MODERN GRID STRATEGY

SMART GRID FEEDER AUTOMATION *A DEVELOPMENTAL FIELD TEST*

Presented by: Thomas Grabowski, Modern Grid Team

EEI Transmission, Distribution and Metering Conference

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SMART GRID FEEDER AUTOMATION
A DEVELOPMENTAL FIELD TEST

MODERN GRID
STRATEGY

Presented by:

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What is a Smart Grid?

Detects problems and fixes them before they impact quality of service

Incorporates measures, communication, Intelligent Equipment, advanced diagnostics and provides feedback control

Has the ability to re-route power flows, change load patterns, improve voltage profiles, and take other corrective actions

Enables loads and distributed resources to participate in operations

Uses Advanced Technology to improve design and operation with reliability, security, efficiency and safety.

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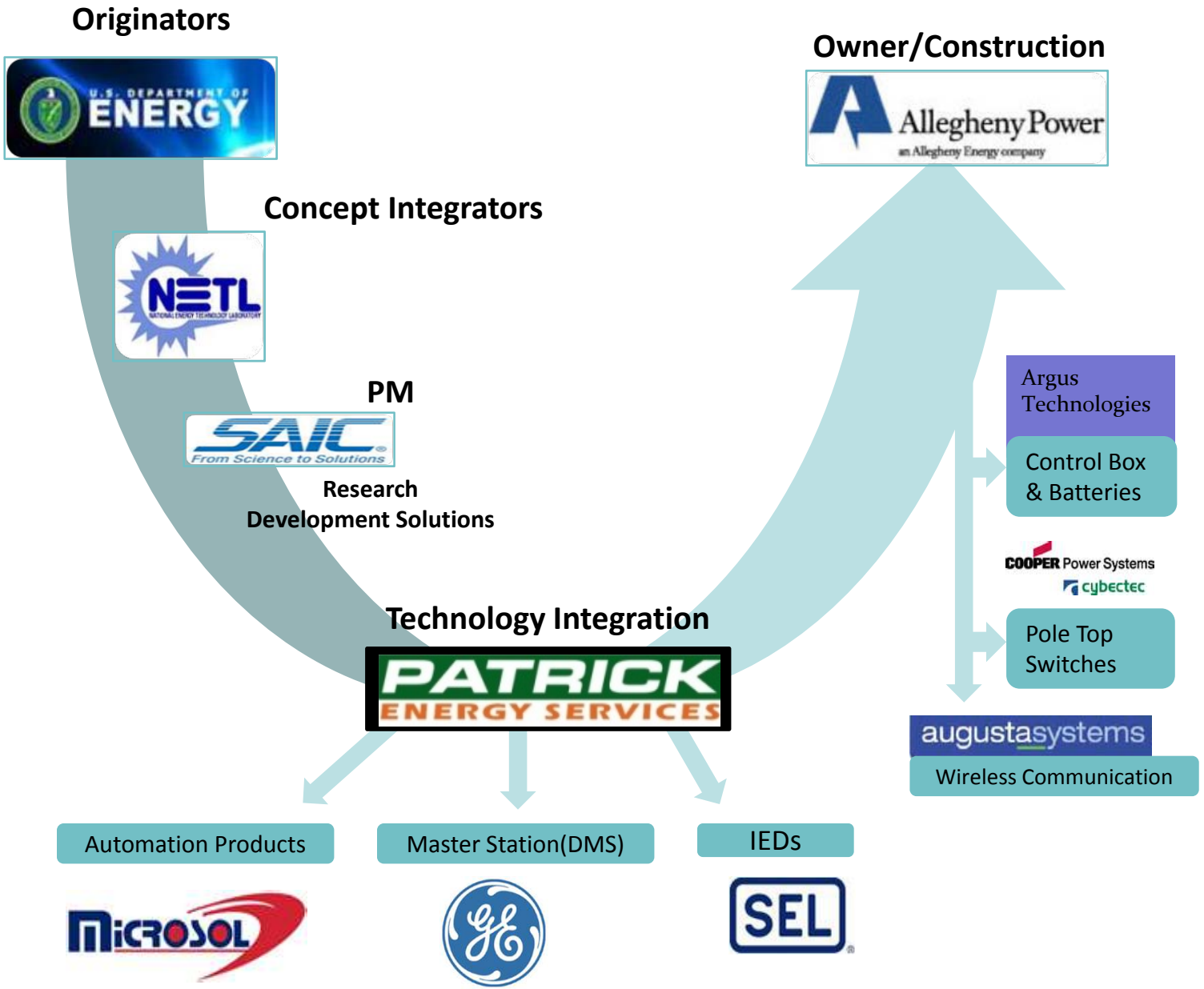
What is the Modern Grid Strategy?

The Department of Energy currently has several initiatives to improve the National Electrical Grid

One of those initiatives is the Allegheny Power Development Field Test: Morgantown, WV

Its purpose is to test off-the-shelf, open architecture technologies to help improve Allegheny Power's customer outage duration

Who is involved?



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Project Objectives

Design and install a feeder automation plan	Develop capability to identify and isolate faulted zones	Install a “Weak Tie” between adjacent feeders to automatically restore service
Prove the autonomous operation of an advanced distribution automation system.	Deliver an improvement in electric service reliability.	Develop an application that can be transferred to utilities nationwide.
Employ Intelligent Electronic Devices	Install Smart Grid type sensing and measurement.	Utilize off the shelf/open architecture technologies.

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Goals for Morgantown DFT Phase 1

- Improve reliability indices
- Ability to defer or avoid some planned capital investments
- Improve power quality
- Minimize the outage labor cost and duration
- Improve the protective coordination scheme
- Maximize coordination of field crews and operation

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Test Circuit Characteristics

Distribution Substation

- Two 138 - 12.5 kV transformers, 33.6 MVA each
- Two Circuits

Circuit 3

- Three normally closed load break switches to form four zones
- Five normally open tie points to adjacent feeders
- 327 distribution transformers

Circuit 4

- Three normally closed load break switches to form four zone
- Five normally open tie points to adjacent feeders
- 341 distribution transformers

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Distribution Reliability Indices

West Run Circuits 3 & 4
Distribution Reliability Indices

SAIDI	2001	2002	2003	2004	2005
West Run #3	19.52	65.84	192.65	198.01	2193.16
West Run #4	27.43	34.15	53.81	102.58	929.5
CAIDI	2001	2002	2003	2004	2005
West Run #3	85.07	55.11	149	655.48	1387.33
Wes Run #4	140.21	164.14	177.41	285.23	1847.76
SAIFI	2001	2002	2003	2004	2005
West Run #3	0.228398	1.189985	1.289199	0.303107	1.580765
West Run #4	0.198227	0.208831	0.303201	0.35942	0.50792

SAIDI – System Average Interruption Duration Index
(Customer Minutes of Interruption/Average # of Customers Served)

CAIDI - Customer Average Interruption Duration Index
(Customer Minutes of Interruption/Average # of Customers Interruptions)

SAIFI – System Average Interruption Frequency Index
(Customer Interruption/Average # of Customers Served)

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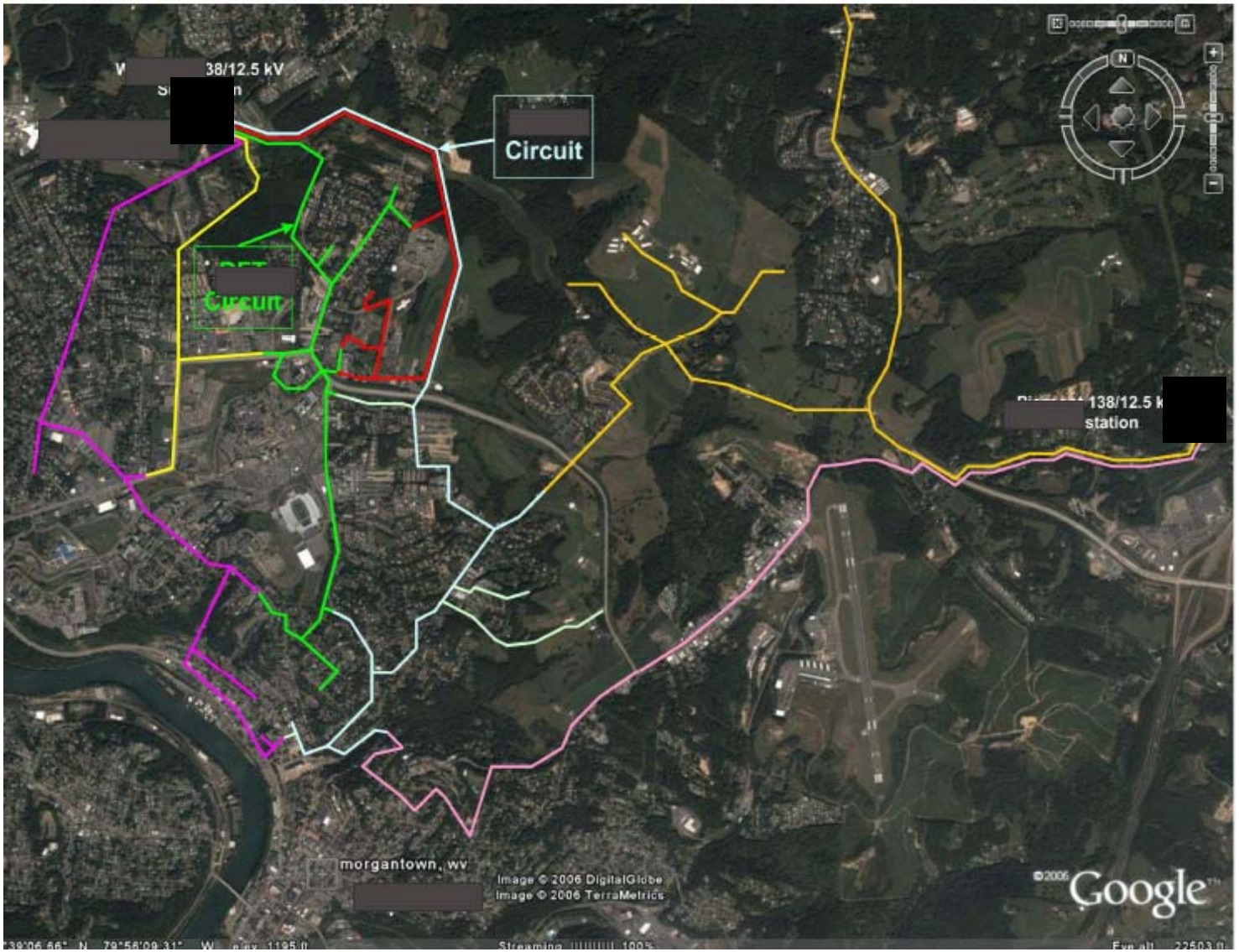
Morgantown Circuit 3 and 4



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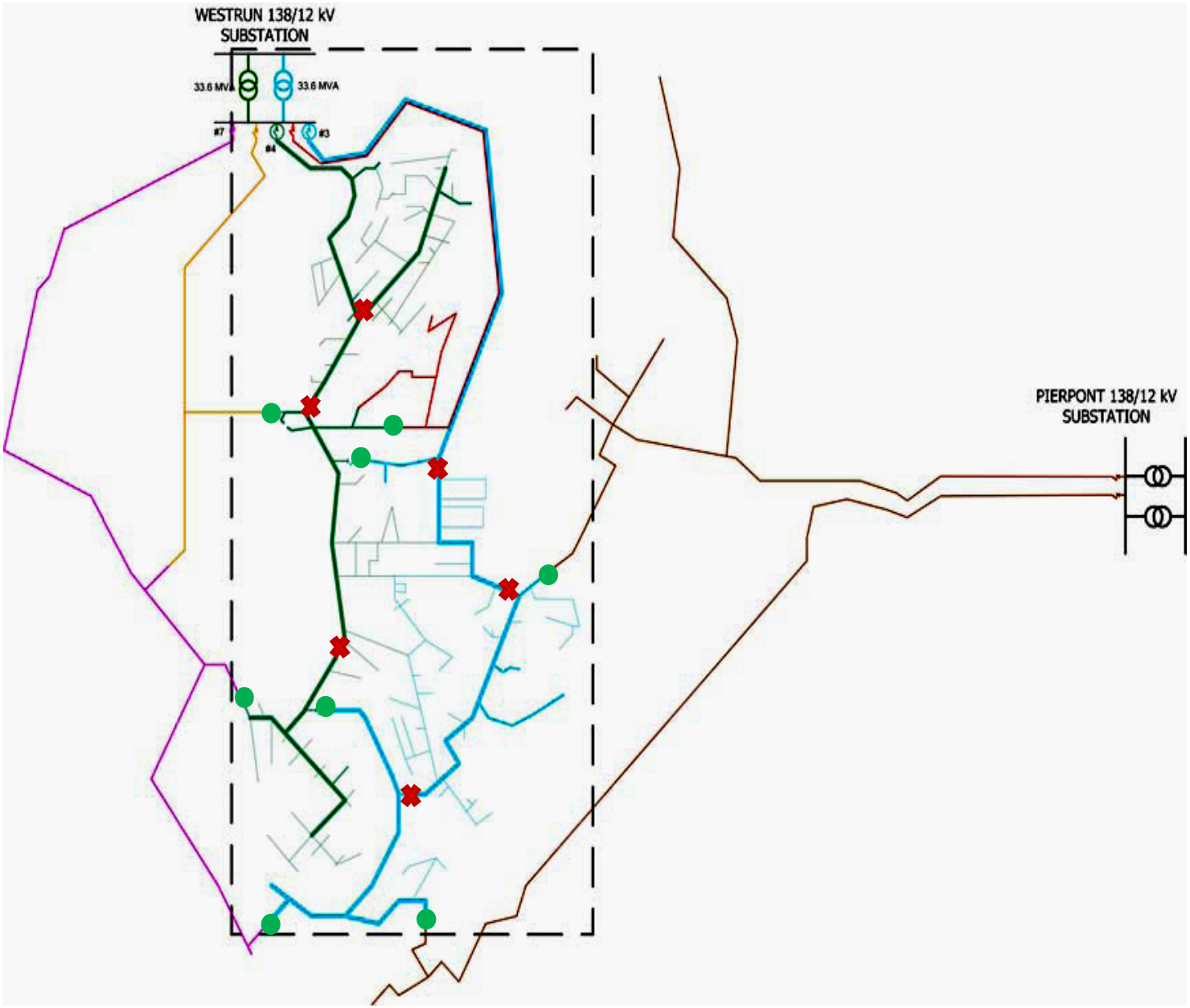
Circuit Diagram



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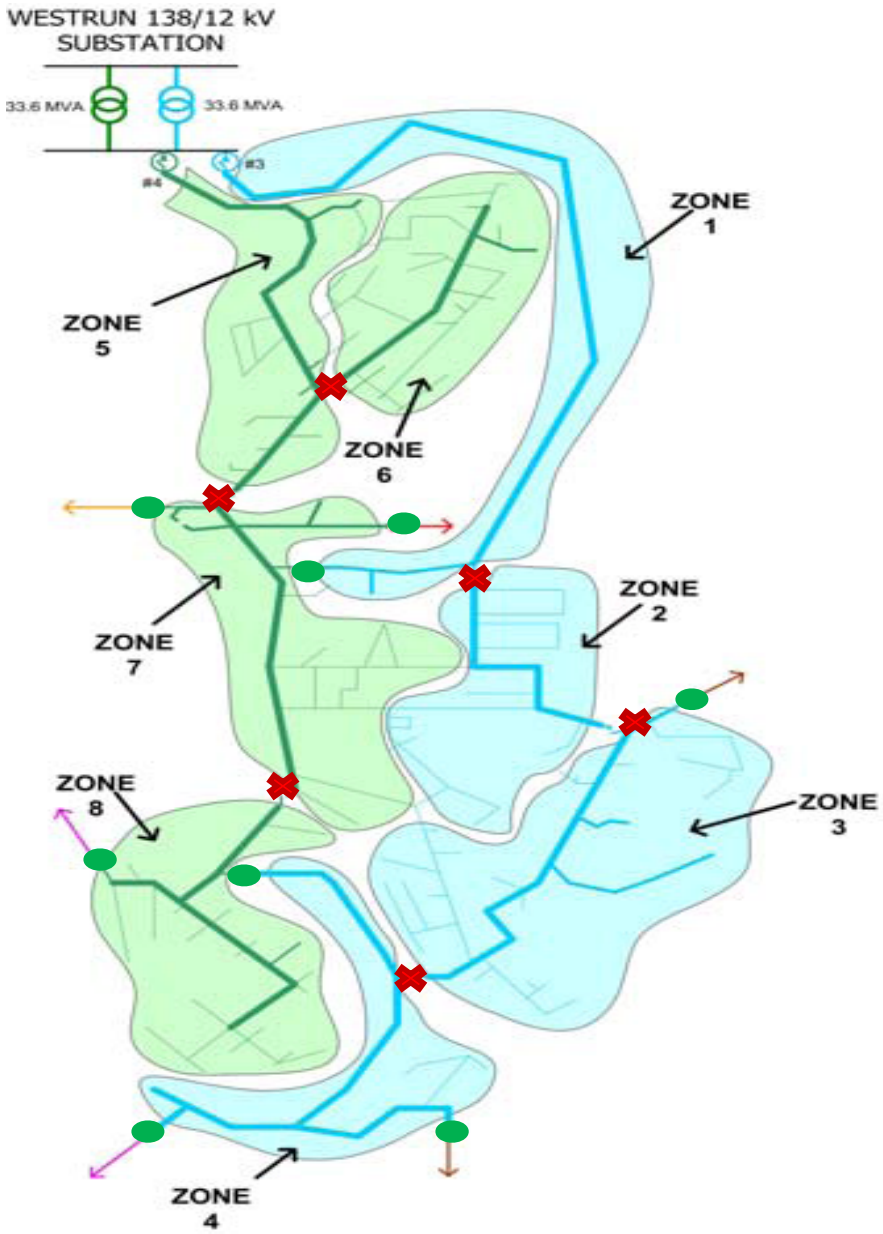
How it works...



Powering the 21st Century Economy

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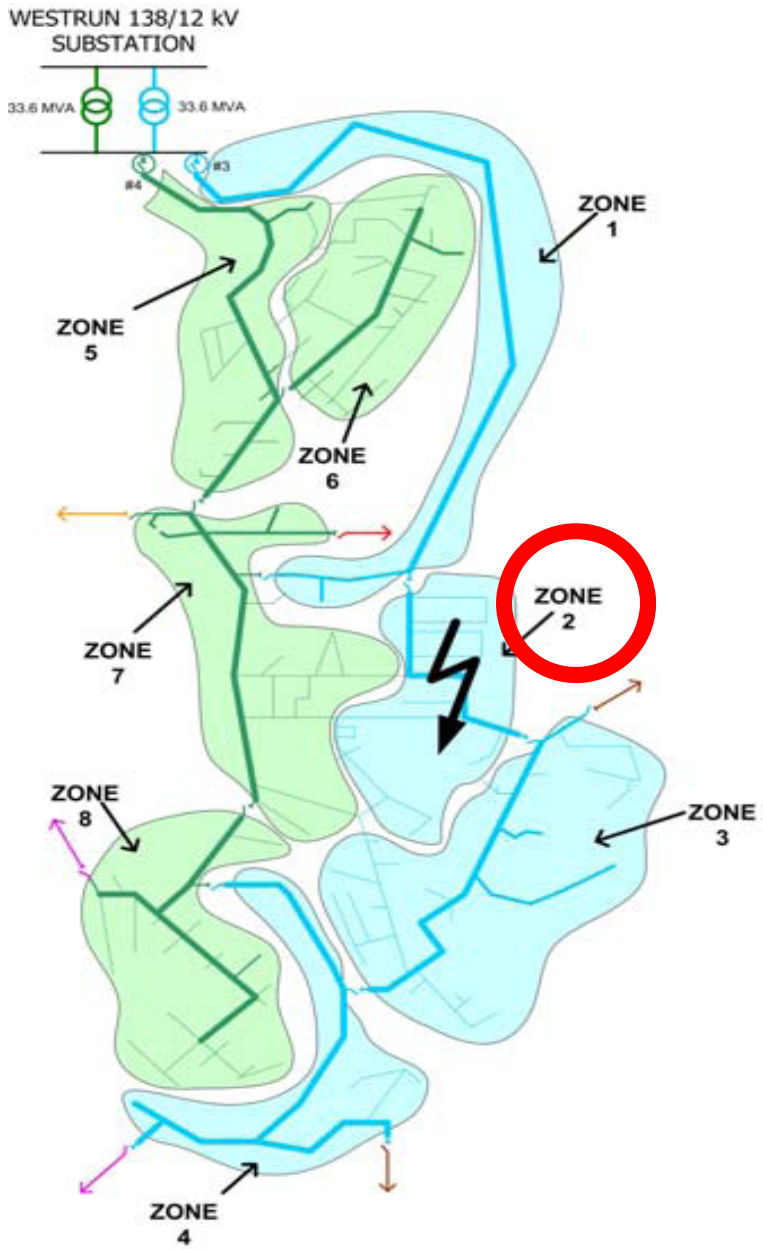
How it works...



A fault occurs in Zone 2

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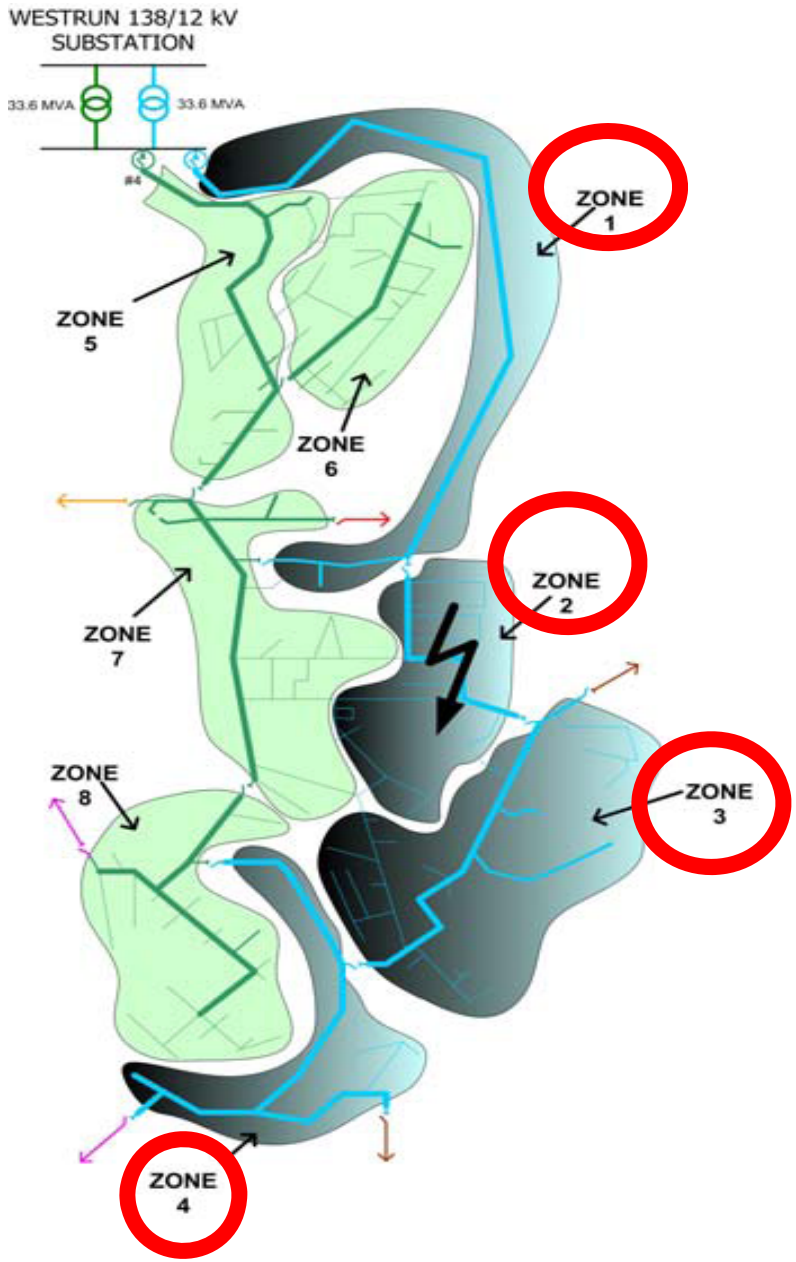
How it works...



The recloser completes its three operation and locks out

All four zones are de-energized

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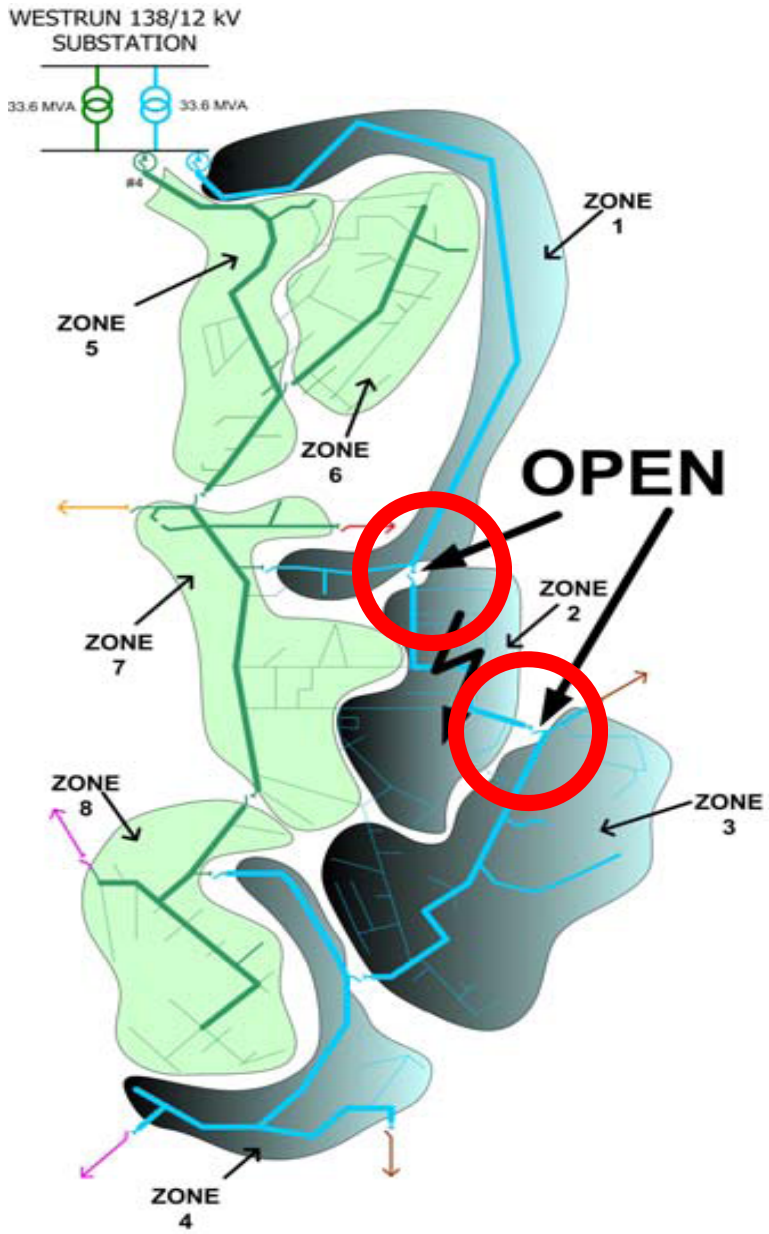
How it works...



DA Logic sequence begins

Open Pole top switches

Isolates Zone 2 from the circuit

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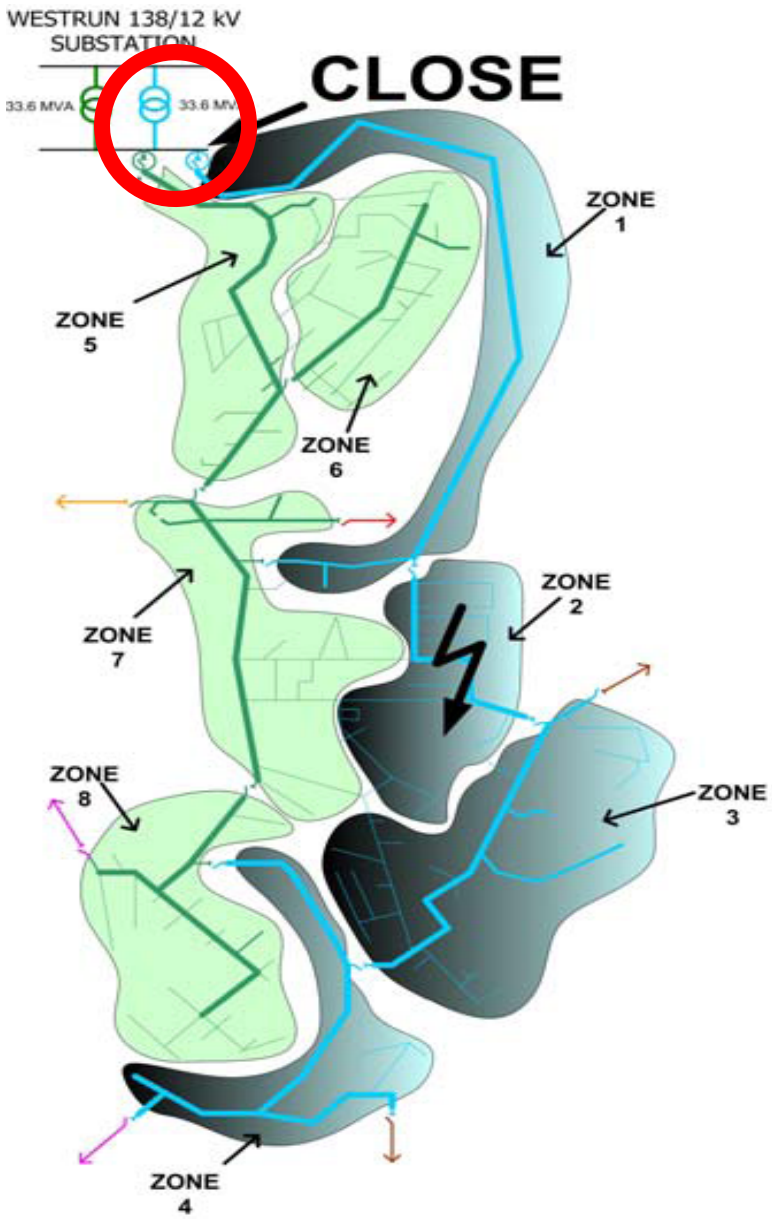
How it works...



Substation Circuit Breaker Closes

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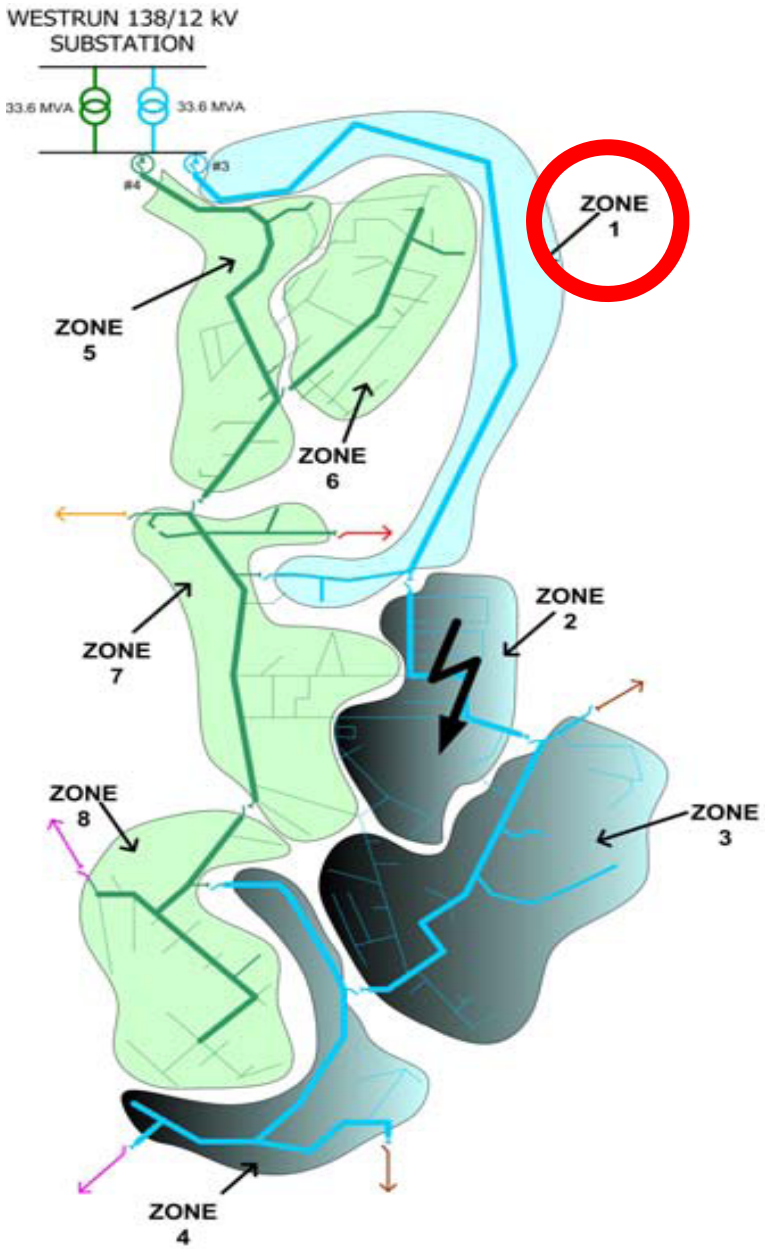
How it works...



Zone 1 in now reenergized

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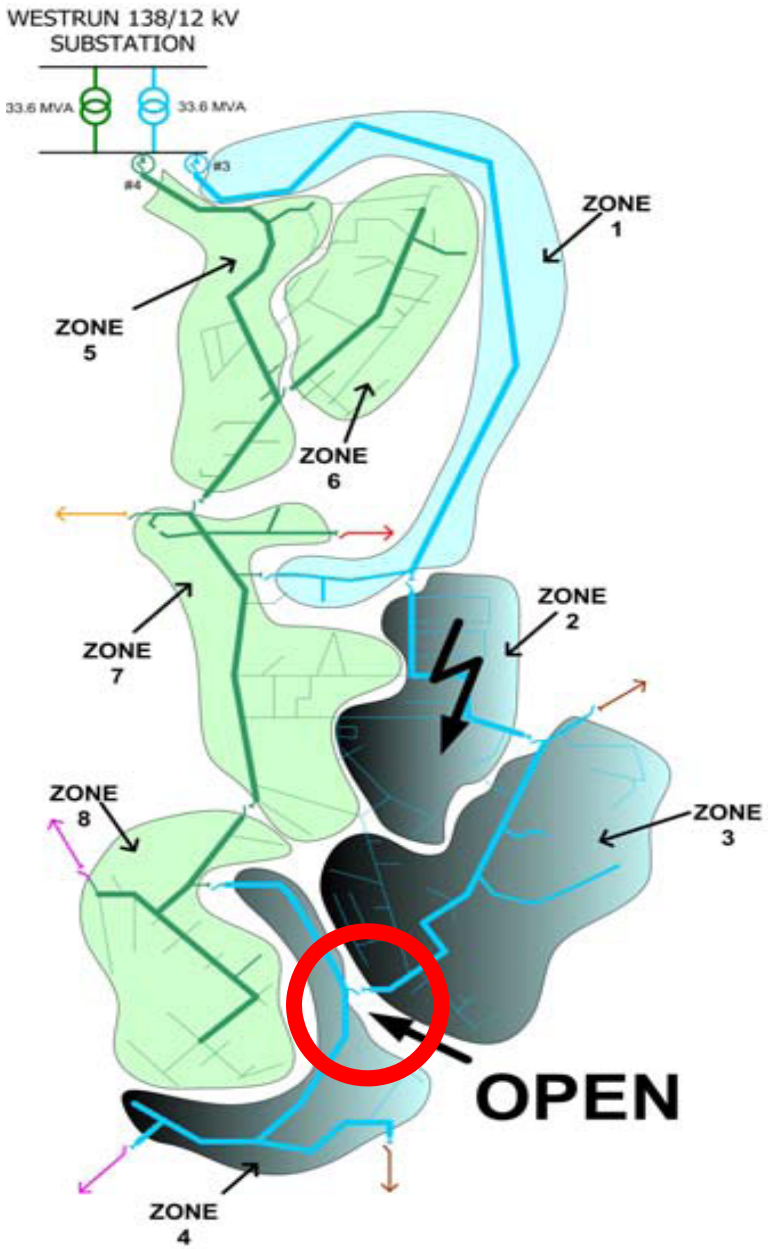
How it works...



Load Break Switch between Zone 3 and Zone 4 opens

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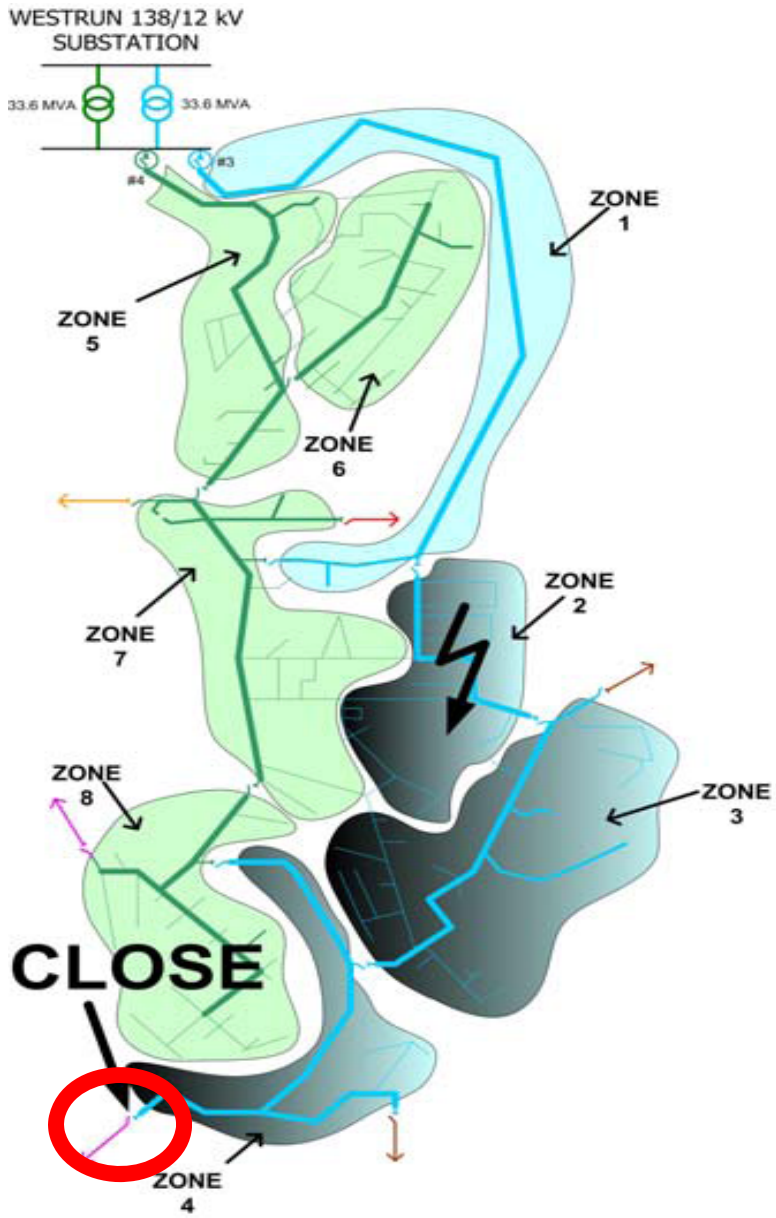
How it works...



Determines capacity of adjacent circuit Load Break Switch between Zone 4

Adjacent Feeder closes if capacity is available

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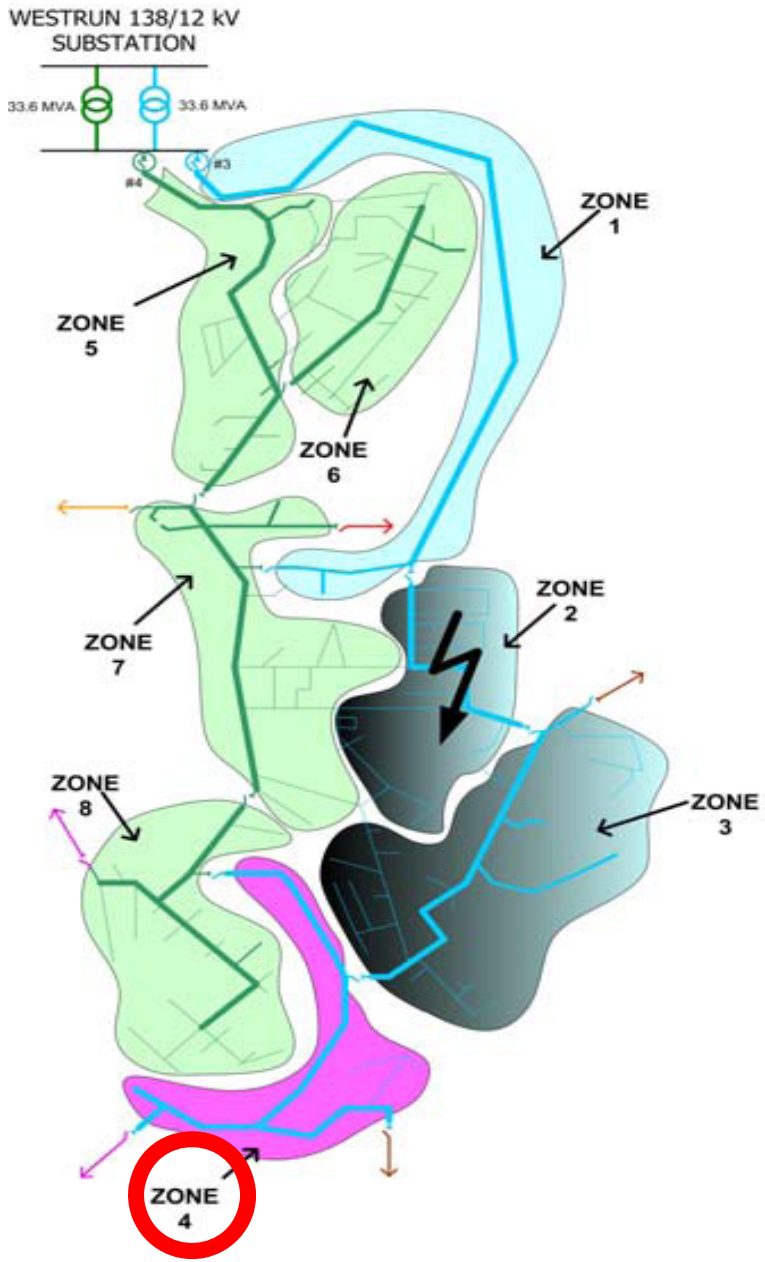
How it works...



Zone 4 is reenergized

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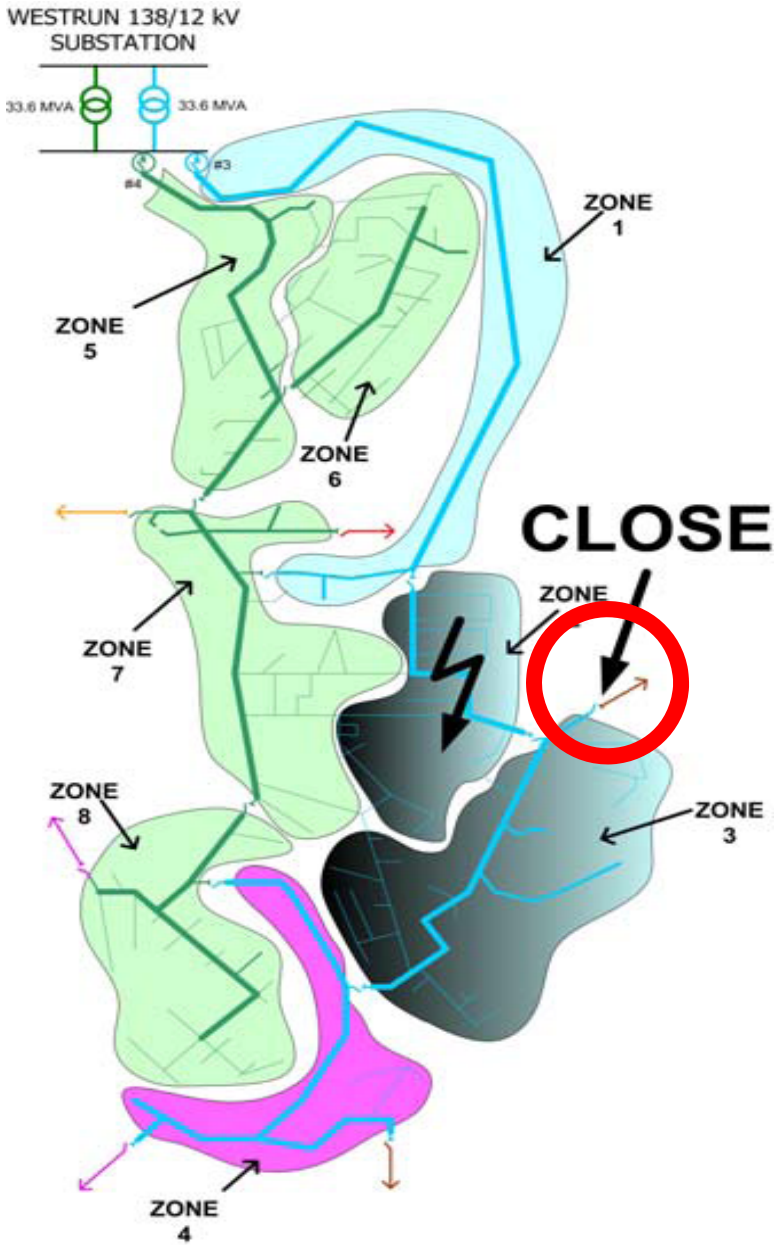
How it works...



Load Break Switch between Zone 3 and adjacent feeder closes

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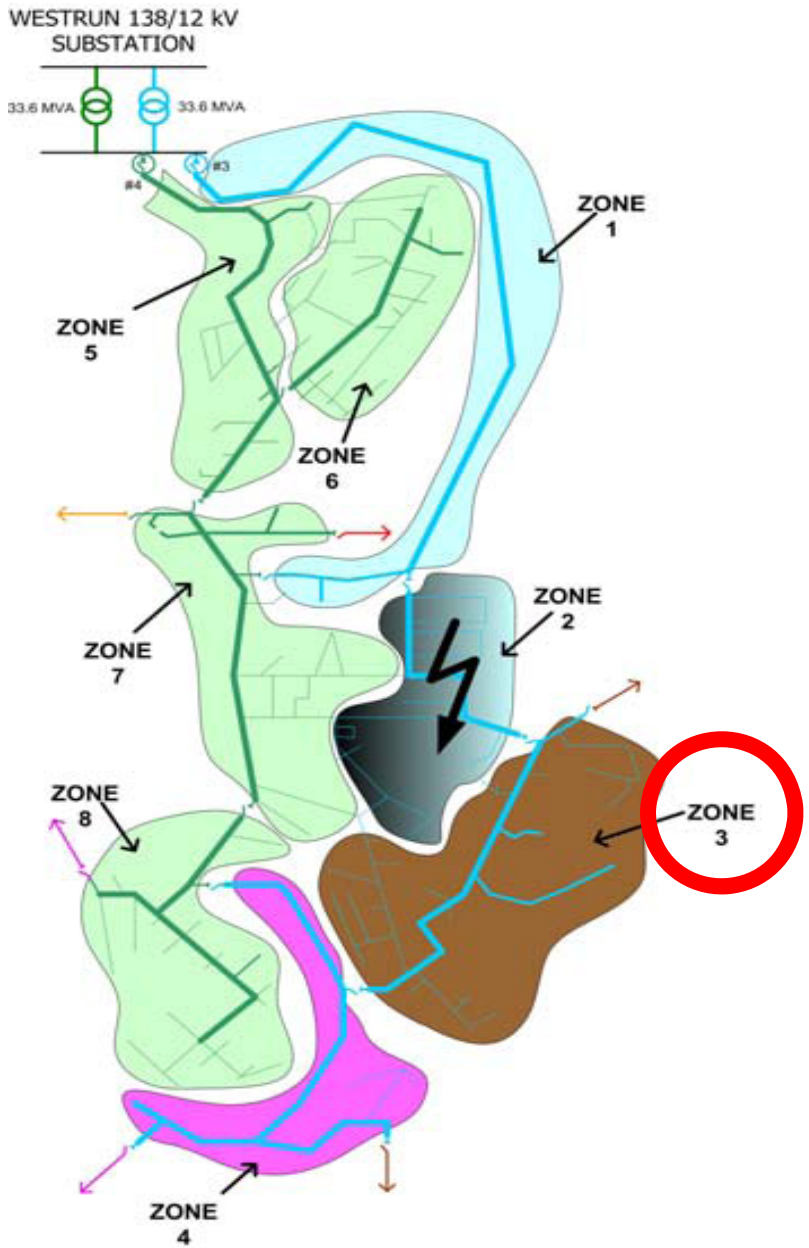
How it works...



Zone 3 is reenergized

Zones 1, 3 and 4 are restored

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The entire process to reenergize

Zones 1, 3, and 4,

which took me 10 minutes to explain

occurs in 60 seconds or less,

without human involvement.

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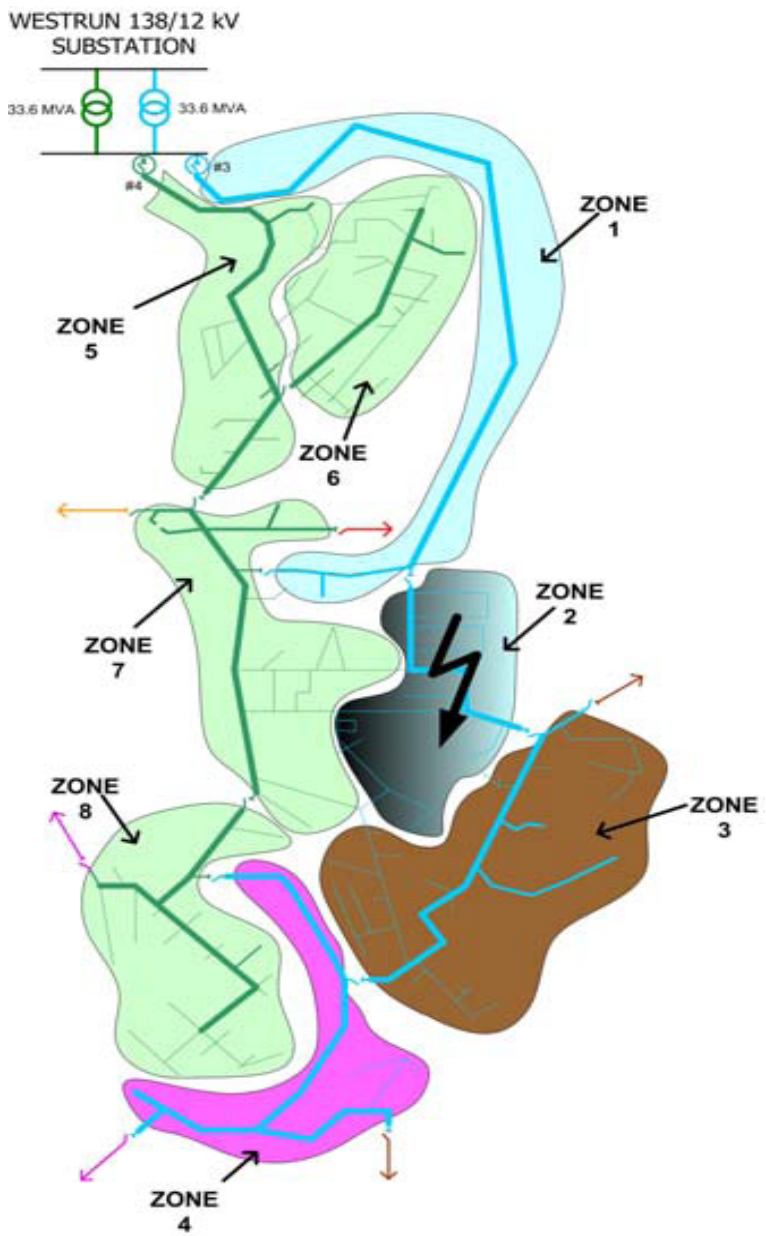
How it works...



DA Logic continues to monitor adjacent circuits for overloads

Takes corrective action if necessary

Checks for subsequent faults on restored zones

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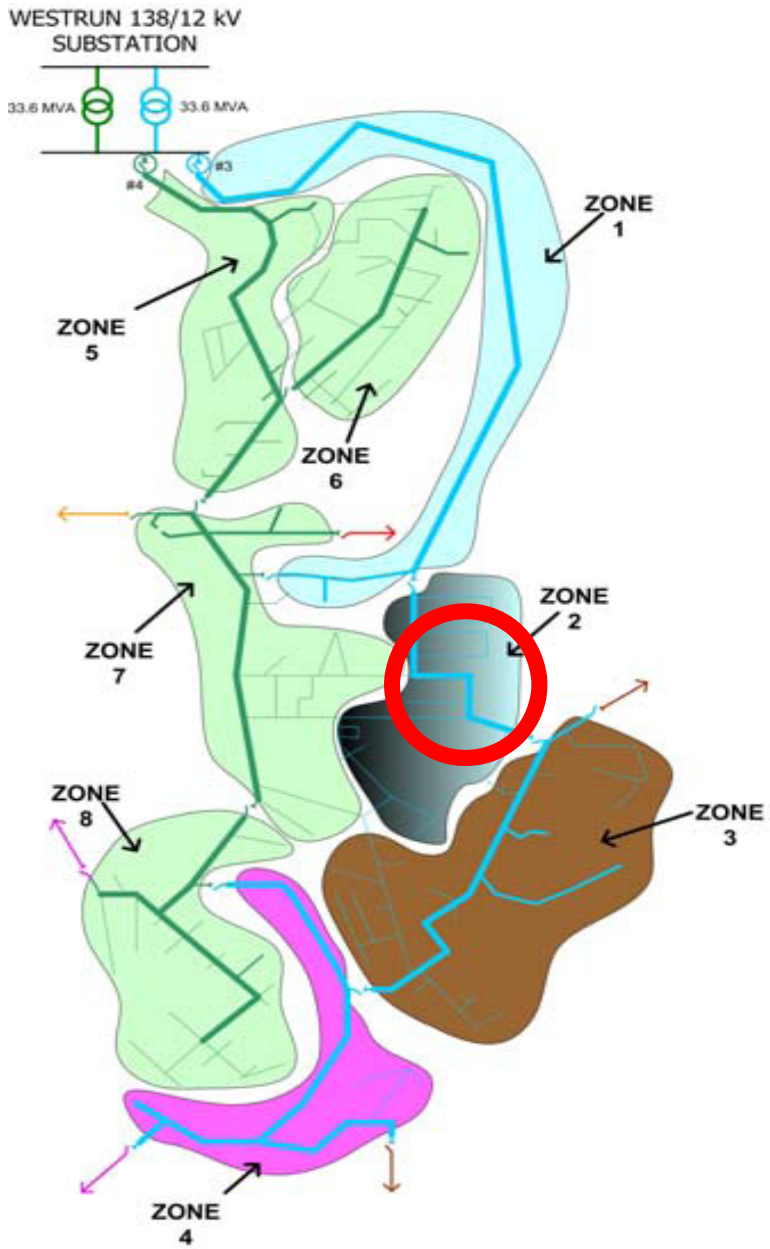
How it works...



The fault in Zone 2 is cleared by crew

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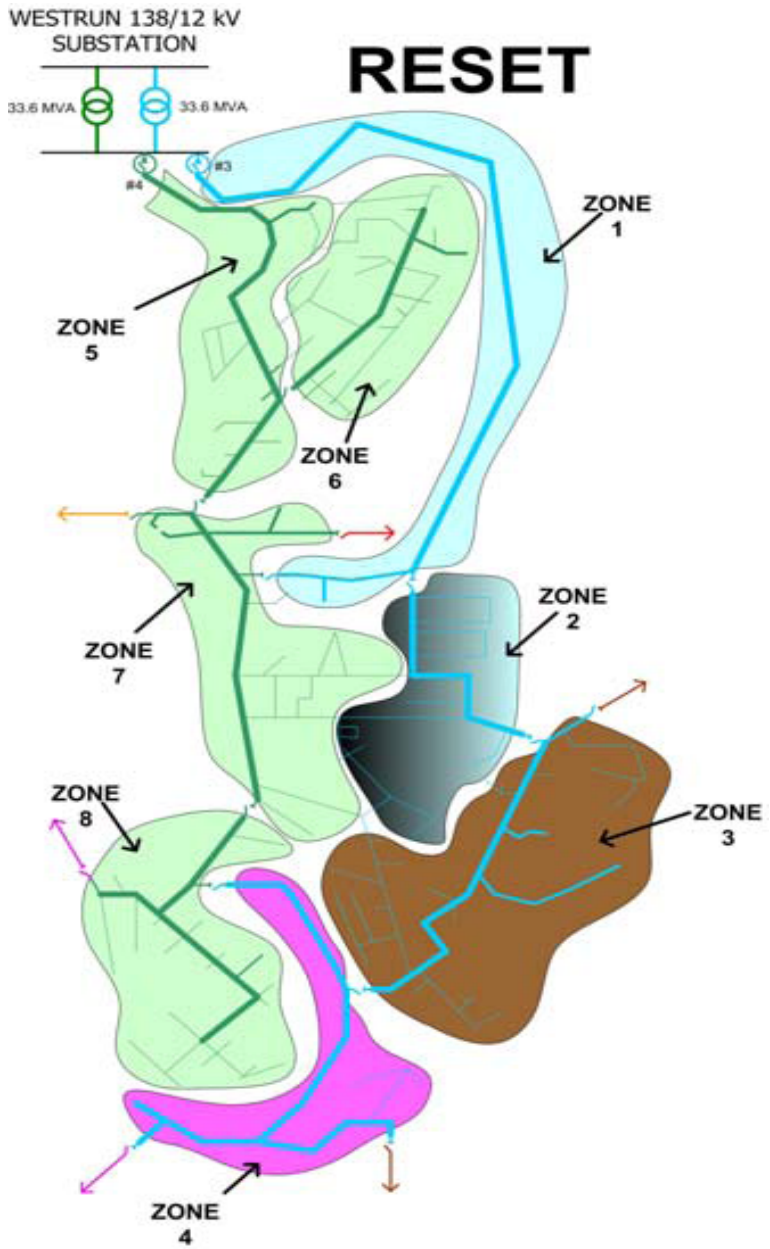
How it works...



Return to normal is initiated by operations personnel

DA Logic automatically returns the circuit to normal configuration

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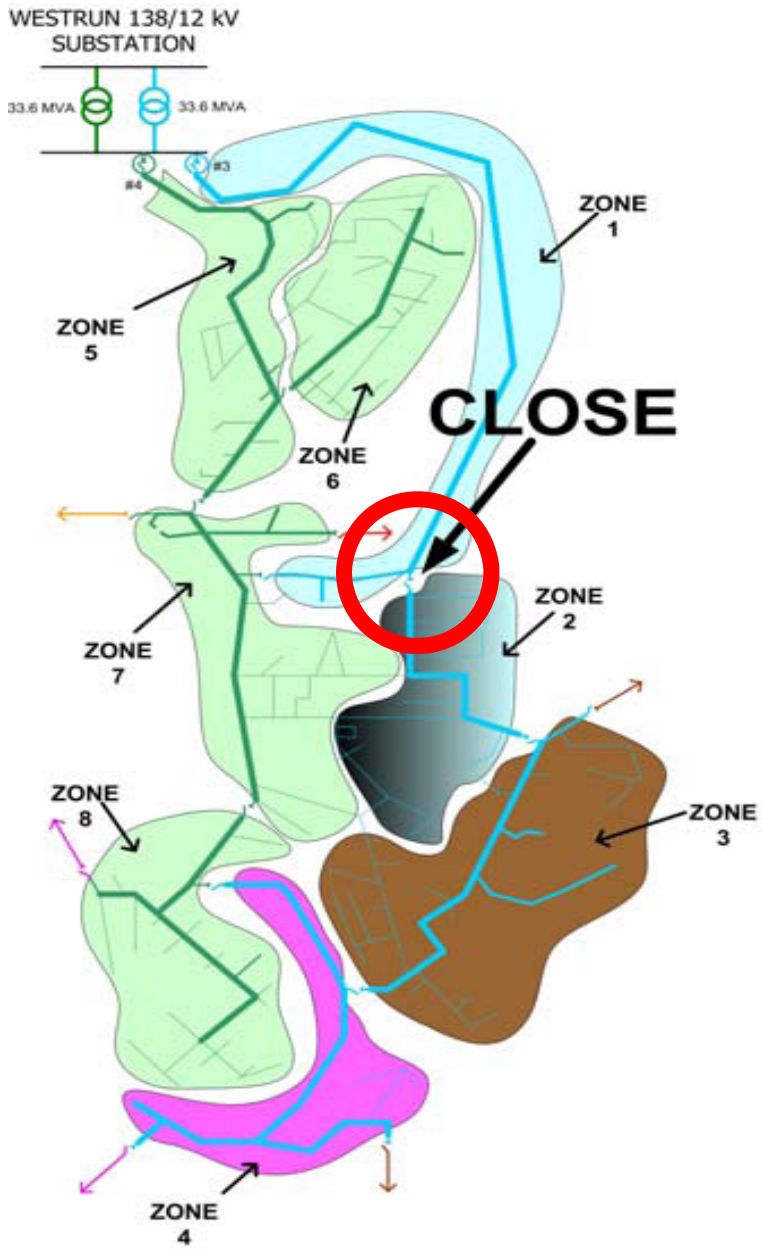
How it works...



Load Break Switch between Zone 1 and Zone 2 closes

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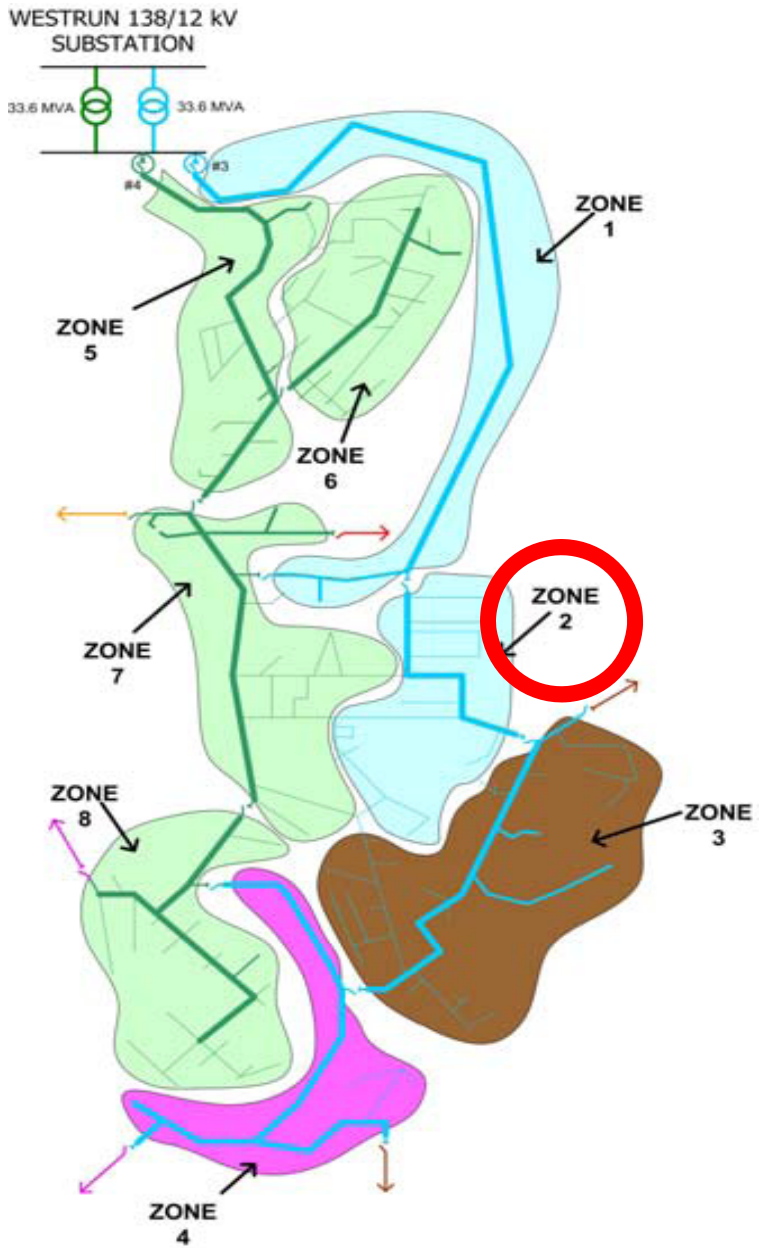
How it works...



Zone 2 is reenergized

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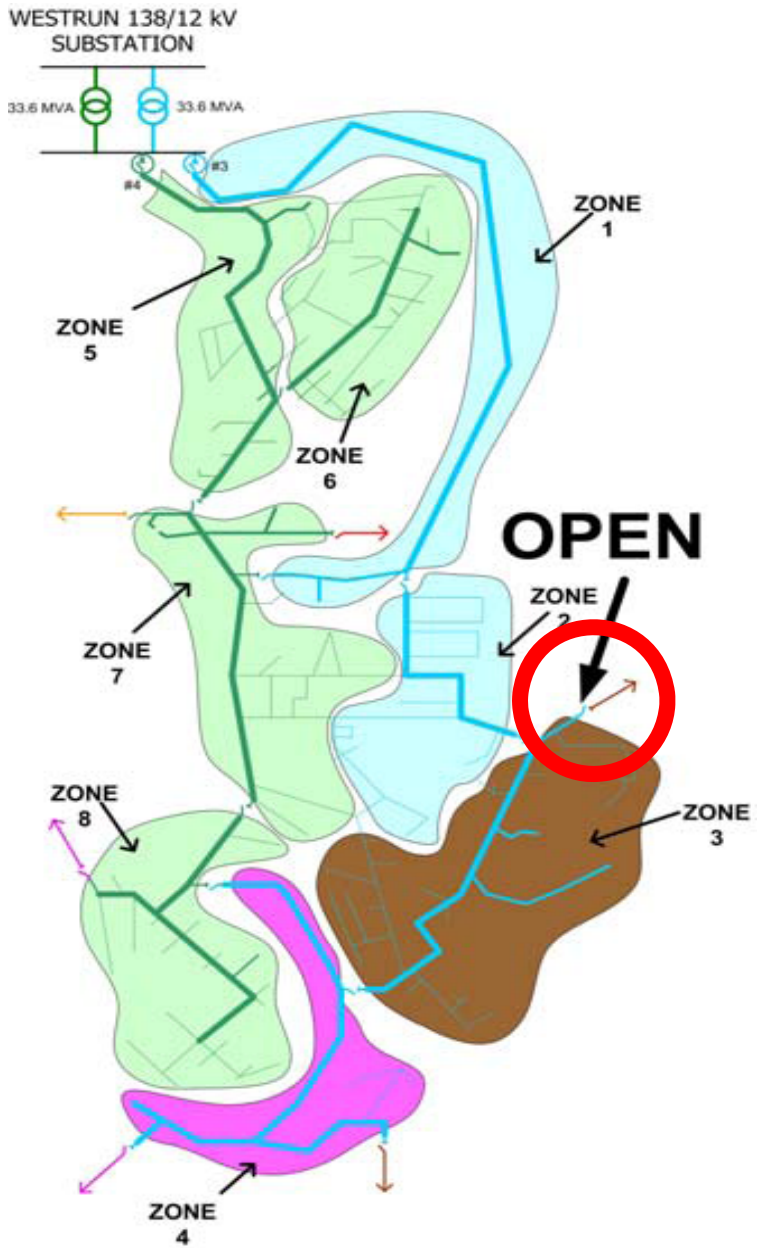
How it works...



Load Break Switch between Zone 3 and adjacent feeder opens

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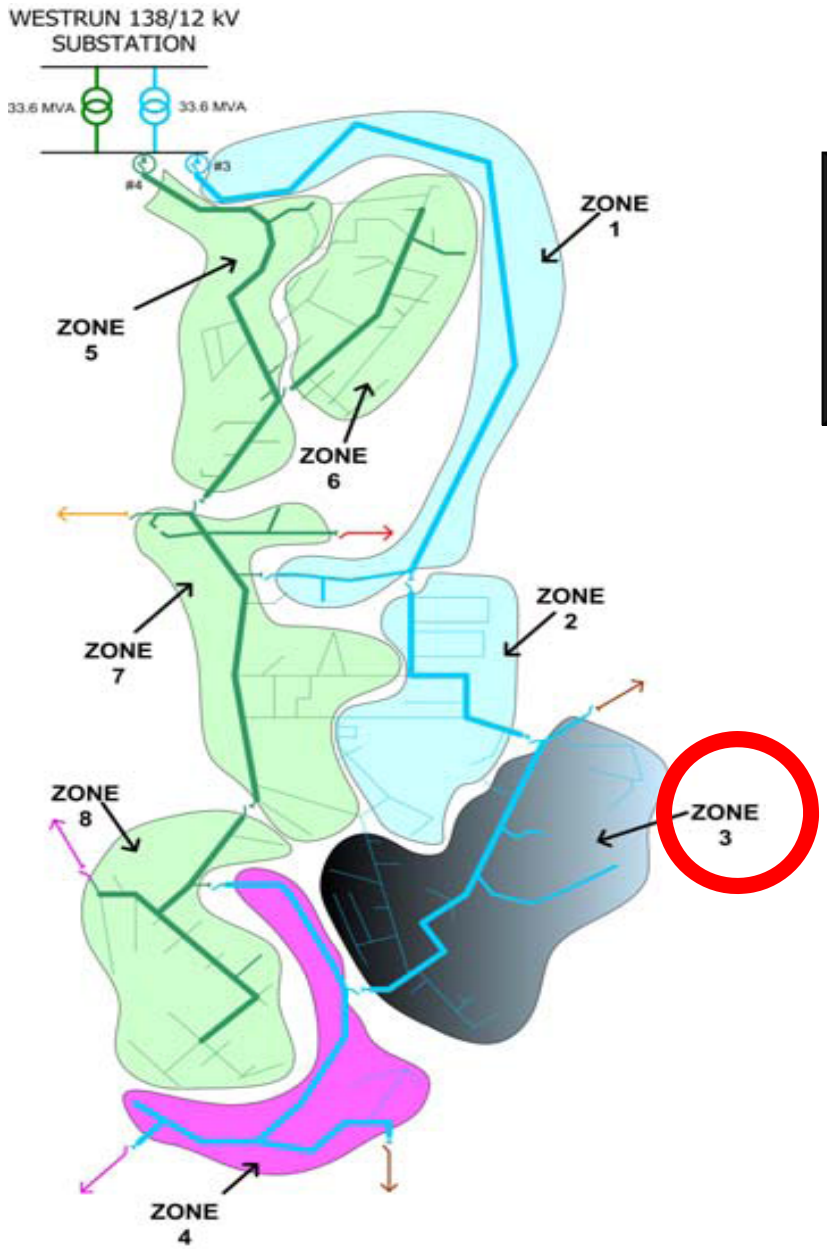
How it works...



Zone 3 is de-energized

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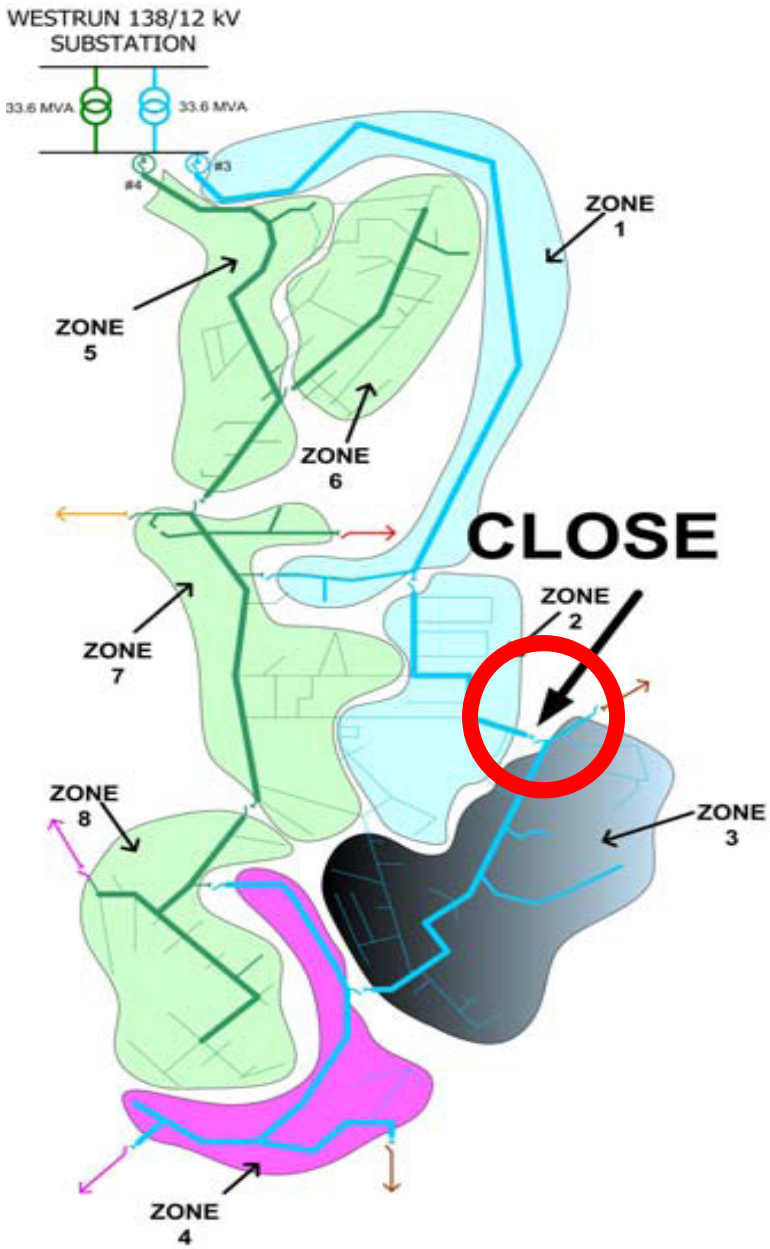
How it works...



Load Break Switch between Zone 2 and Zone 3 closes

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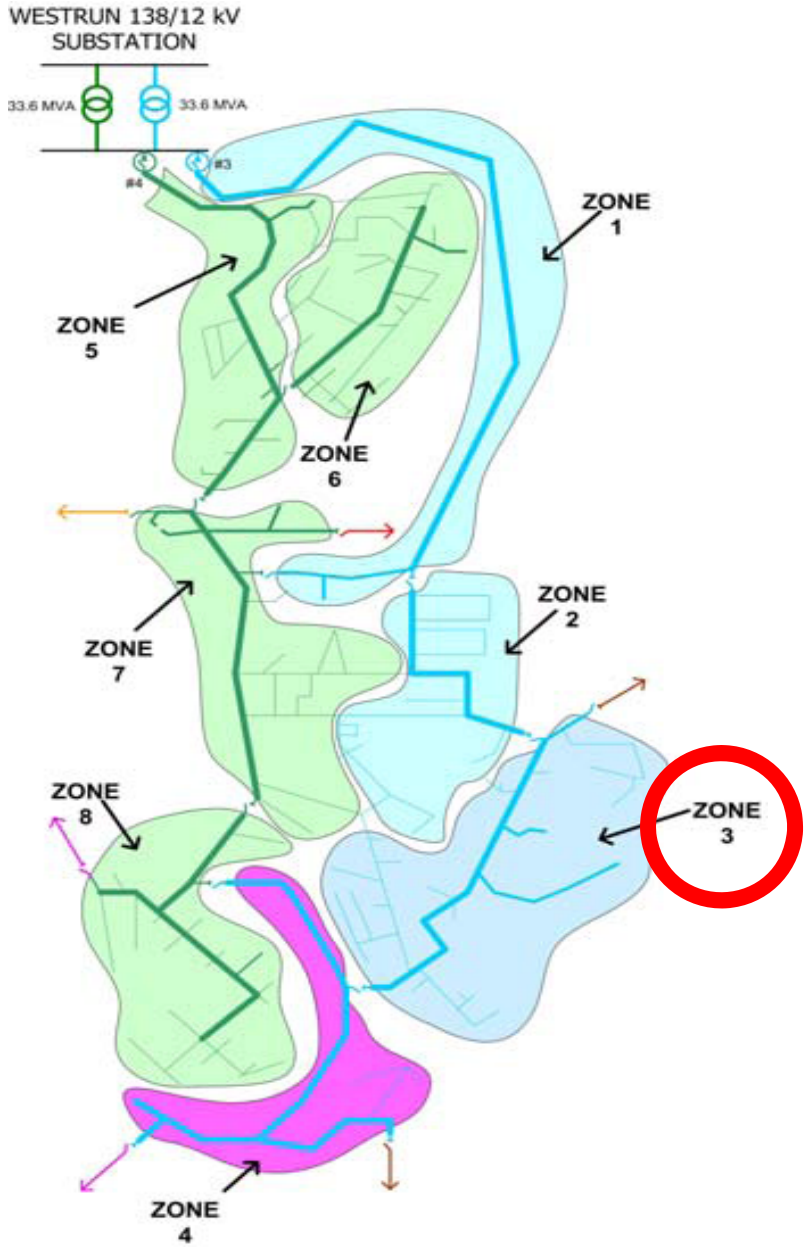
How it works...



Zone 3 is reenergized

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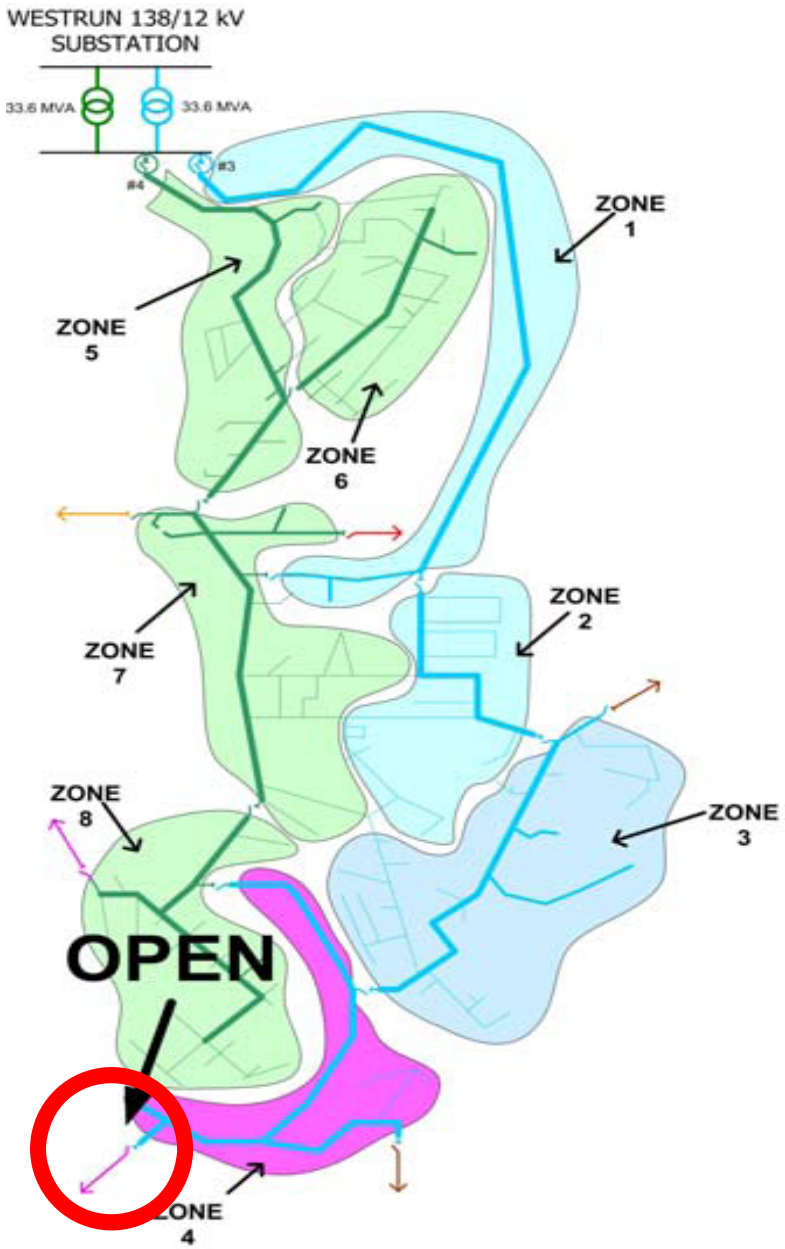
How it works...



Load Break Switch between Zone 4 and adjacent feeder opens

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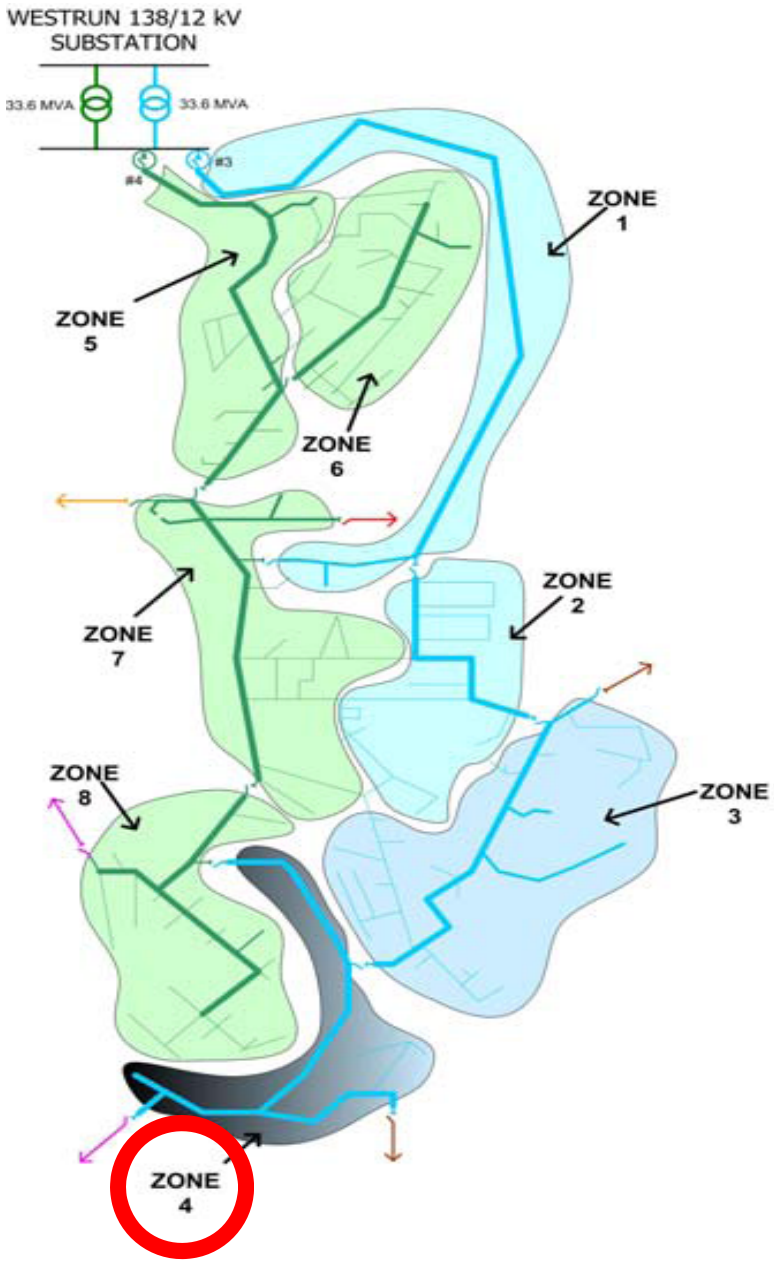
How it works...



Zone 4 is de-energized

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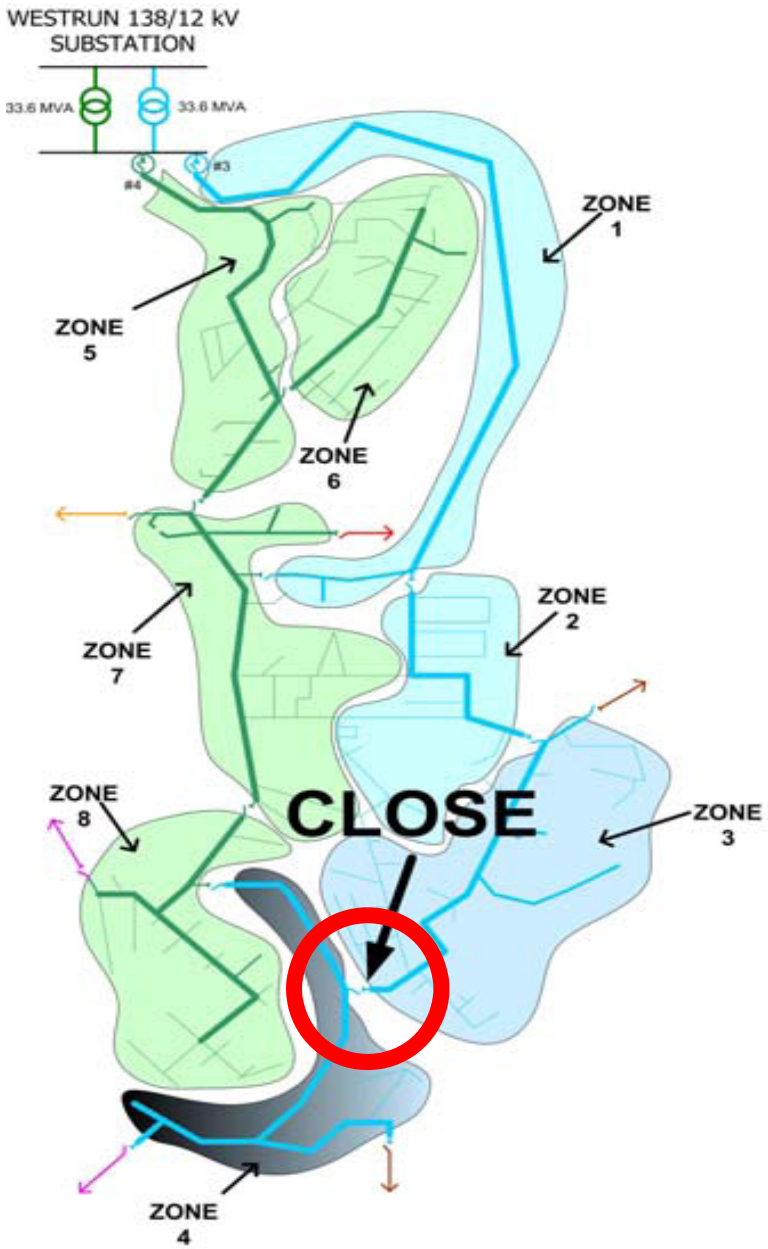
How it works...



Load Break Switch between Zone 3 and Zone 4 closes

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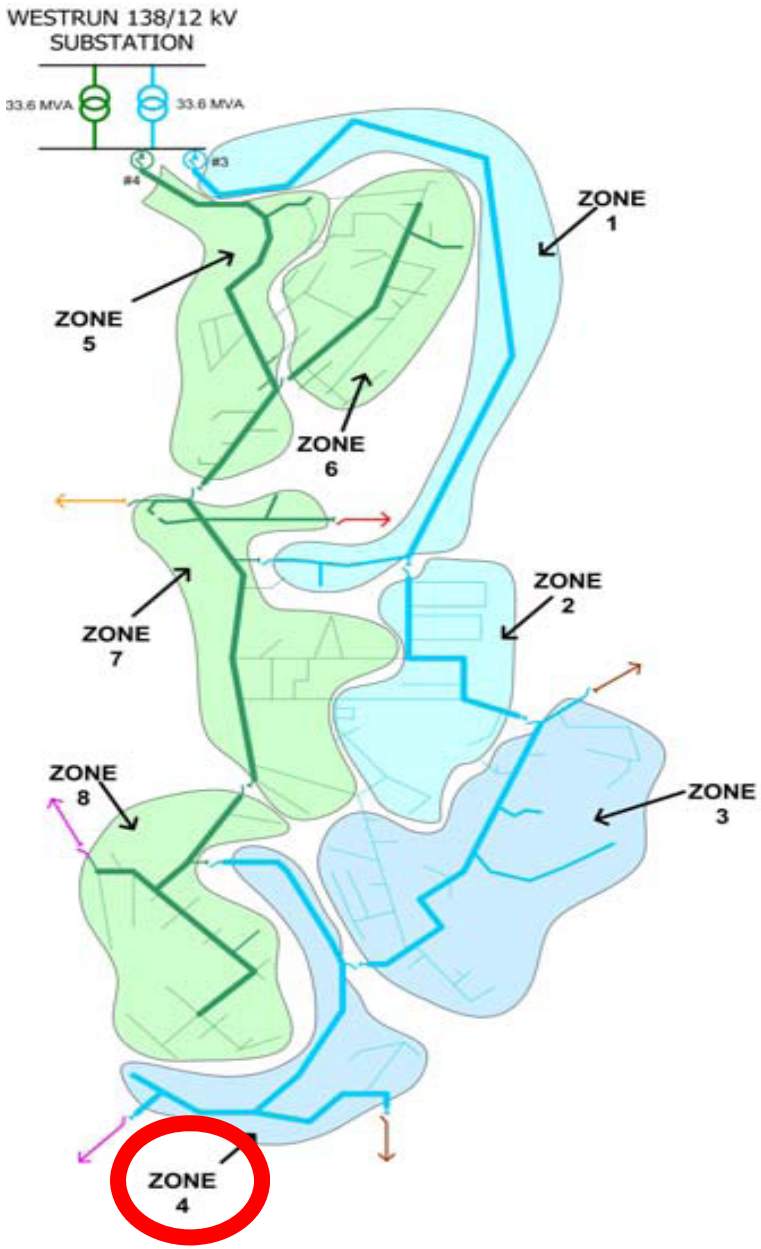
How it works...



Zone 4 is reenergized

Circuit is back to normal configuration

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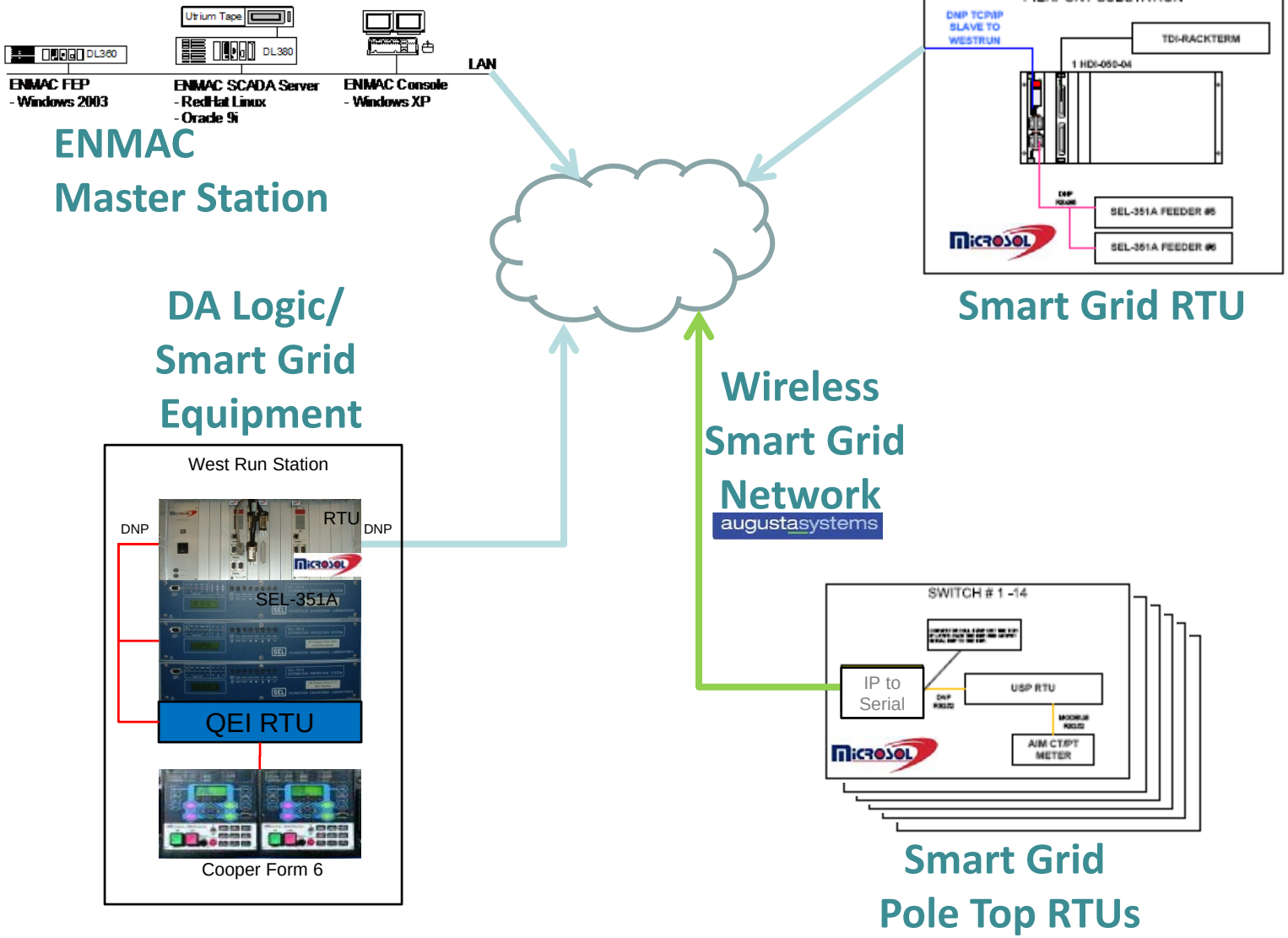
Smart Grid Equipment Configuration



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Wi-Fi Intelligent Wireless Network

Support the continuous connections and reconfiguration	Maximizes throughput utilization and minimizes latency	Secure data through encryption and authentication
Monitors health of communications backbone	The self-healing nature	Monitors status of all access points via SNMP and PING
Employs Wi-Fi mesh-enabled communications architecture	Relies on standard wireless communications protocols	Provides communications between the reclosers and switches in the distribution circuits

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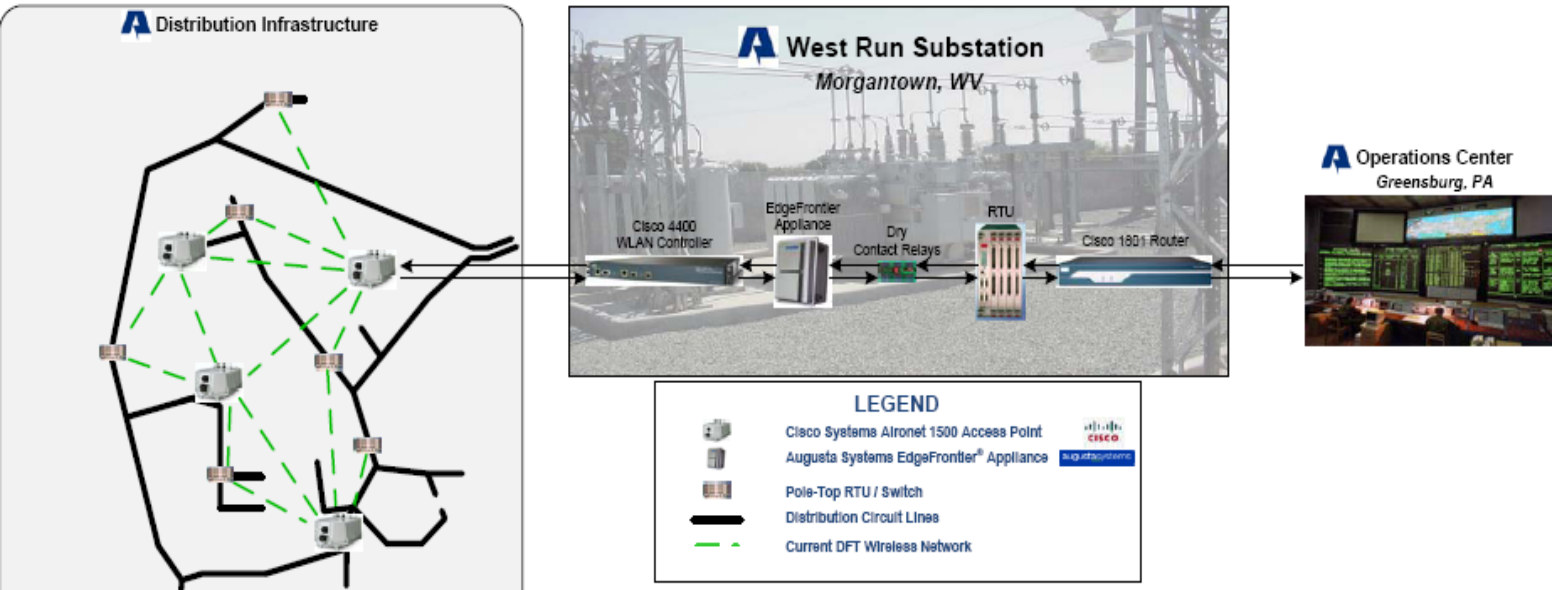
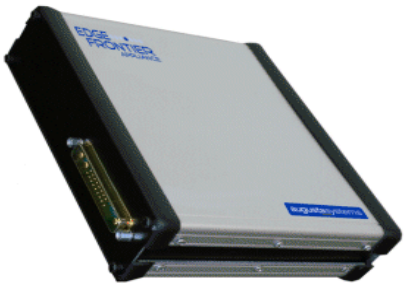
Wi-Fi Intelligent Wireless Network



Pole-Mounted Access Point
Cisco Aironet 1510 Mesh Access Point

EdgeFrontier Appliance with embedded EdgeFrontier middleware



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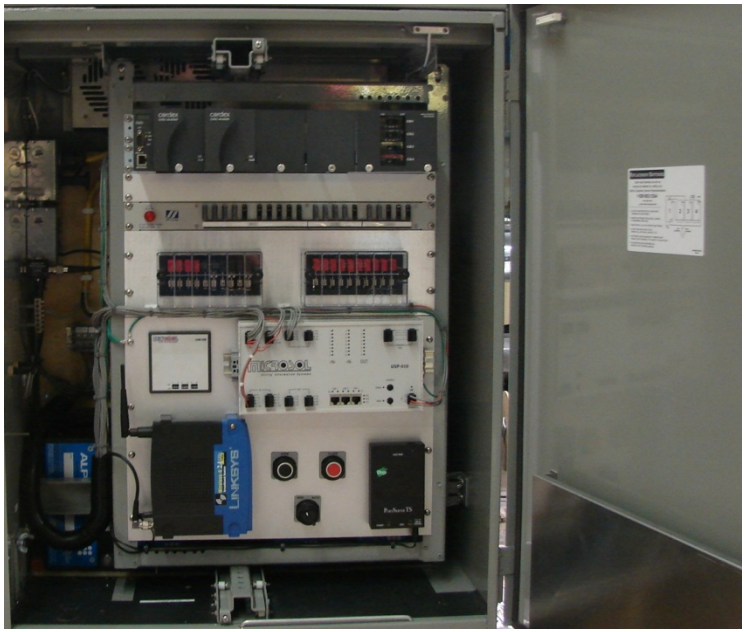
Pole Controller Cabinet

Typical controller cabinet located on Pole directly below DAS Pole-top Switch, contains:

- **Switch Controller**
- **Intelligent RTU**
- **Radio**
- **Battery and charger**



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Cooper DAS Switch and Controller

- **Three-phase**
- **Electronically controlled**
- **Vacuum switch**
- **Medium voltage level**
- **Embedded CTs**
- **Solid dielectric system**
- **Remote controllable**

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Smart Grid RTU

- **Fully distributed and network centric**
- **TCP/IP communication capability**
- **Cyber security features**
- **Standard protocol conversion**
- **I/O data gathering, control and automation functionality.**
- **Scalable**

West Run Smart Grid RTU

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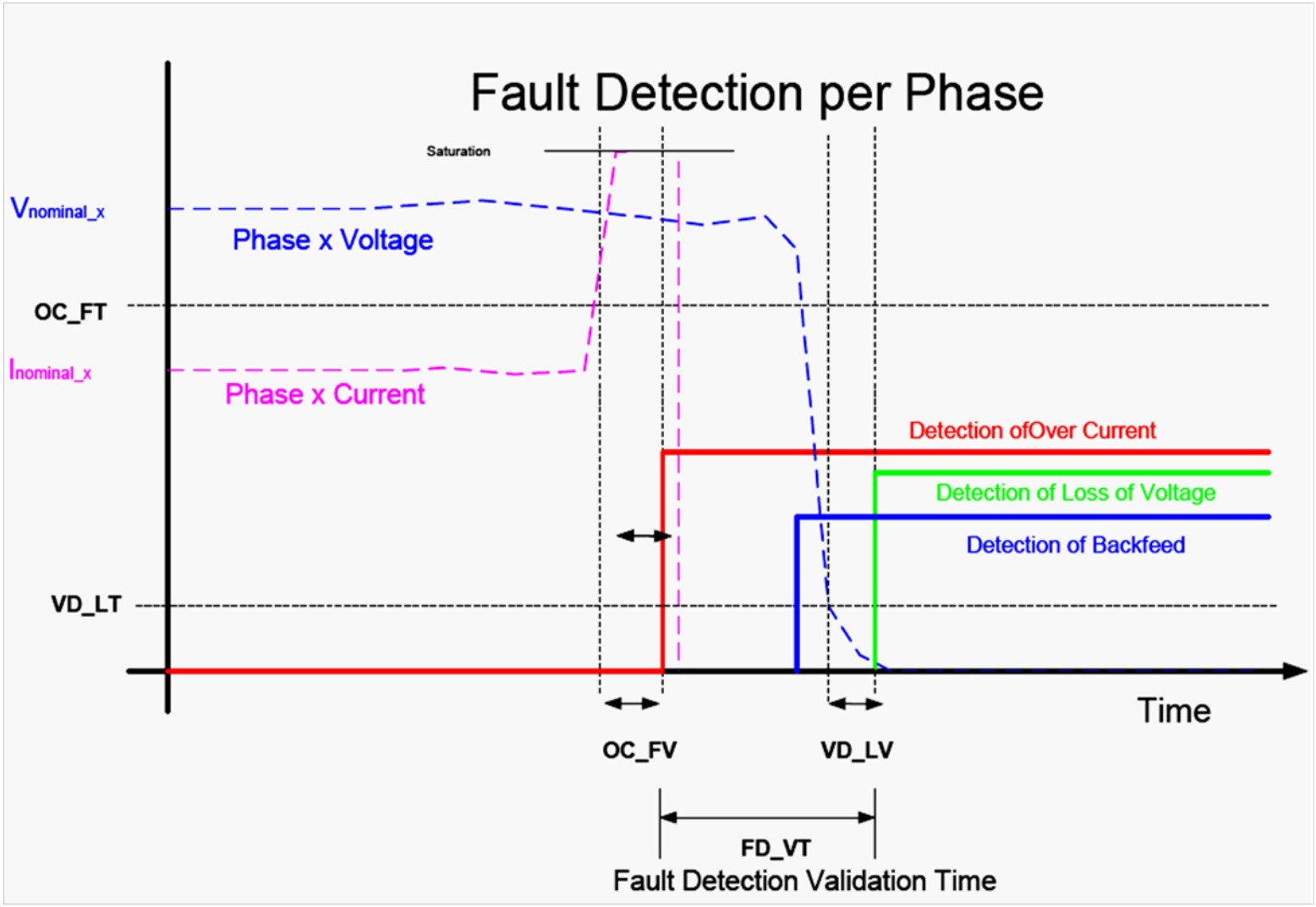
Distribution Automation (DA) Logic



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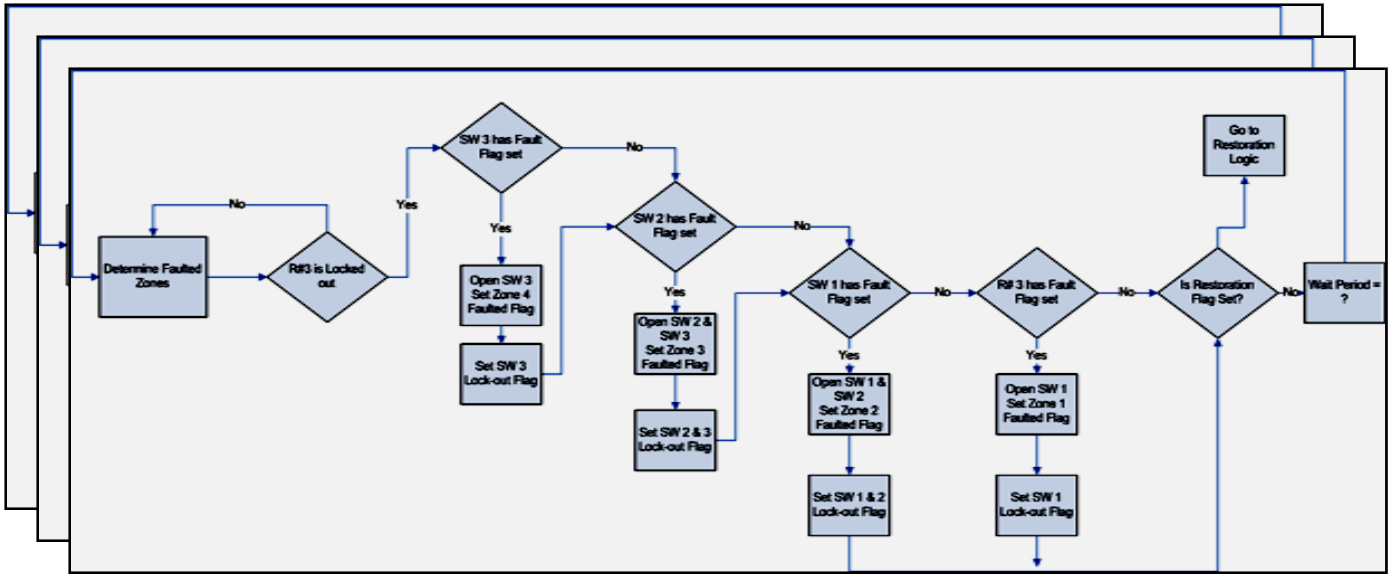
DA Logic Flow Diagram Modules



Programmable Logic (Current)

- Open Substation-based system
- Uses predetermined scripted sequences
- Provided shortest development time
- Least costly approach
- Most flexible for testing and revision

Robust Application (Phase II)

- Dynamic network model
- Customer Specifics
- Intuitive Interface
- Drag and drop for circuit re-configurations

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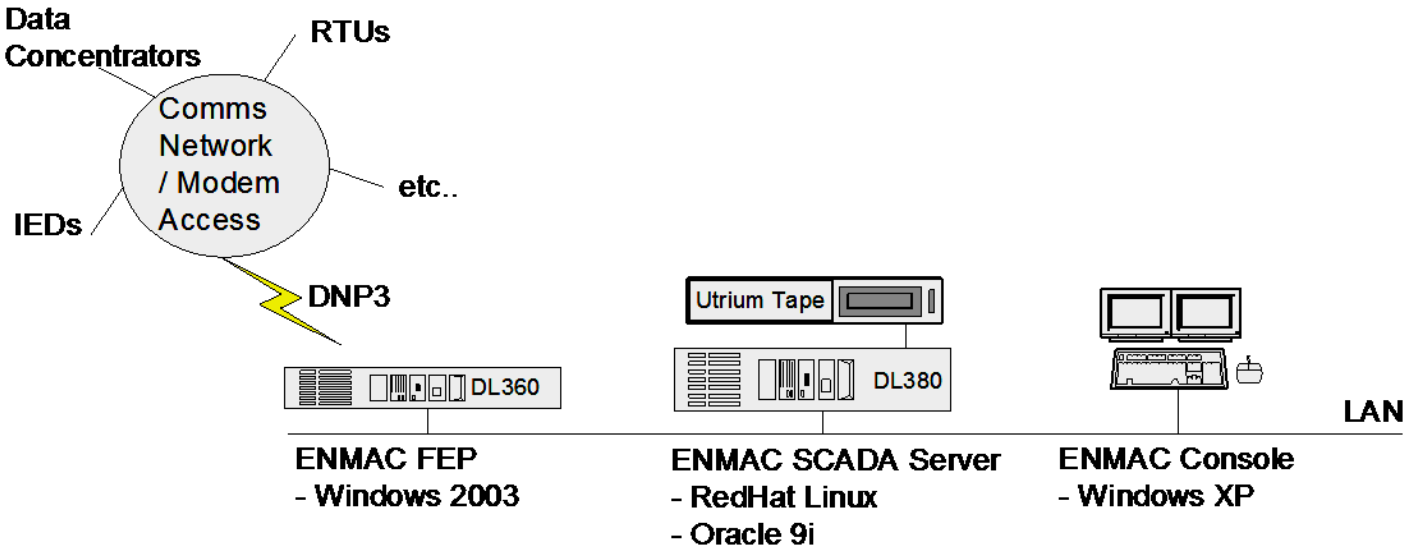
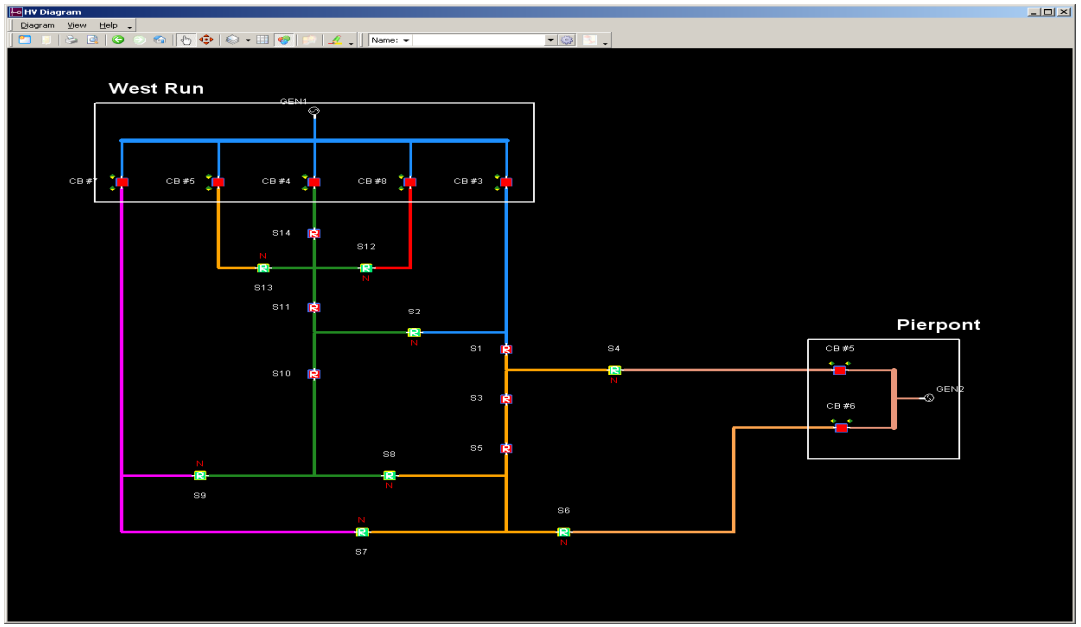
Distribution Management System (DMS)





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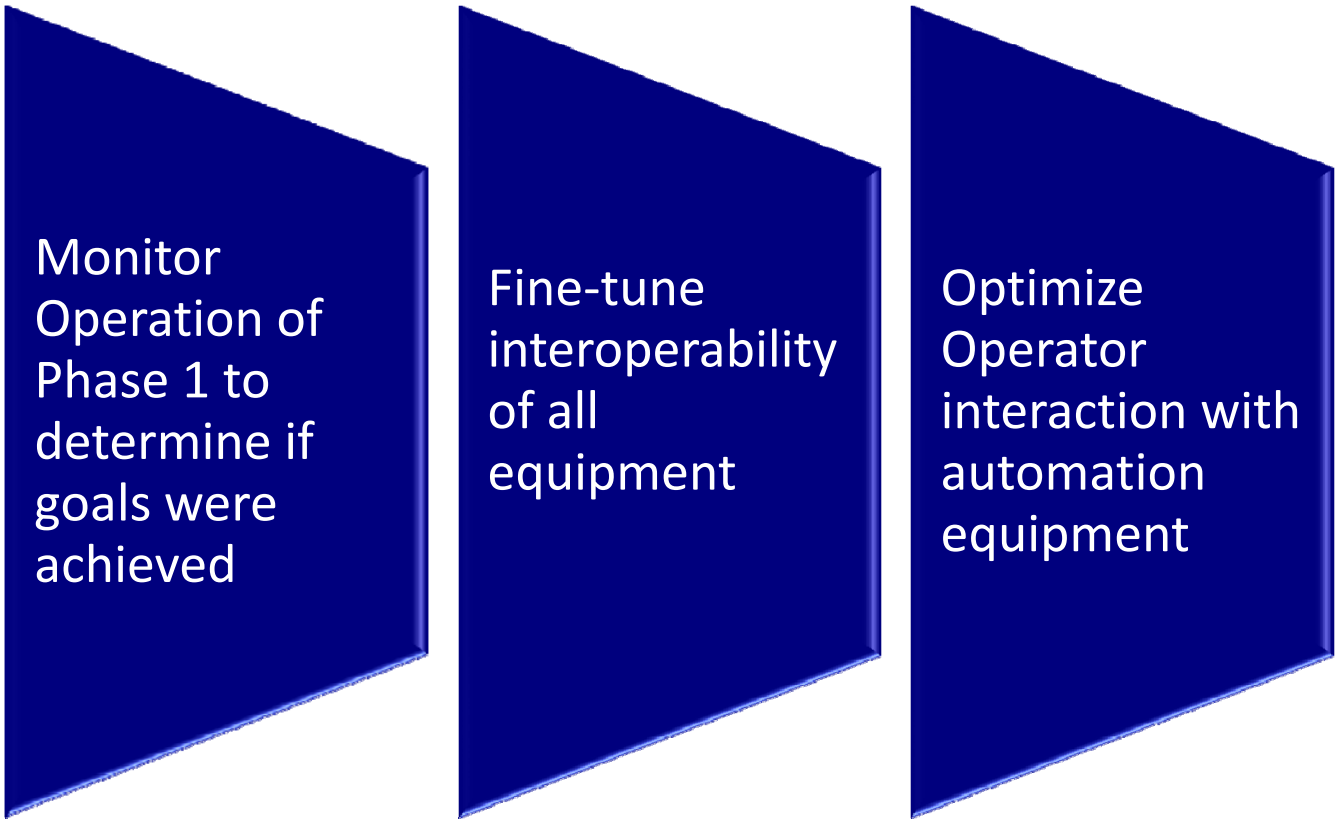
Completing Phase 1



Phase 1 scheduled for completion in April, 2009

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Phase 2 Development

Provide frequency response and voltage support to the transmission system	Provide peak shaving and load leveling	Improve power quality to 21st century requirements
Improve reliability indices	Integrate under-frequency and under-voltage grid friendly appliances	Integrate advanced metering infrastructure
Expand dynamic feeder reconfiguration to dynamic islanding	Test advanced distribution automation systems	Defer or avoid planned capital investments

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Contact Information

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QUESTIONS

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