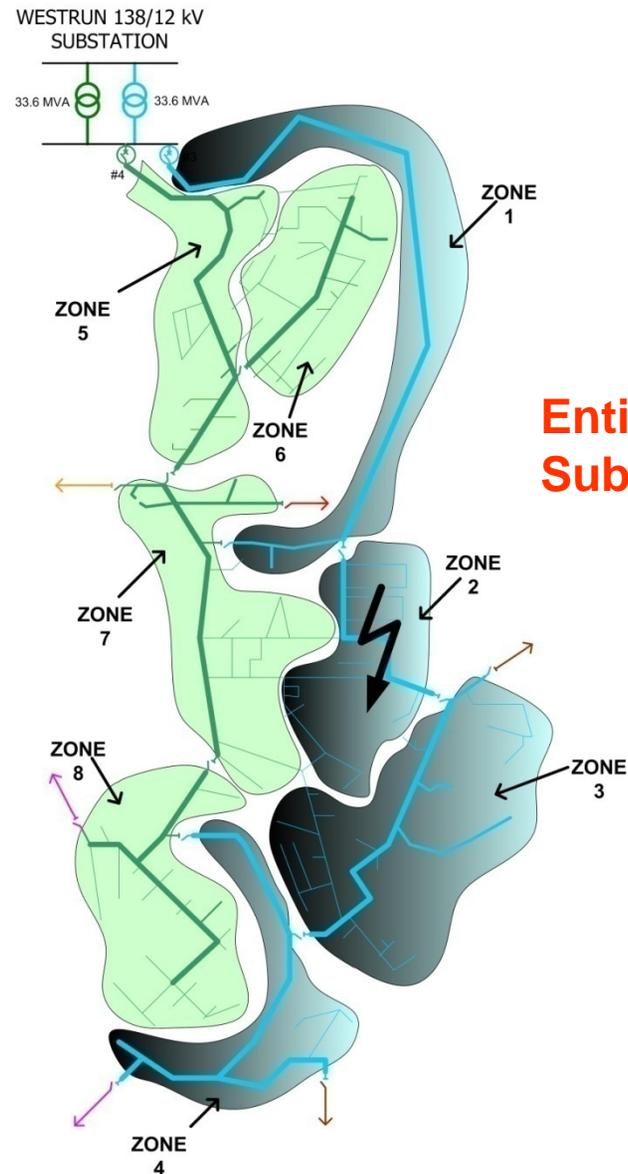
Autonomous Dynamic Feeder Reconfiguration



Fault in Zone 2

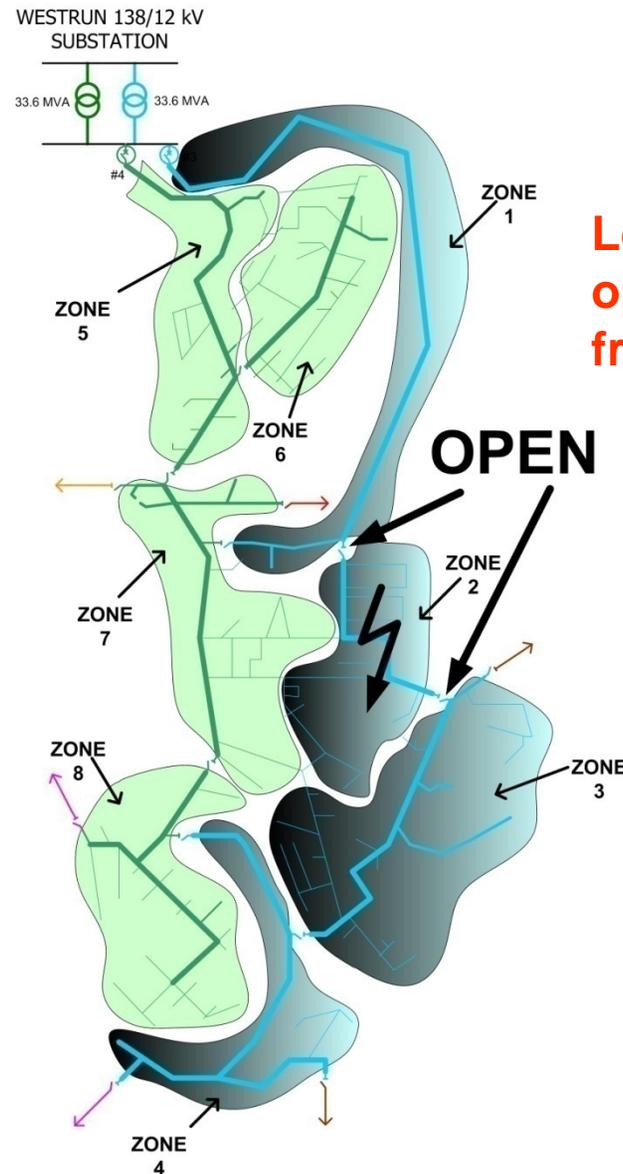


Autonomous Dynamic Feeder Reconfiguration



**Entire Circuit Trips at
Substation Breaker**

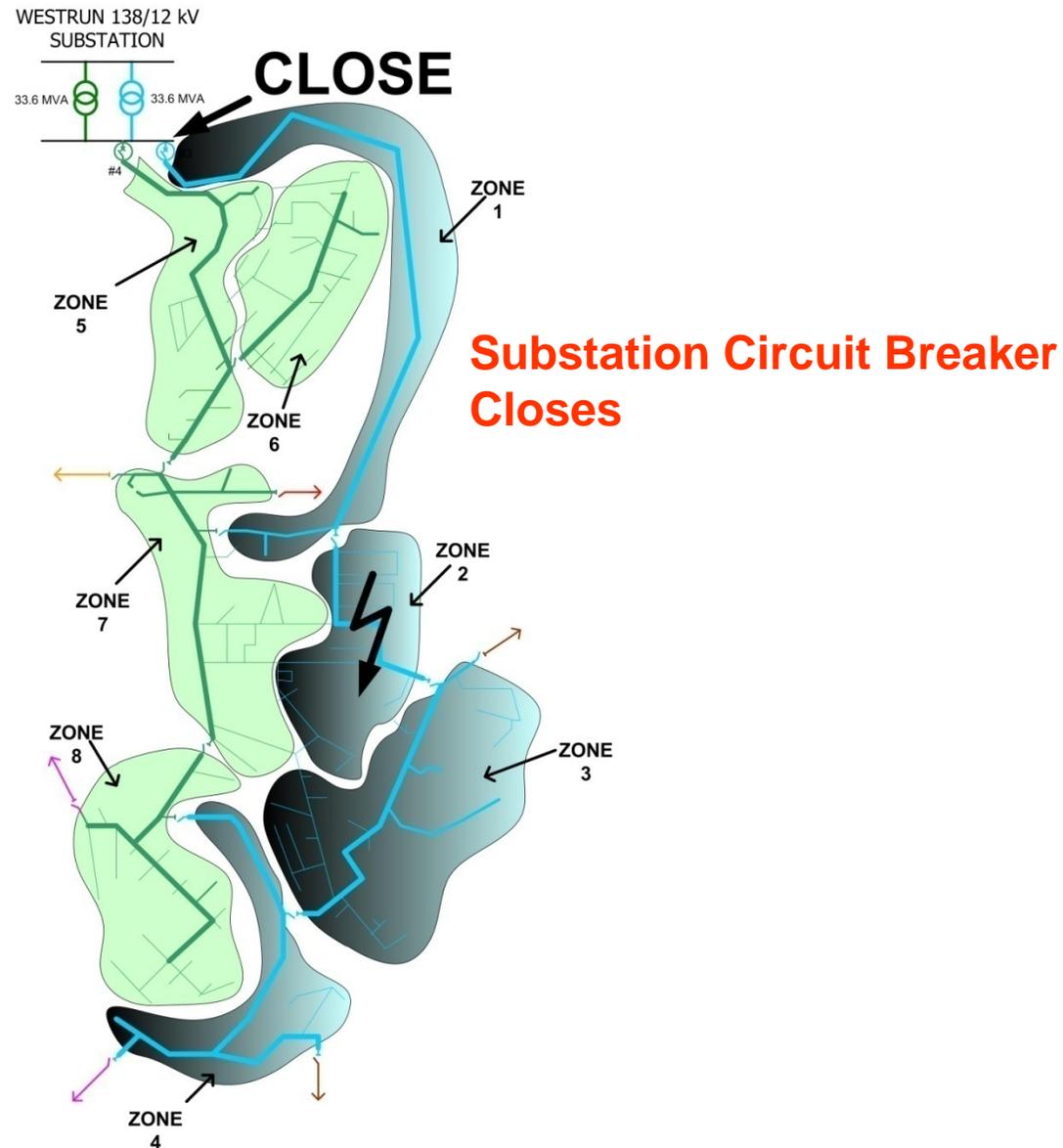
Autonomous Dynamic Feeder Reconfiguration



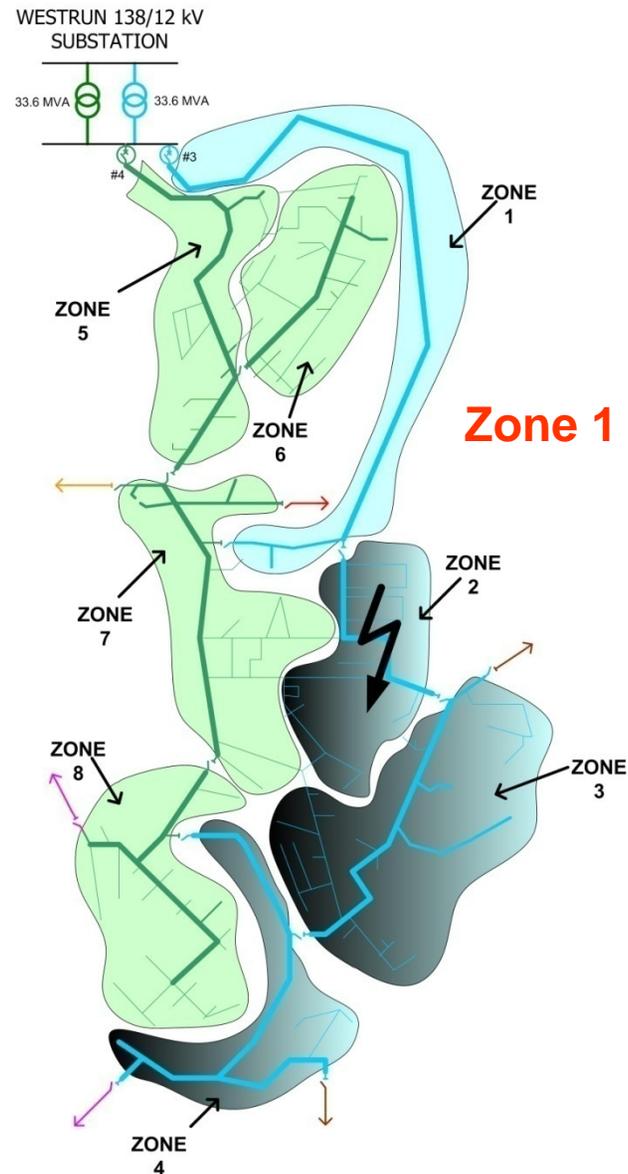
**Load Break Switches
open isolating Zone 2
from the Circuit**



Autonomous Dynamic Feeder Reconfiguration



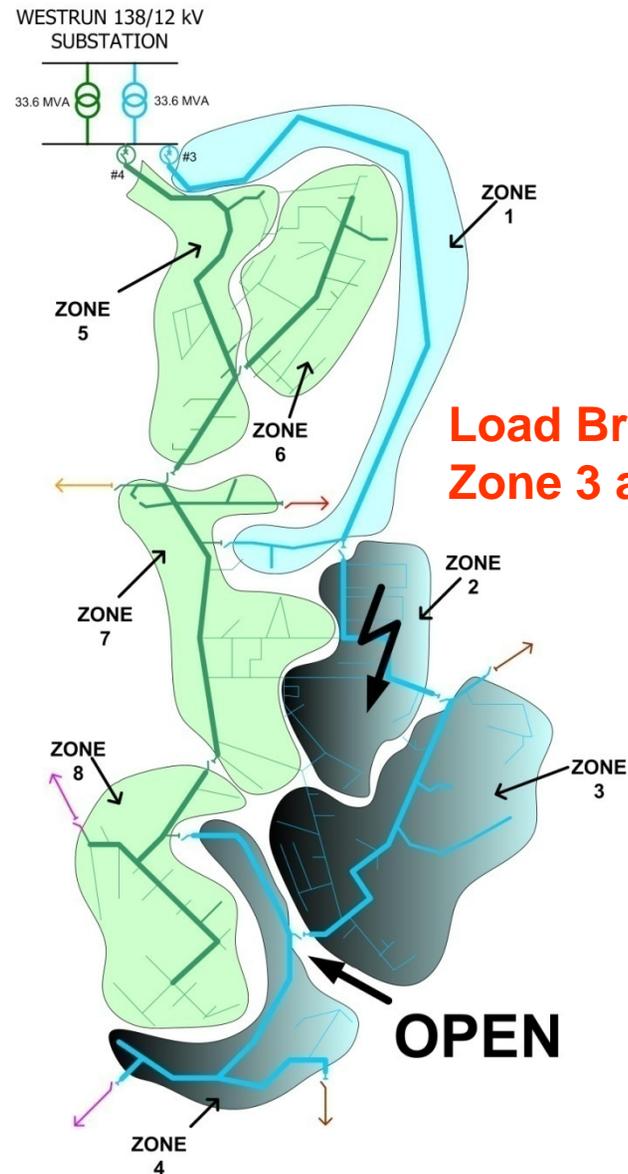
Autonomous Dynamic Feeder Reconfiguration



Zone 1 is now reenergized

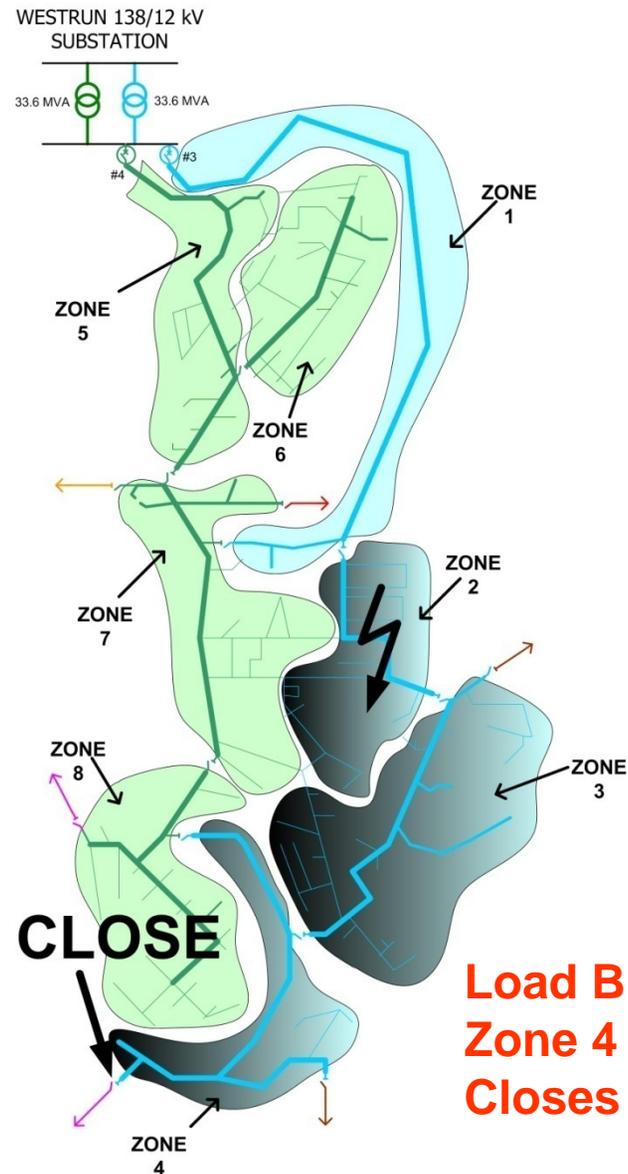


Autonomous Dynamic Feeder Reconfiguration



**Load Break Switch between
Zone 3 and Zone 4 opens**

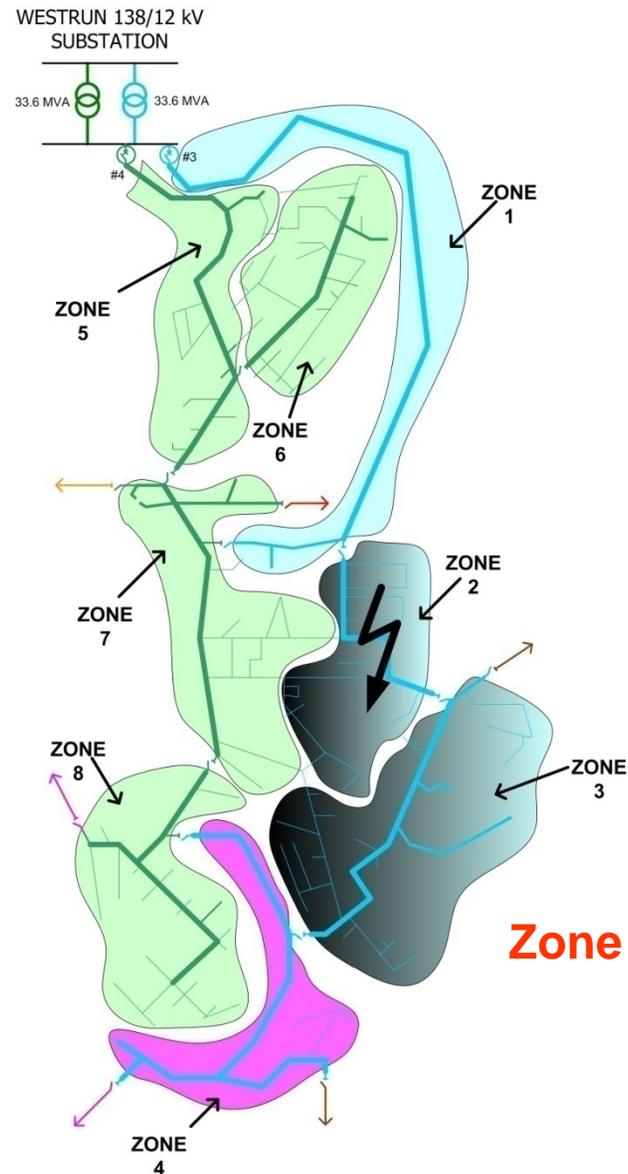
Autonomous Dynamic Feeder Reconfiguration



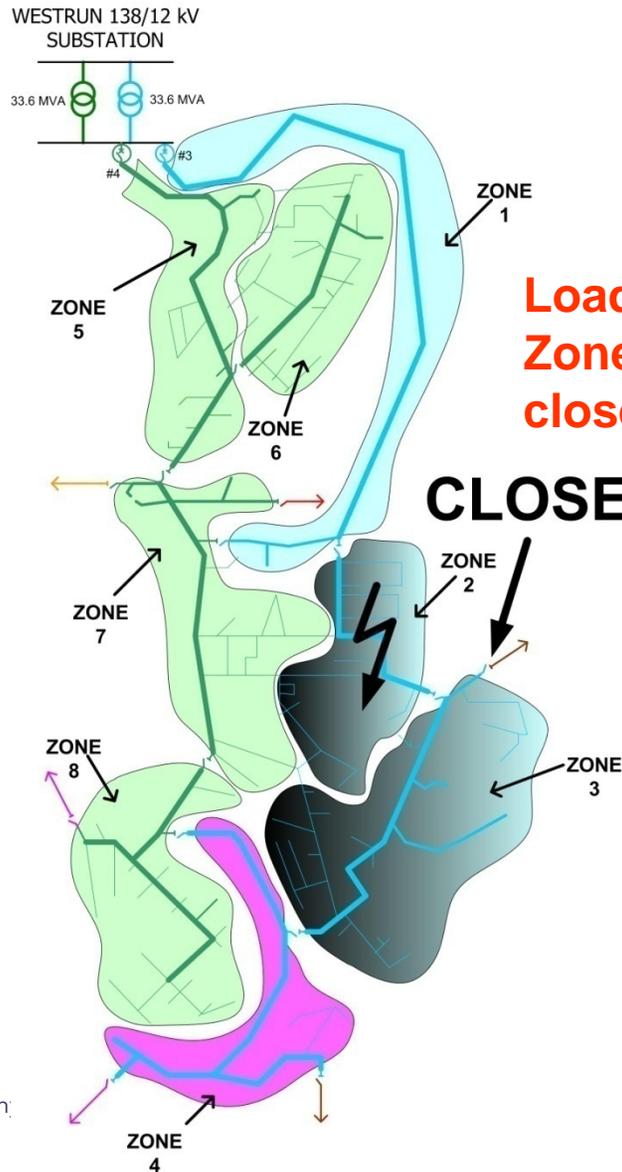
**Load Break Switch between
Zone 4 and Adjacent Feeder
Closes**



Autonomous Dynamic Feeder Reconfiguration



Autonomous Dynamic Feeder Reconfiguration

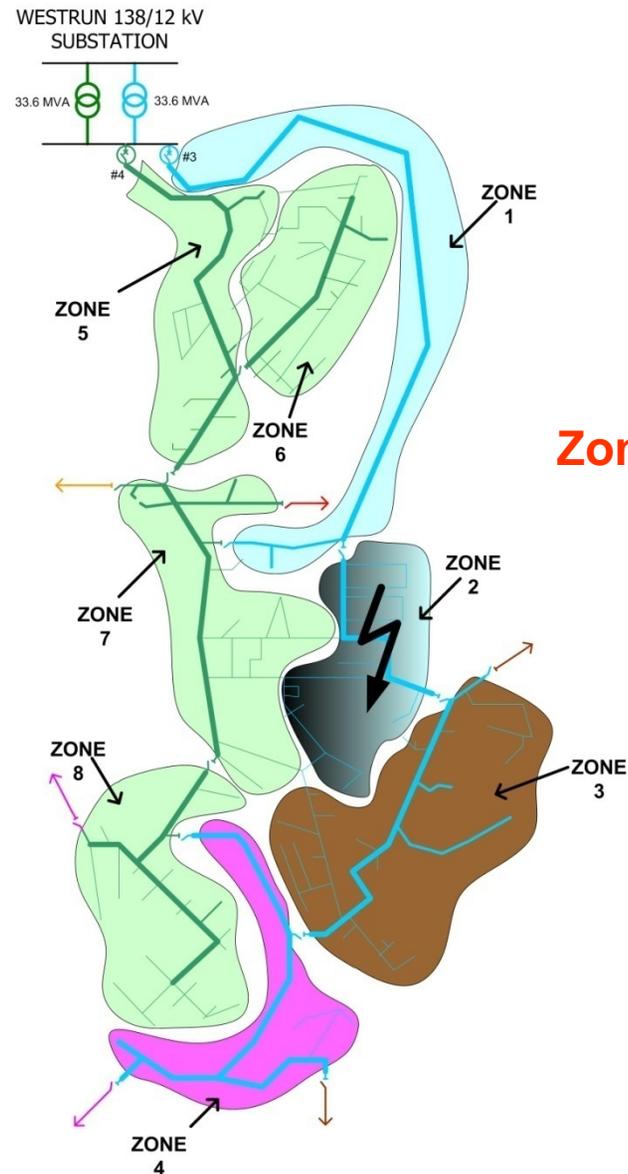


**Load Break Switch between
Zone 3 and adjacent feeder
closes**

CLOSE



Autonomous Dynamic Feeder Reconfiguration



Zone 3 is reenergized



- **Demonstrate BPL operation over 69kv lines**
- **Some key applications:**
 - **Utility wideband data applications (WAMS)**
 - **Enables modern transmission circuit protection systems using advanced digital relaying methods**
 - **Early detection of failures on the HV system**
 - **SCADA expansion to remote stations**
 - **Station surveillance**
 - **Replace old pilot wire for protective relay applications**



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- **Continuous BPL operation achieved for 16 weeks over a 5-plus mile link using one station-based and one line-based repeater**
- **Data rates range 2 – 20 Meg BPS**
- **Methods developed for locating noise sources and found effective**
- **Coupling techniques successful and scalable**
- **FCC compliance demonstrated**



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- **Test at 138 KV operation using similar techniques**
- **Survey noise characteristics on a variety of HV lines**
- **Develop low cost method to power transmission line repeaters from line voltage**
- **Improve noise source location diagnostics**
- **Develop correlation of noise sources and line defects**

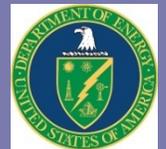


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West Virginia Super Circuit



- **Nine DOE funded projects to develop Renewable and Distributed Systems Integration**
- **\$50 million to be invested over five years**
- **Will reduce peak load electricity demand by at least 15 percent at distribution**
- **WV Super Circuit is one of the nine projects**



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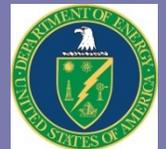
West Virginia Super Circuit

- **Objective: Improve distribution system performance, reliability, and security of electricity delivery through the integration of distributed resources and advanced technologies.**
- **Duration: 5 years**
- **Estimated Cost: \$5.4 million federal/4 million non-federal**



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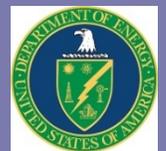
- **Customer owned distributed generation**
- **2400 AMI meters**
- **Storage devices (NaS battery)**
- **Solar (PV) cells**
- **Dynamic islanding**
- **DSM and Demand Response**
- **Expand Dynamic Feeder Reconfiguration concept to adjacent circuits**



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WV Super Circuit Goals

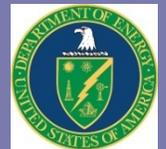
- **Reduce peak power demand >15%**
- **Cost to be competitive with capacity upgrades**
- **Demonstrate the viability of multi-agent technologies**
- **Address interoperability issues between control and protection systems and DER**
- **Determine system and societal benefits of integrated operation of advanced technologies**
- **Demonstrate feasibility of dynamic islanding and micro-grids**
- **Demonstrate the reliability benefits of Dynamic Feeder Reconfiguration**



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WV Super Circuit Participants

- **Allegheny Power**
- **Augusta Systems, Inc.**
- **North Carolina State University**
- **Science Applications International Corp.**
- **Tollgrade Communications**
- **West Virginia University (WVU) Research Park**
- **WVU Advanced Power and Electricity Research Center**



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