Large Scale Deployment of Distribution Grid Modernization
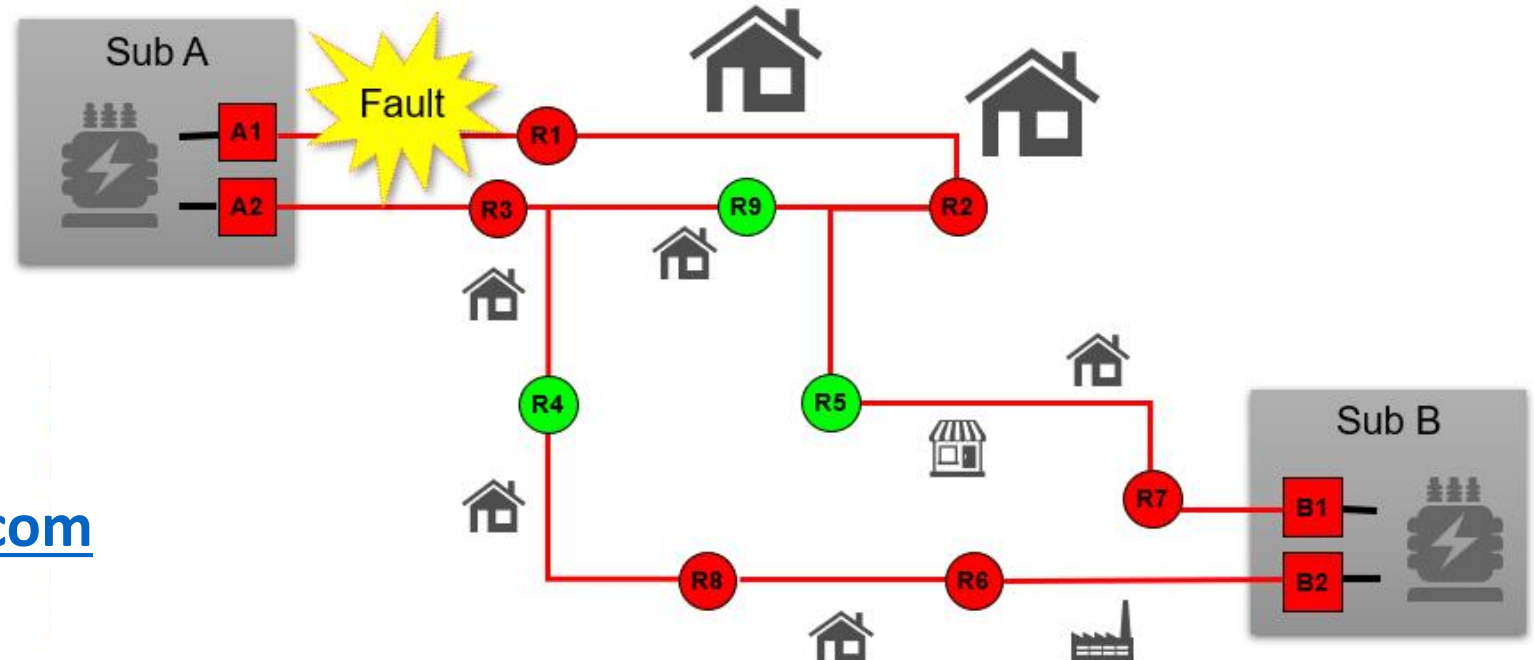
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FirstEnergy Distribution Smart Grid
# Large Scale Deployment of Dx Grid Modernization
Agenda

- FirstEnergy Overview

- What is Distribution Automation?
    - Significant DA Events
    - Overall Performance

- FirstEnergy's CEI Smart Grid Pilot

- FE Large Scale Deployment of Grid Modernization
    - Ohio- OH Grid Modernization

- ADMS with Advanced Applications

FirstEnergy Electrical System

- 6,100,000 customers

- 65,000-square-mile service territory

- 10 electric utility operating companies in six states

- 24,000 miles of transmission lines

- Approximately 269,000 miles of distribution lines

- Approximately 12,000 employees
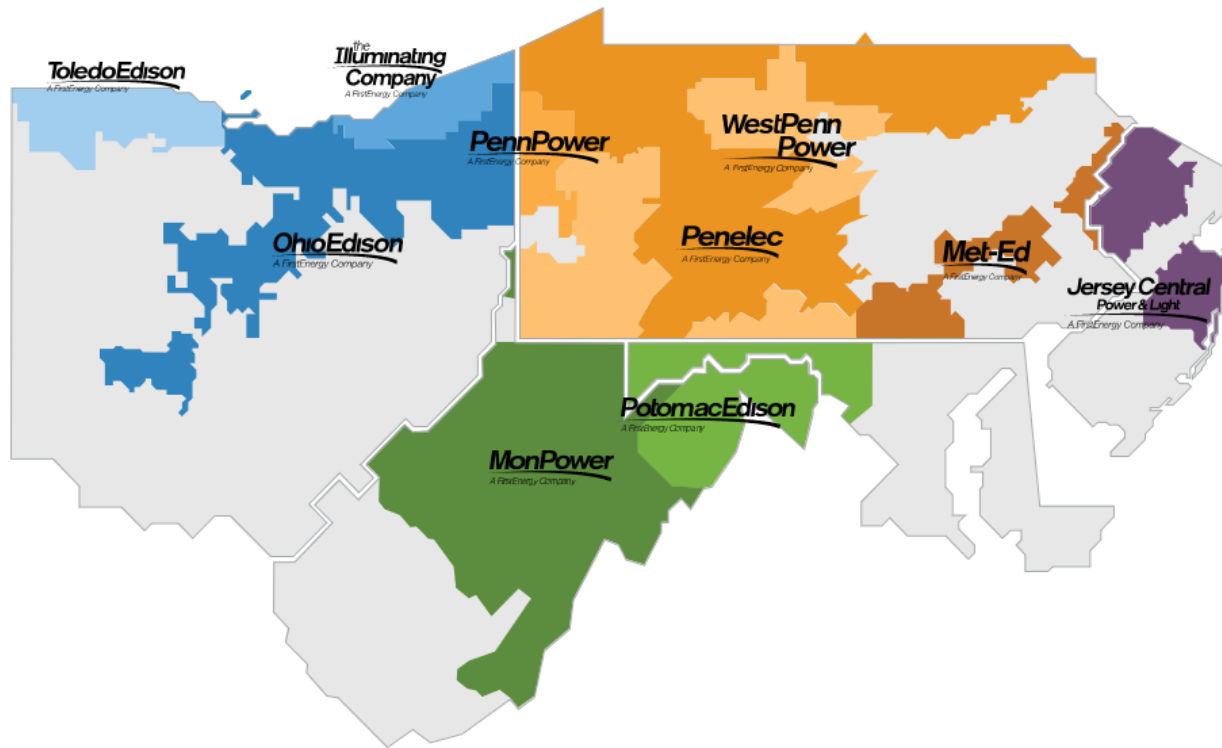
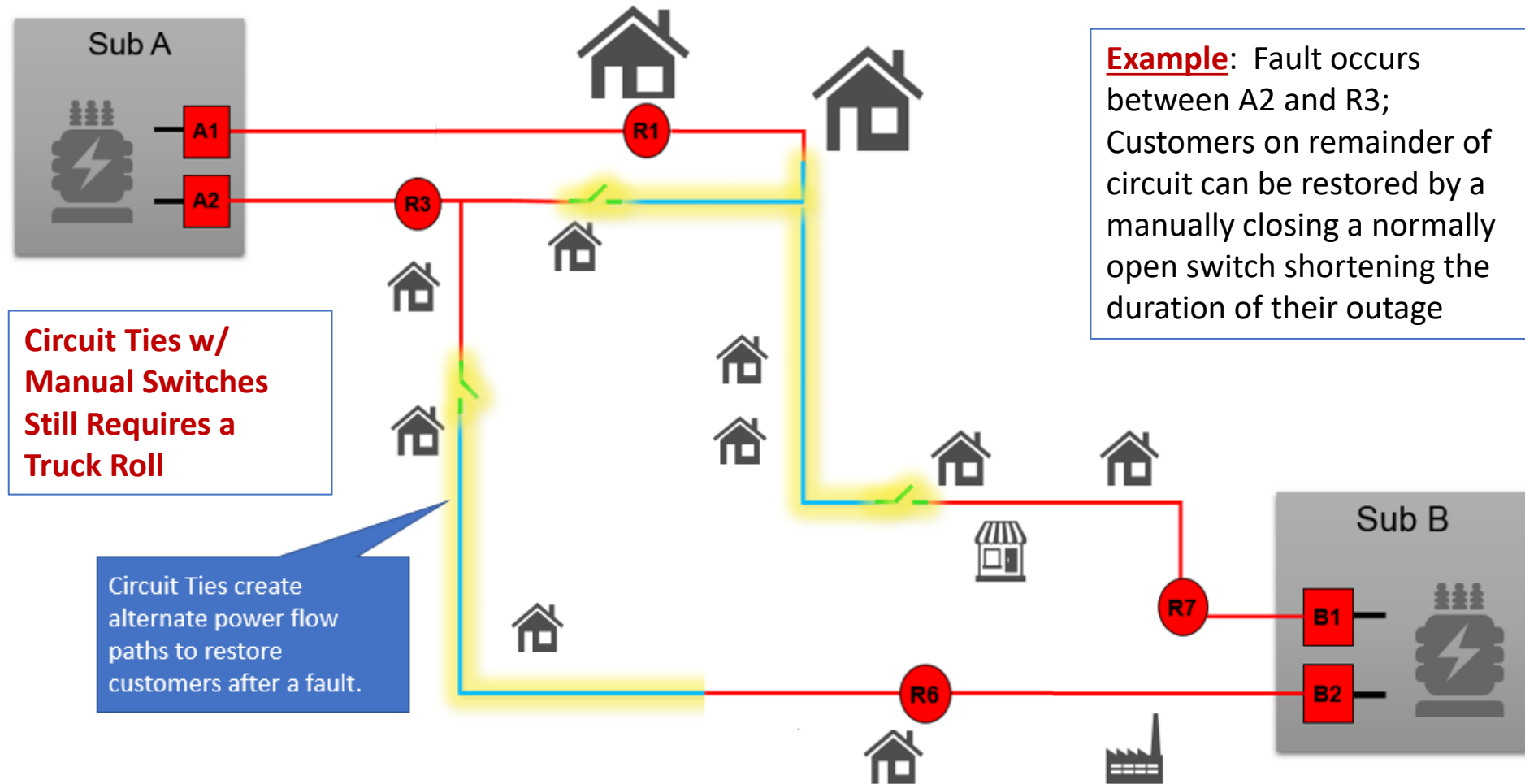|	Customers	Square Miles
Ohio		
Ohio Edison	1,053,000	7,000
The Illuminating Company	752,000	1,600
Toledo Edison	308,000	2,300
Pennsylvania		
Met-Ed	574,000	3,300
Penelec	581,000	17,600
Penn Power	175,000	1,100
West Penn Power	723,000	10,364
West Virginia/ Maryland/Virginia		
Mon Power	392,000	13,005
Potomac Edison	426,000	5,500
New Jersey		
Jersey Central Power & Light	1,139,000	3,200

Circuit Ties for DA

- Traditional circuit design brought power from a generating source to the substation and then to end use customers

Reclosers R1, R3, R6, R7
Breakers   A1, A2, B1, B2
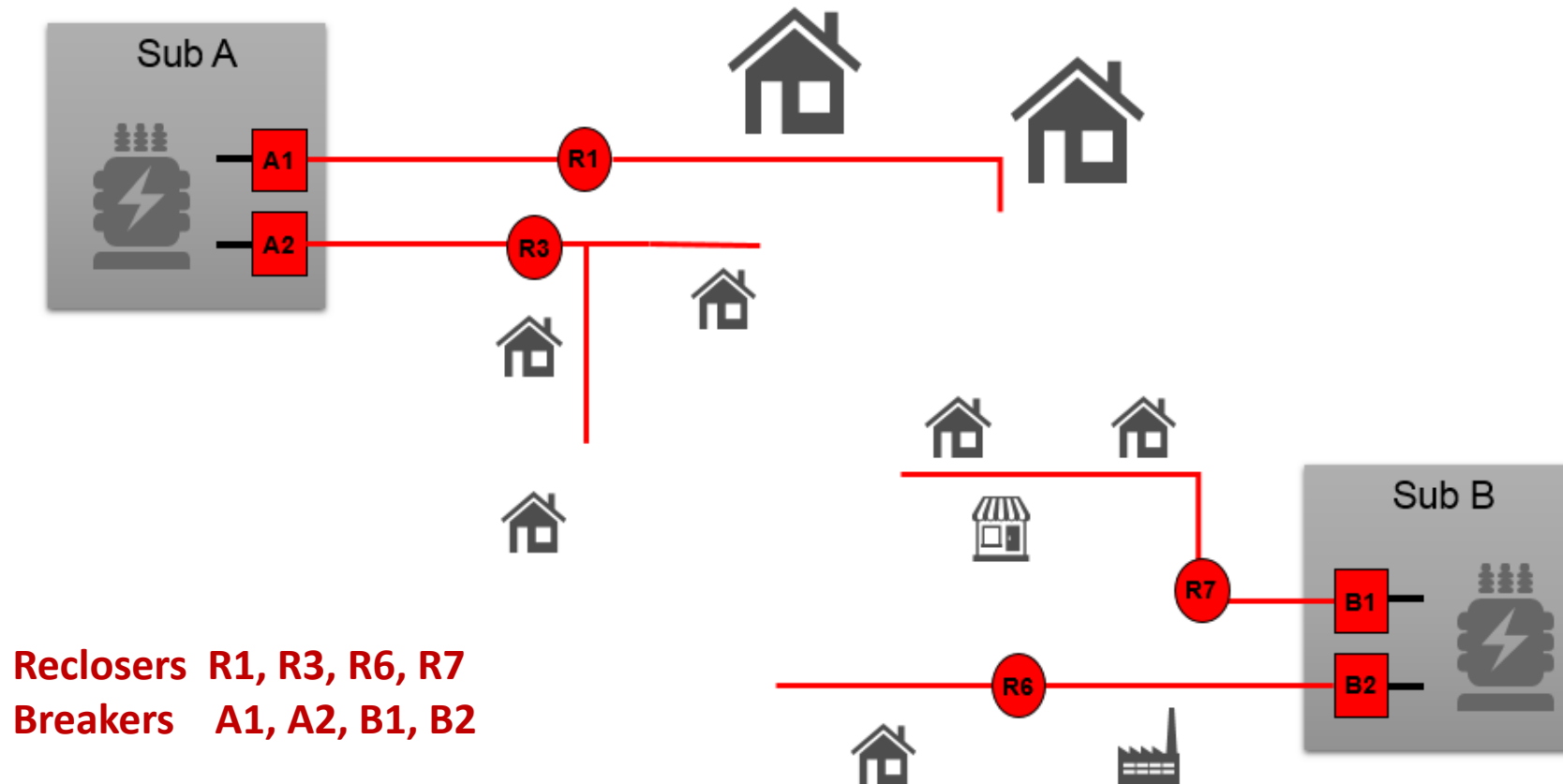
Circuit Ties *(continued)*

- Customer Benefits: allow customers to be served from multiple sources; facilitates modern grid architecture

Example: Fault occurs between A2 and R3; Customers on remainder of circuit can be restored by a manually closing a normally open switch shortening the duration of their outage

Circuit Ties w/ Manual Switches Still Requires a Truck Roll

Circuit Ties create alternate power flow paths to restore customers after a fault.

Reclosers

- Reclosers divide up the distribution circuit into small sections
- Customer Benefits: improved restoration times and fewer outages by isolating faults to smaller groups of customers

Example: Fault occurs between A2 and R3; R3 automatically opens; R9 or R4 automatically closes and remaining customers on circuit experience momentary outage

Reclosers include circuit fault isolation and give system operators the flexibility to re-route power to mitigate outages

Circuit Ties create alternate power flow paths to restore customers after a fault. Reconductoring increases wire sizes to increase power carrying capacity

Reconductoring for DA

- When creating new circuit ties, wire size needs to be increased to accommodate new power flows on the lines

- Customer Benefits: facilitates power flows from multiple sources; improves the resiliency of the line making it better able to withstand adverse weather conditions
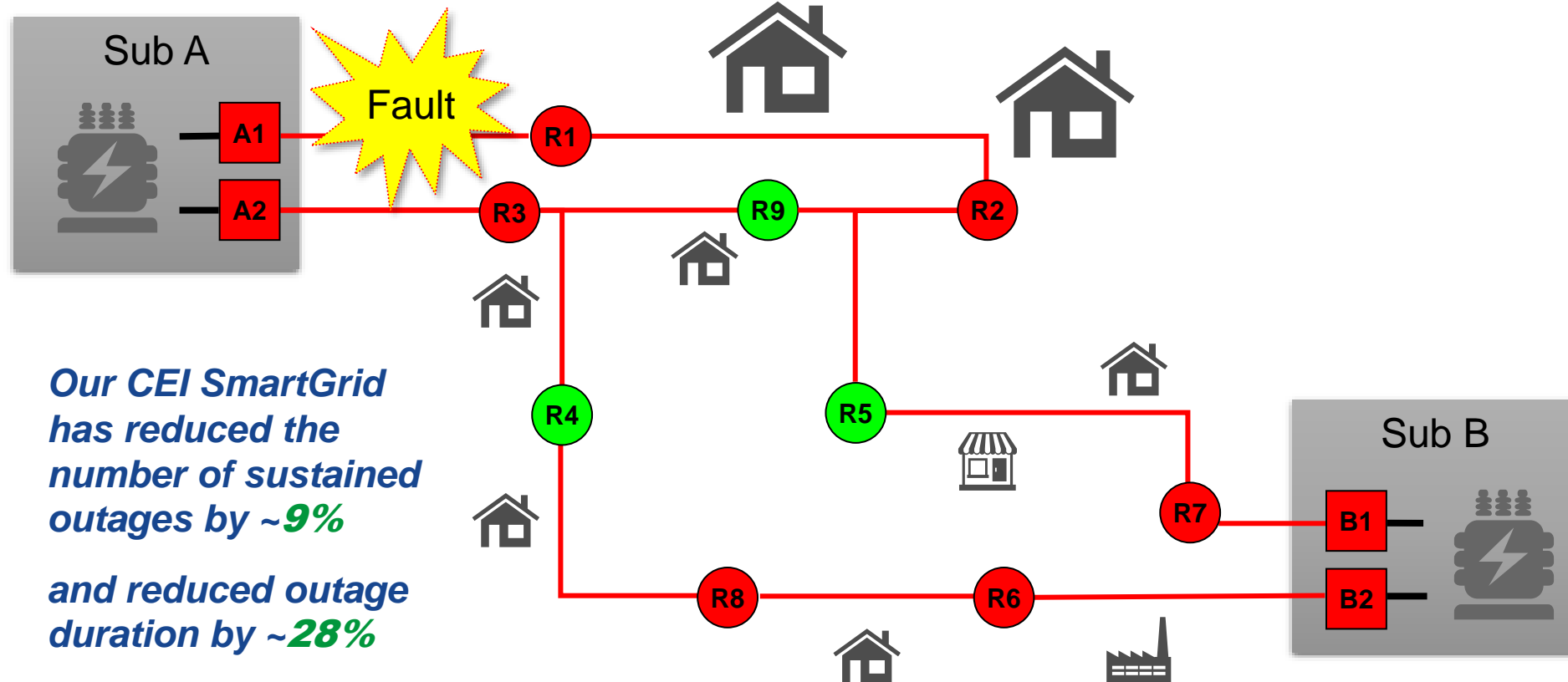

Line workers reconductoring a circuit

How does Distribution Automation work?
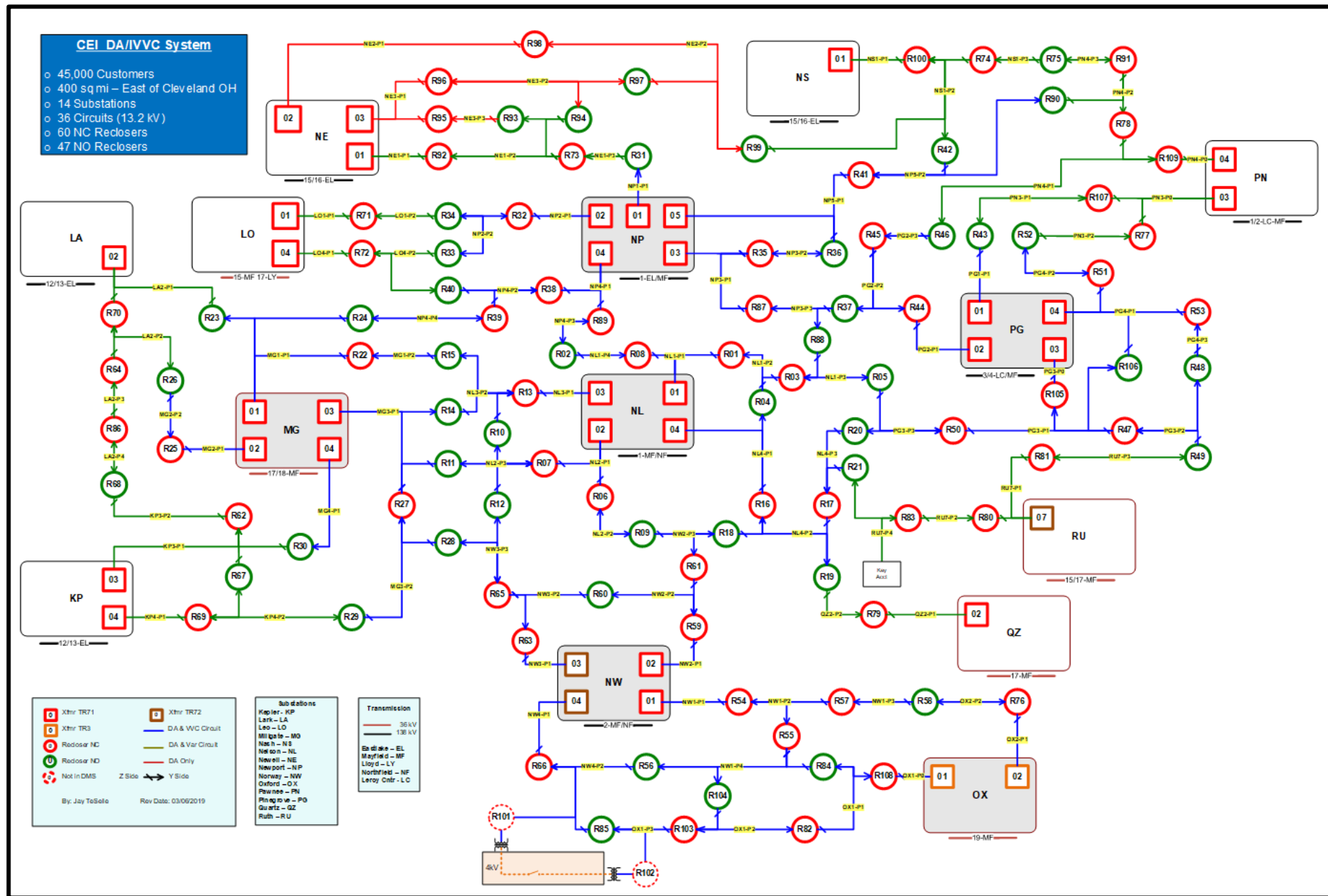
**Fewer Outages
Quicker Restoration**

Distribution Automation

Fewer Outages
Quicker Restoration

Sub A

A1

A2

Fault

R1

R3

R9

R2

R4

R5

R7

R8

R6

Sub B

B1

B2

Our CEI SmartGrid has reduced the number of sustained outages by ~9%

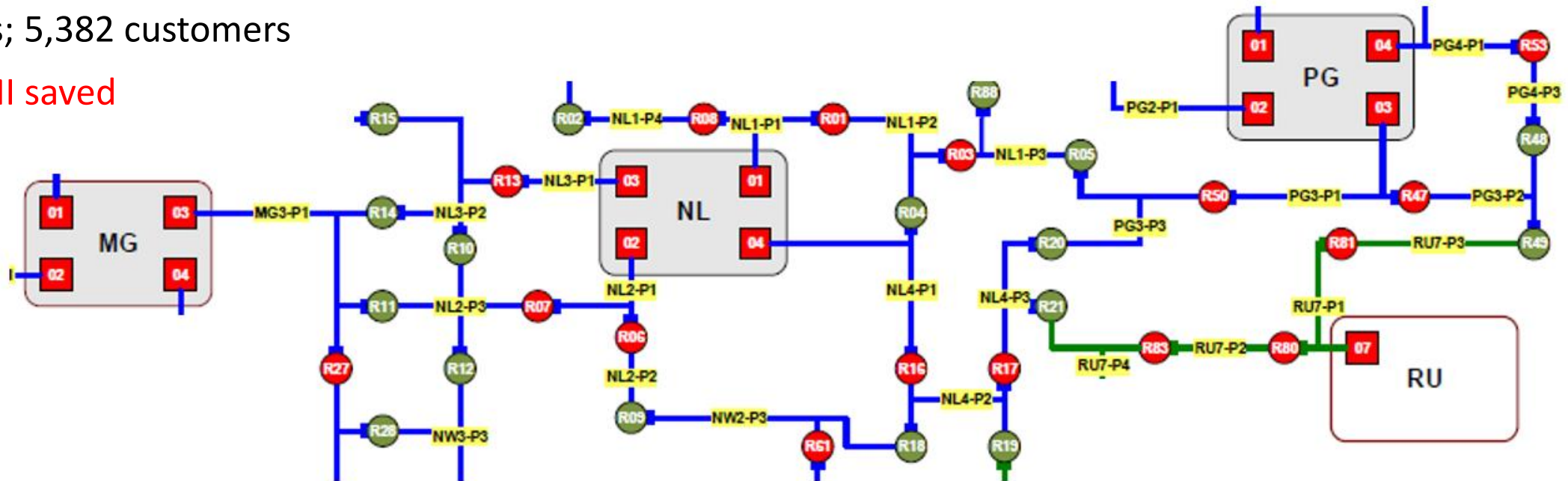*and reduced outage duration by ~28%*

FE OH- CEI Smart Grid Pilot
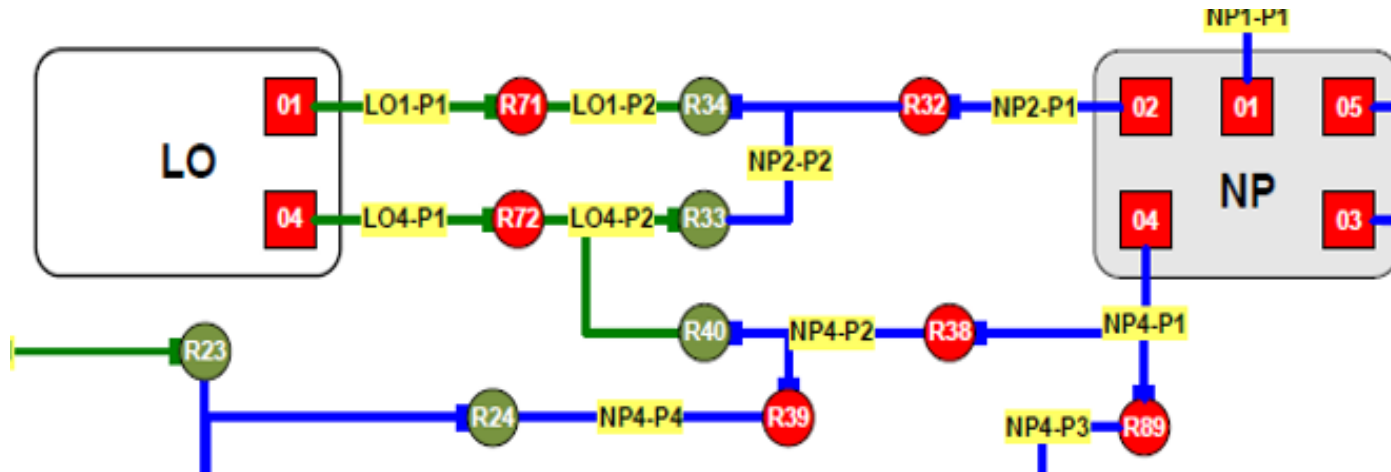# 36 circuits
in service 2013

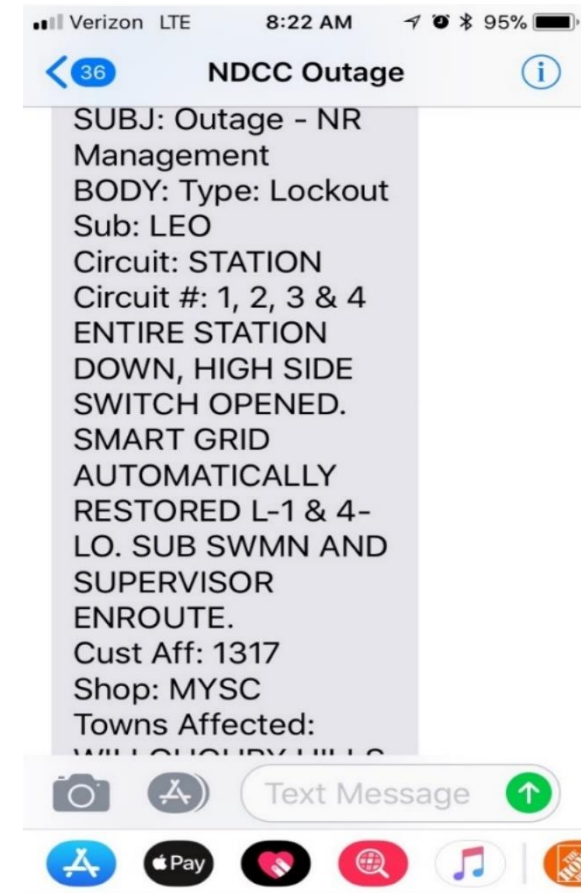# Substation LoV- Loss of Voltage (Loss of Tx)

- Substation Loss of Transmission Supply

- April 10, 2015 at 10:39pm

- By design, FISR initiated 90 seconds after the LoV

- FISR operated correctly restoring service to (4) circuits

- 24 reclosers; 5,382 customers

- 556,600 CMI saved

Leo Sub: Monday April 2, 2018

	Customers Served	Time Off	FISR Start	FISR End	Min	Man Rest	Min
1-LO	2463	13:29:22	13:33:03	13:33:47	0:04:25		
2-LO	361	13:29:22				15:38:00	2:08:38
3-LO	597	13:29:22				15:38:00	2:08:38
4-LO	958	13:29:22	13:33:26	13:33:47	0:04:25		

3,421 CI saved, 437,888 CMI

NDCC Outage

SUBJ: Outage - NR Management
BODY: Type: Lockout
Sub: LEO
Circuit: STATION
Circuit #: 1, 2, 3 & 4
ENTIRE STATION DOWN, HIGH SIDE SWITCH OPENED. SMART GRID AUTOMATICALLY RESTORED L-1 & 4– LO. SUB SWMN AND SUPERVISOR ENROUTE.
Cust Aff: 1317
Shop: MYSC
Towns Affected:

Pushing Dx Smart Grid to the next Level

- FE Hard Critique of DA and VVO Performance

- DA / VVO

  1. Did it work?

  2. What did it save?

  3. If it didn't work (max opportunity), <u>why not</u>?

  4. Get it fixed

"In its evaluation of the settlement, the (OH) PUCO gave substantial weight to the Companies' experience in their CEI Smart Grid Pilot area"

CEI Pilot Distribution Automation, DA, Performance:
June 2013 thru Feb 2021 (93 months)

| Description	Statistic
Since June 2013 Smart Grid events	353
Average Smart Grid events per month	**3.8**
Since June 2013 CMI Saved	20,598,592
Since June 2013 CI Saved	91,692
Average CMI Saving per event	**58,352**
Average CMI Saving per month	223,684.58
Average CMI Customers have saved	**439**

Performance: ~50% Main Gut, ~30%* overall circuit
*when including tap outages in the denominator

VVO - How it Works
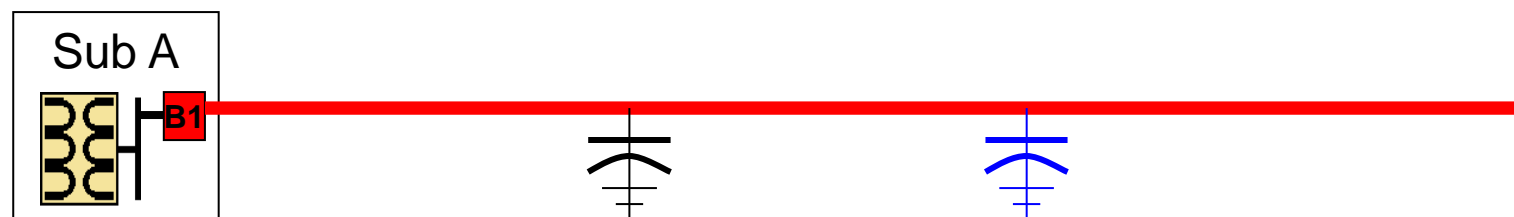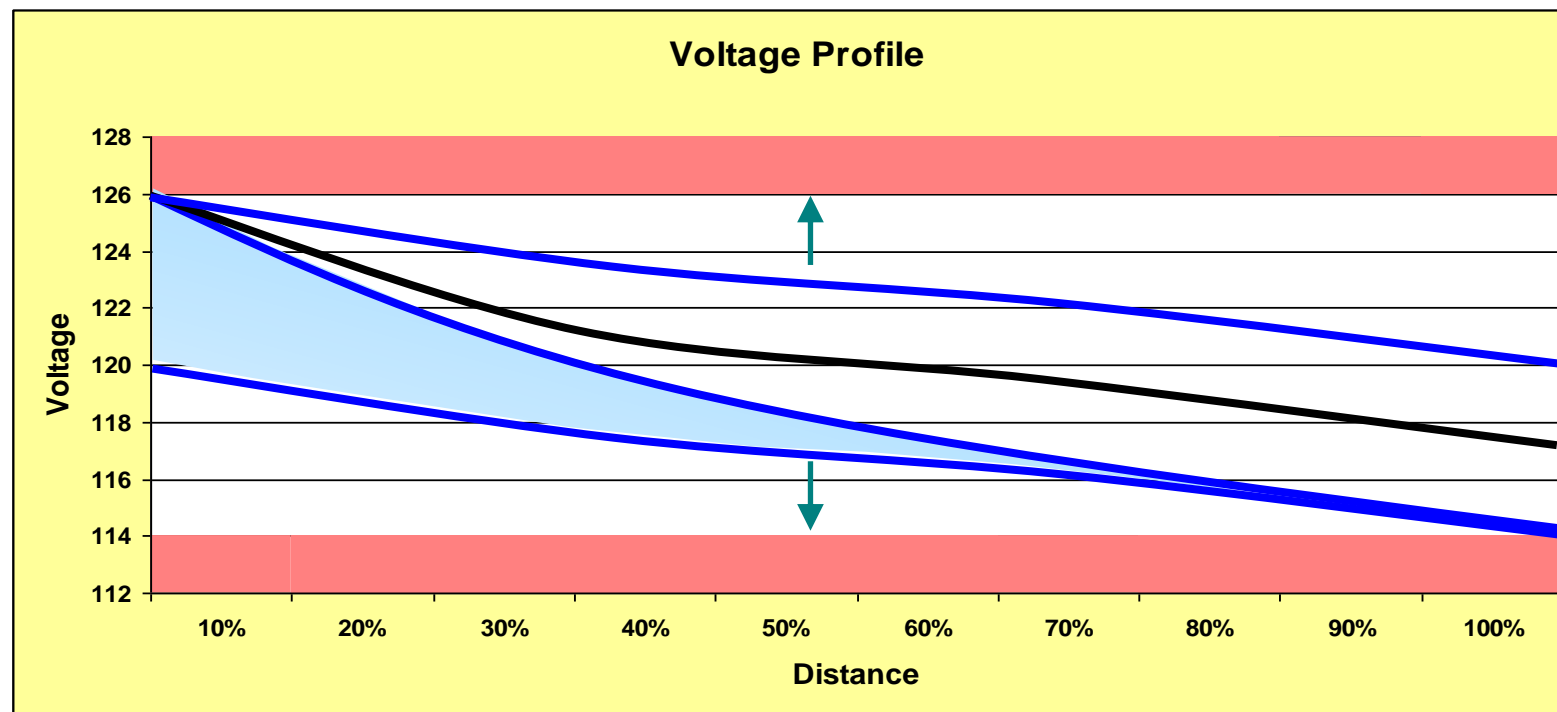
OH Grid Mod I Overview
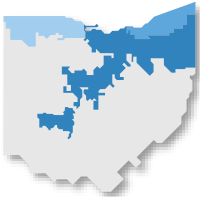
Settlement approved by PUCO on 7/17/19 includes phase-one capital investments in grid modernization of up to $516 million over three years.

36-Month Targeted Deployment Plan

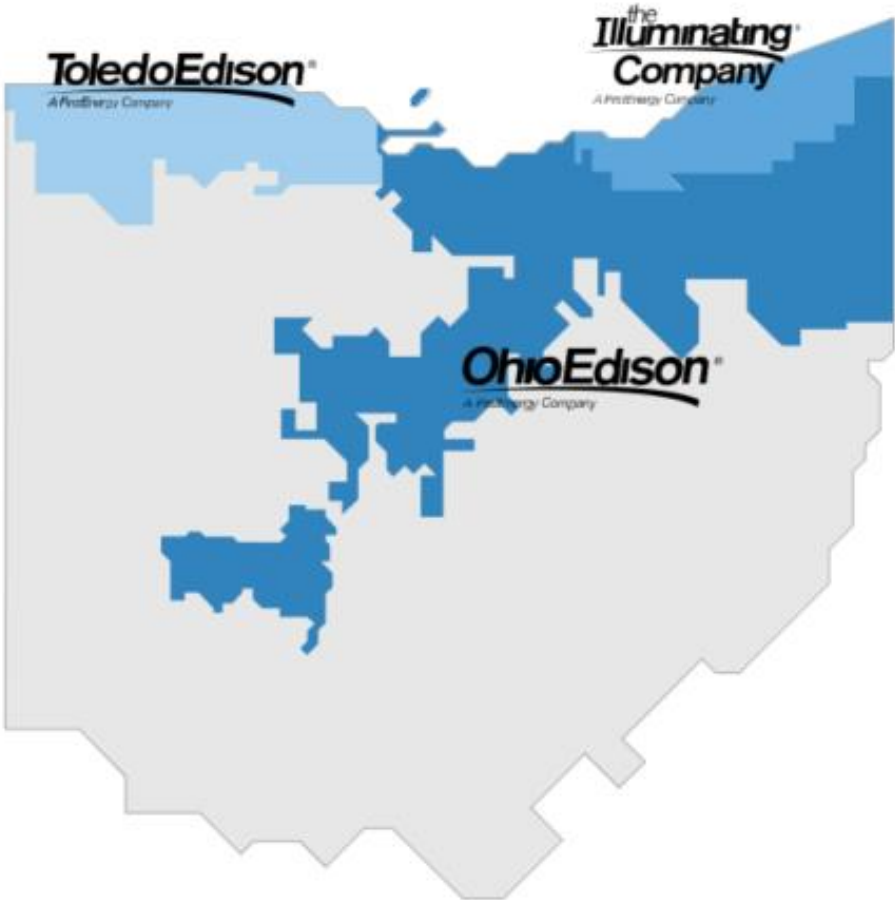|	CEI	OE	TE	TOTAL
DA Circuits	85	85	30	200
IVVC Circuits	87	85	30	202
Smart Meters	~310,000	~280,000	~110,000	700,000

Of FirstEnergy's 2.1M customers and 2,821 circuits in Ohio,
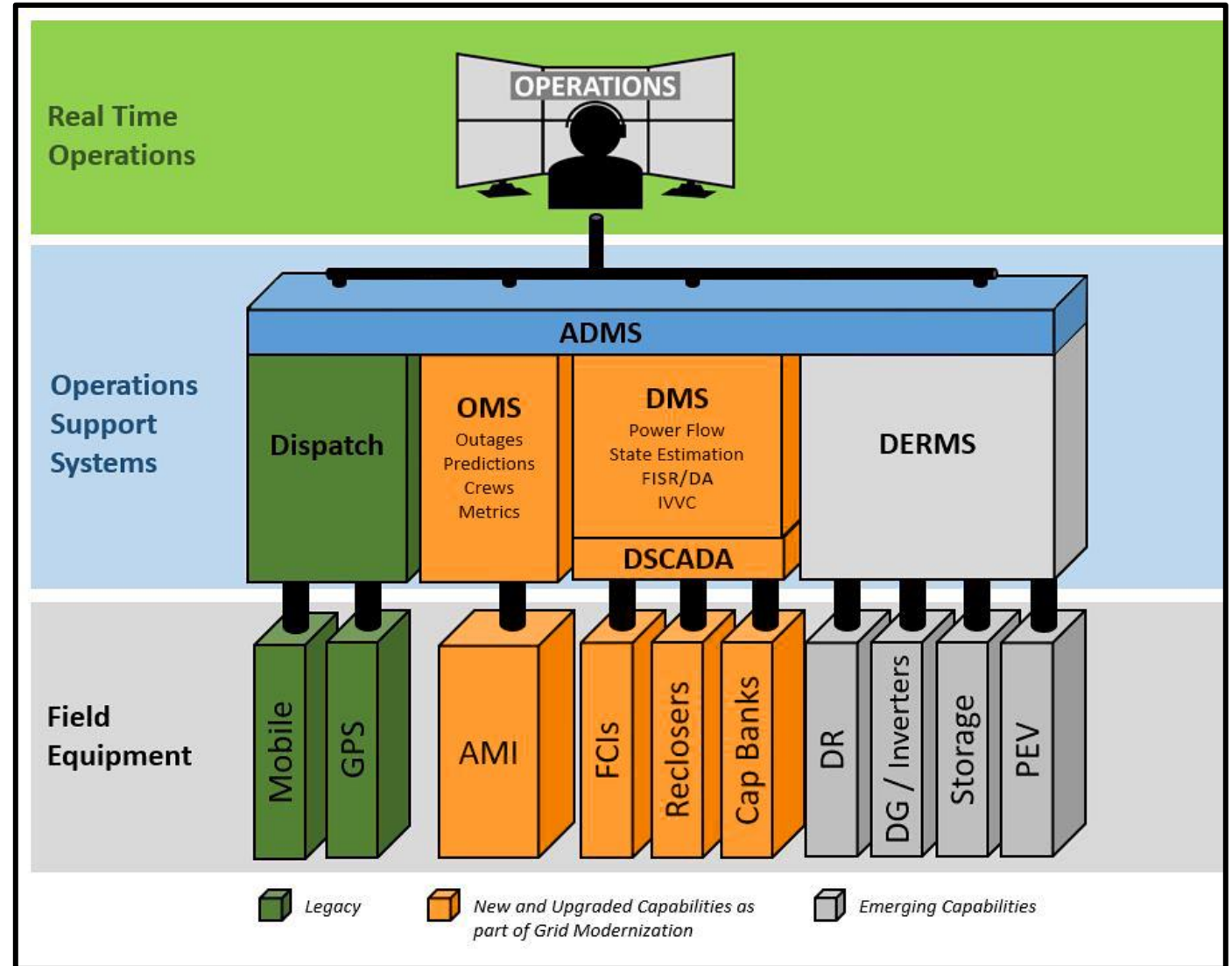
Grid Mod I will impact:

Circuits
- **7%** of circuits
- **18%** of circuit miles
- **66** of the WPCs

Customers
- **18%** overall
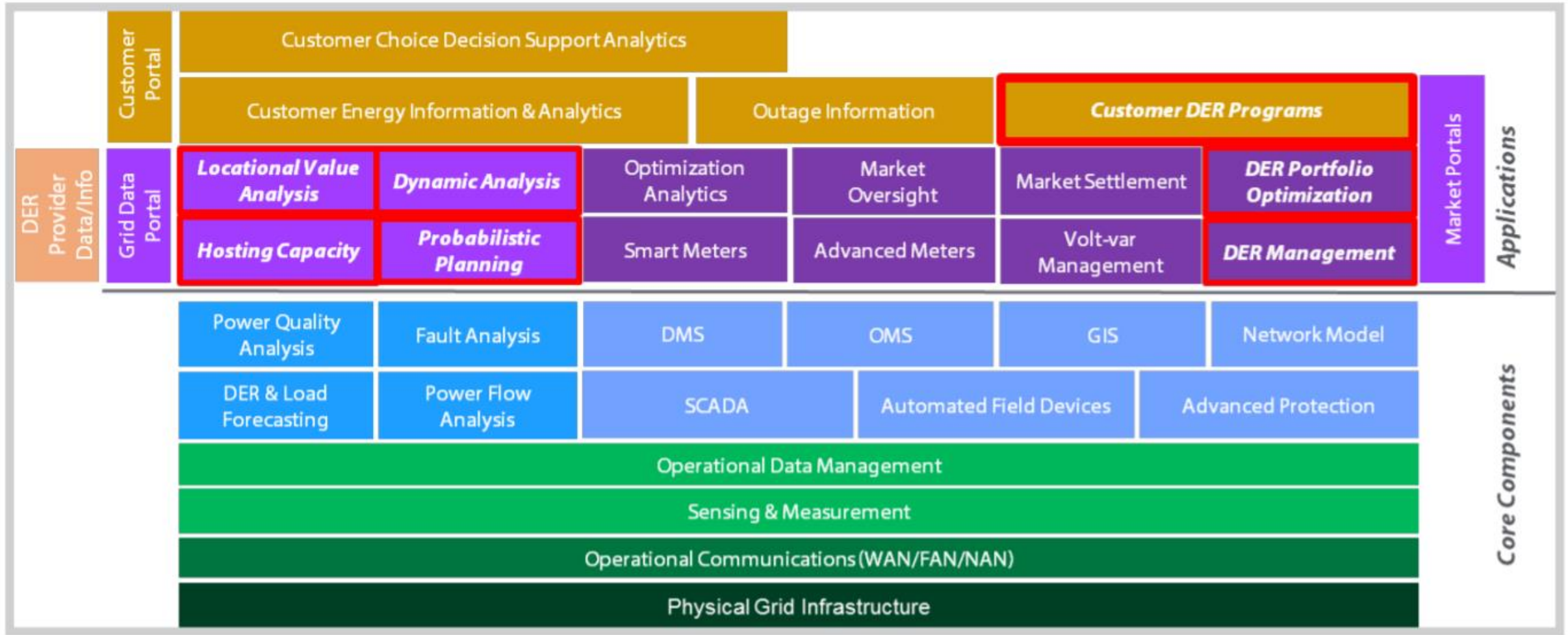- **16%** impacted by DA
- **14%** impacted by IVVC

Advanced Distribution Management System (ADMS)

The Platform: Grid Architecture

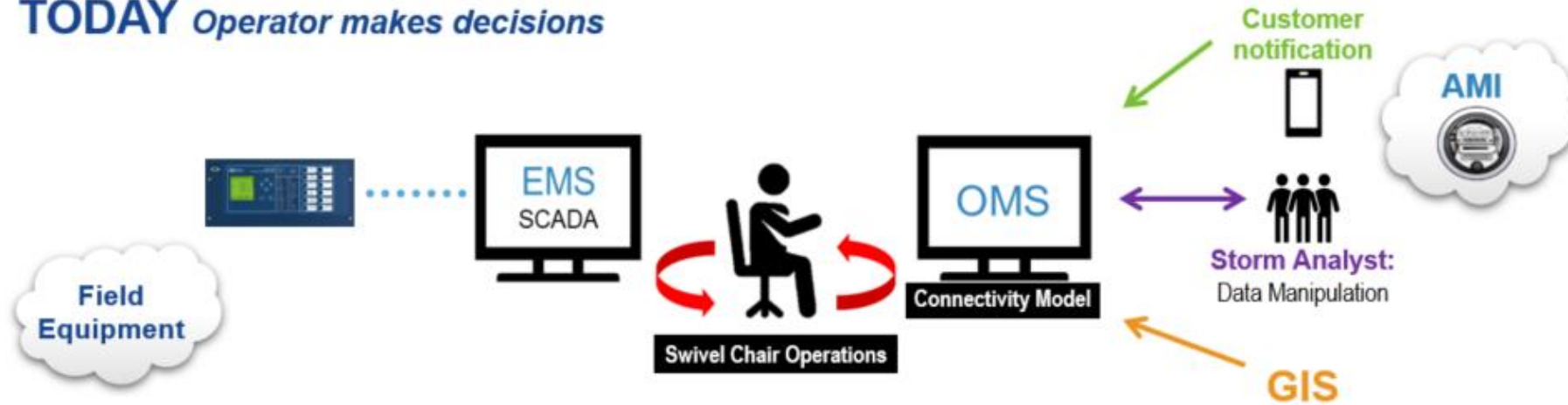Figure 1: Next Generation Distribution System Platform & Applications

Objects outlined in red are future considerations

Source: U.S. DOE

Managing the Grid Today vs. Tomorrow
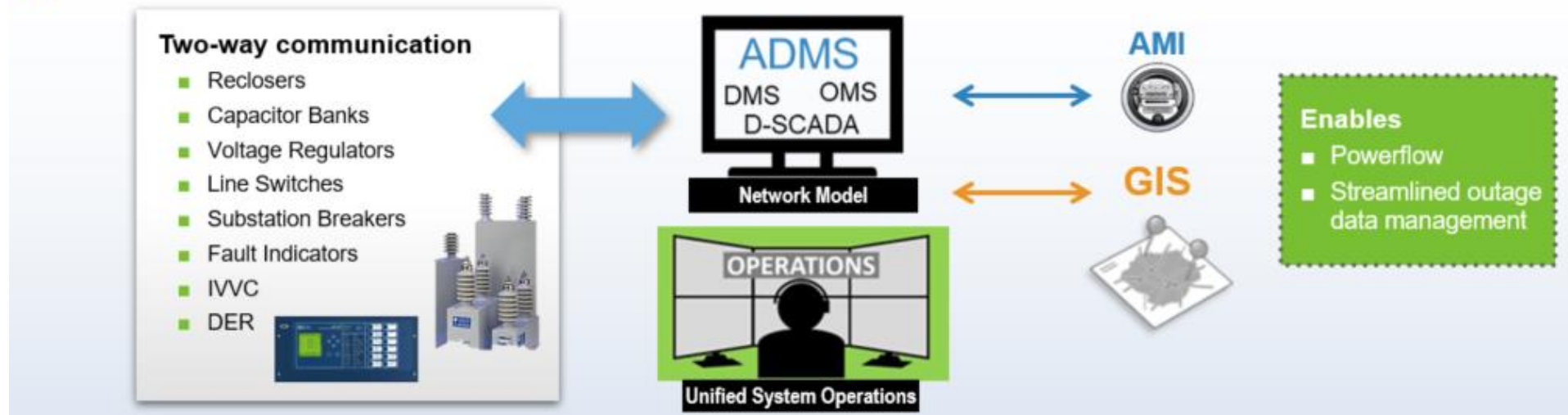
Distribution Platform Data

An advanced distribution management system (**ADMS**) is the software platform that supports the full suite of outage and distribution management. An **ADMS** includes functions that automate outage restoration and optimize the performance of the distribution grid.

Advanced technology enables operational capabilities through advanced applications

Oracle NMS Platform - Distribution System Grid Management

Supporting Utility Innovation and a Sustainable Energy Future
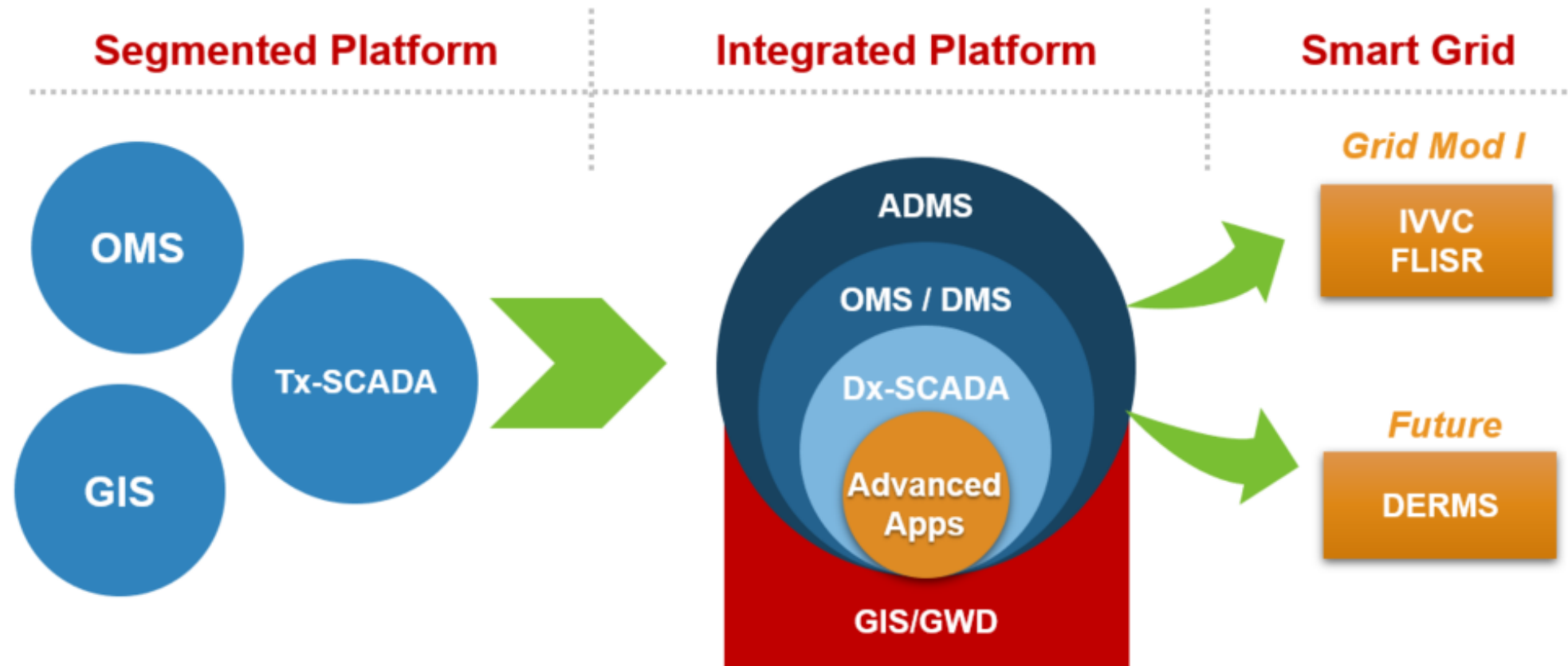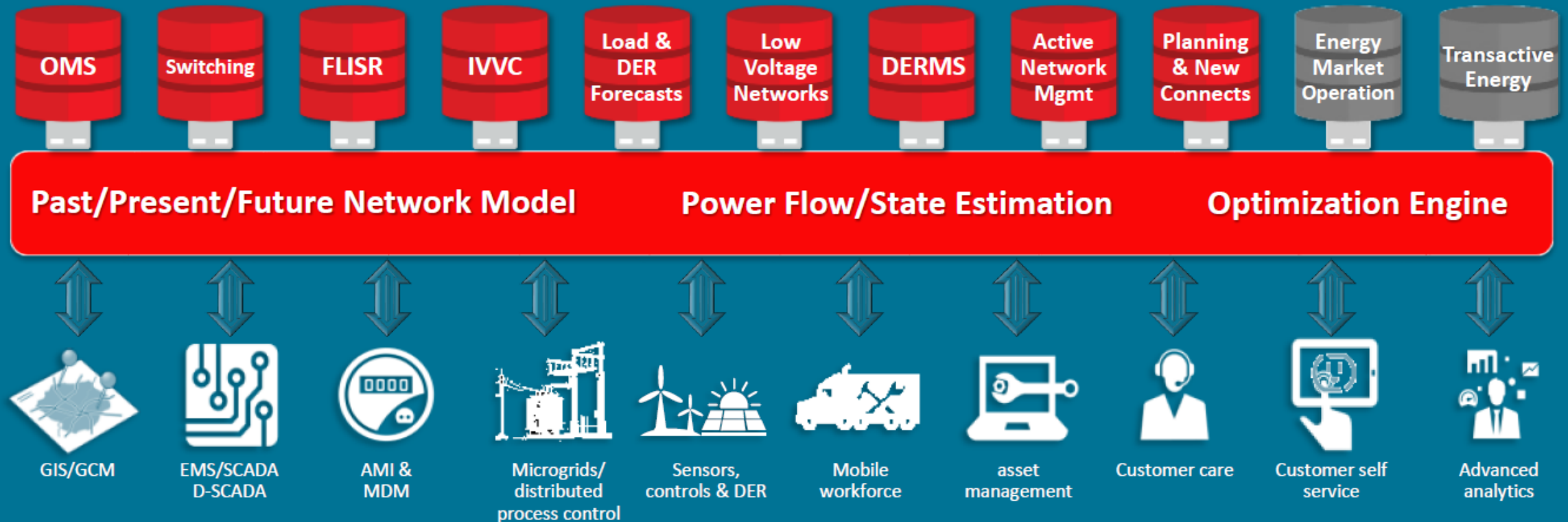
OMS · Switching · FLISR · IVVC · Load & DER Forecasts · Low Voltage Networks · DERMS · Active Network Mgmt · Planning & New Connects · Energy Market Operation · Transactive Energy

Past/Present/Future Network Model · **Power Flow/State Estimation** · **Optimization Engine**

GIS/GCM · EMS/SCADA D-SCADA · AMI & MDM · Microgrids/ distributed process control · Sensors, controls & DER · Mobile workforce · asset management · Customer care · Customer self service · Advanced analytics

Grid of the Future Expectations

Continue providing safe, reliable and affordable service while adapting the system to support:

More customer choices

More energy usage information

Greater flexibility to restore outages

Integrating renewables and distributed energy resources

Integrating new technologies

Thank You

QA

Modifying Circuits for Distribution Automation (DA)

Reclosers

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- Customer Benefits: improved restoration times and fewer outages by isolating faults to smaller groups of customers

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