

Automatic Source Transfer

Charlene Ericson

May 10th 2023

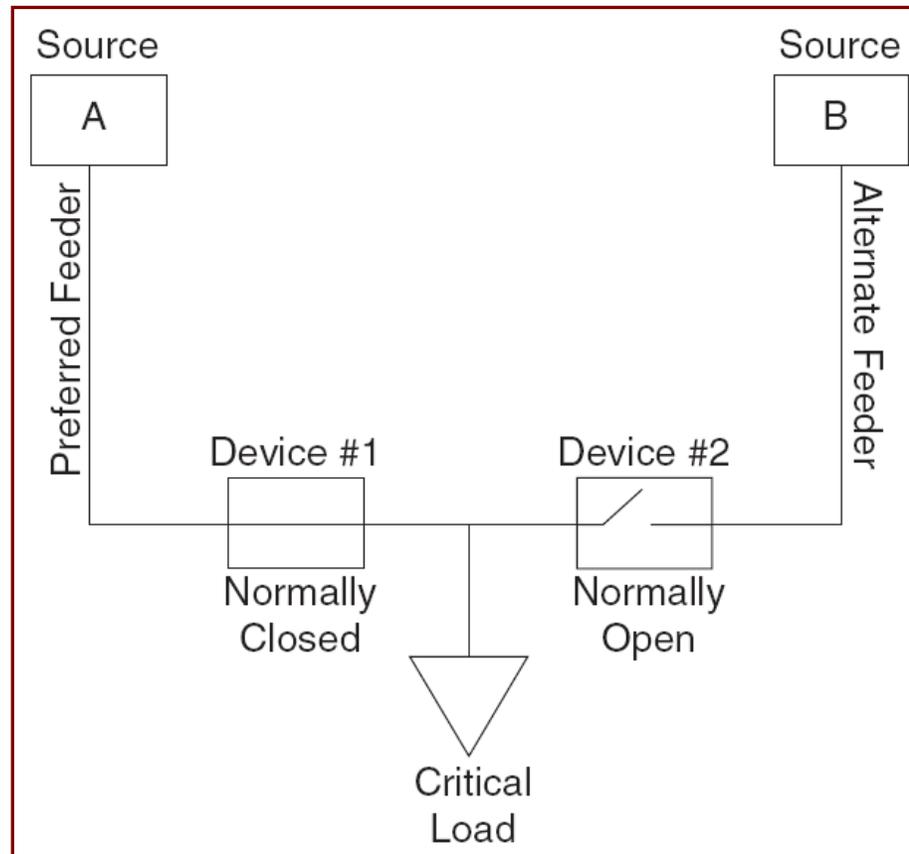


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Objective

Transfer to an alternate source for a voltage event on the preferred source



Technology and Equipment

- Form 6 control
- ProView™ and PeerComm™ software
- Flexible communications
- NOVA™, NXT, VSA ,or VWE 3-phase reclosers, or NOVA-TS or NOVA STS triple-single reclosers
- Internal voltage sensors



Example applications

- Single critical load
 - Controls back-to-back on a pole
 - Twisted pair RS-485
 - One or two pole spans apart
 - Fiber optic cable
- Group of critical loads
 - Controls located up to miles apart
 - Radios and antennas

Theory of operation

- AST monitors voltage on the source side of both reclosers
- Two reclosers maintain constant communication with each other via the PeerComm™ protocol
- When AST is in the Ready state
 - If the voltage of the closed recloser falls below a preset limit, the AST system starts timing
 - Upon completion of the timer, the closed recloser will open and the open recloser will close restoring service to the critical load.
- The AST will remain in this active state
- Restoring the load back the preferred source depends upon the restoration mode selected

Overcurrent protection

- AST is additional functionality
- Controls retain all overcurrent protection capability
- Faults between the AST reclosers will be isolated without “Testing the Line”

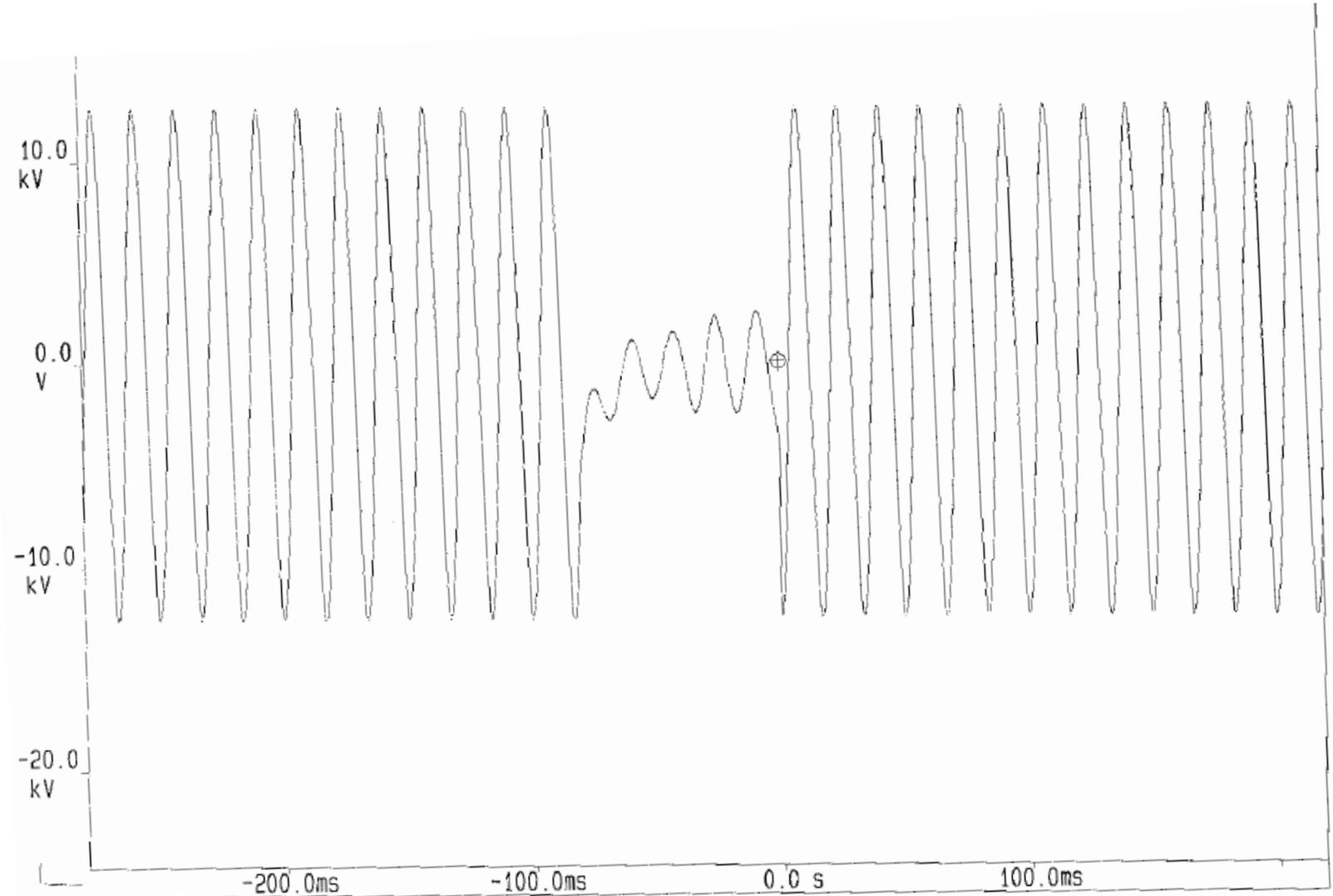
What Triggers AST?

- **Undervoltage** (Extremely common)
 - Voltage goes below a user-defined threshold
- **Overvoltage** (NOT commonly used)
 - Voltage goes above a user-defined threshold
- **Voltage Unbalance** (NOT commonly used)
 - Ratio of negative sequence to positive sequence voltage goes above a user-defined threshold

Eaton AST Transfer Times

6 cycles

With 15 kV NOVAs and fiber optic



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Transfer Times

With 15 kV NOVA reclosers and serial fiber optic

Setup	Master	Slave	Fast	Break then Make	Test 1 Open Time (ms)	Test 2 Open Time (ms)	Test 3 Open Time (ms)	Average Open Time (ms)	Restore Open Time 1 (ms)	Restore Open Time 2 (ms)	Restore Open Time 3 (ms)	Average Restor Open Time (ms)
1	Primary	Alternate	Enabled	Enabled	90.62	100.7	84.3	91.9	142.2	142.1	141.6	141.9667
2	Primary	Alternate	Enabled	Disabled	89.76	88.5	83.82	87.4	0	0	0	0
3	Primary	Alternate	Disabled	Enabled	192.01	195	190.8	192.6	150.4	151.3	134.7	145.4667
4	Primary	Alternate	Disabled	Disabled	185	176.6	190.6	184.1	0	0	0	0
5	Alternate	Primary	Enabled	Enabled	241	234.5	223	232.8	141	147.9	142.7	143.8667
6	Alternate	Primary	Enabled	Disabled	240.7	237	237	238.2	0	0	0	0
7	Alternate	Primary	Disabled	Enabled	227	236	223	228.7	146	133	133	137.3333
8	Alternate	Primary	Disabled	Disabled	225	230	240	231.7	0	0	0	0

CAUTION! Performance times are NOT guaranteed

Bidirectional times are not equal, which device is the preferred device does matter.

Restoration modes

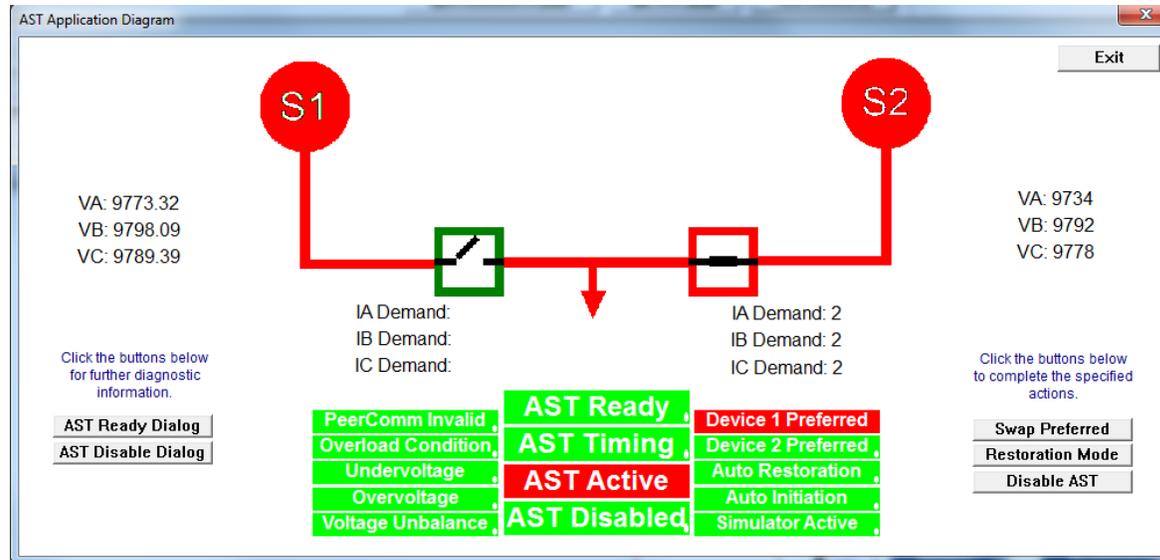
- Parallel or Non-Parallel
- Manual restoration
 - Optional Voltage Seeking
- Automatic restoration
 - Manual initiation
 - Automatic initiation

Restoration modes: Manual Restoration

- Once the system has transferred the load to the alternate source it will stay in the AST Active state until it is manually restored to the AST ready state
- **Exception! Voltage Seeking is selected**
 - If voltage seeking is selected AND the control is in the AST Active State AND the voltage on the alternate source is lost AND there is a healthy voltage on the preferred source the AST system will transfer the load back to the preferred source

Restoration modes: Auto Restoration

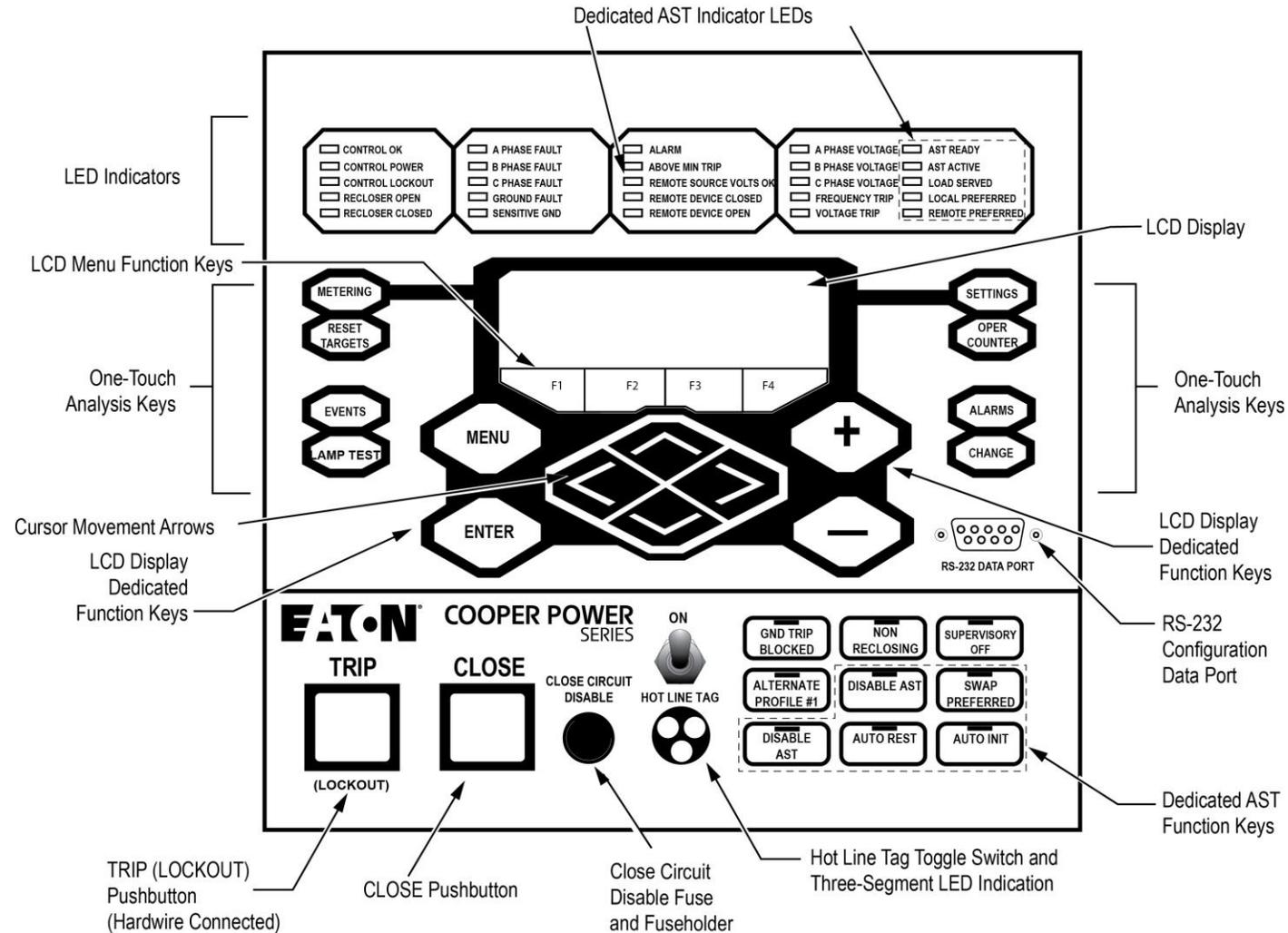
Auto restoration returns the system to AST Ready state given that conditions are such that changing the OPEN/CLOSE state of each recloser will bring the system back to AST Ready



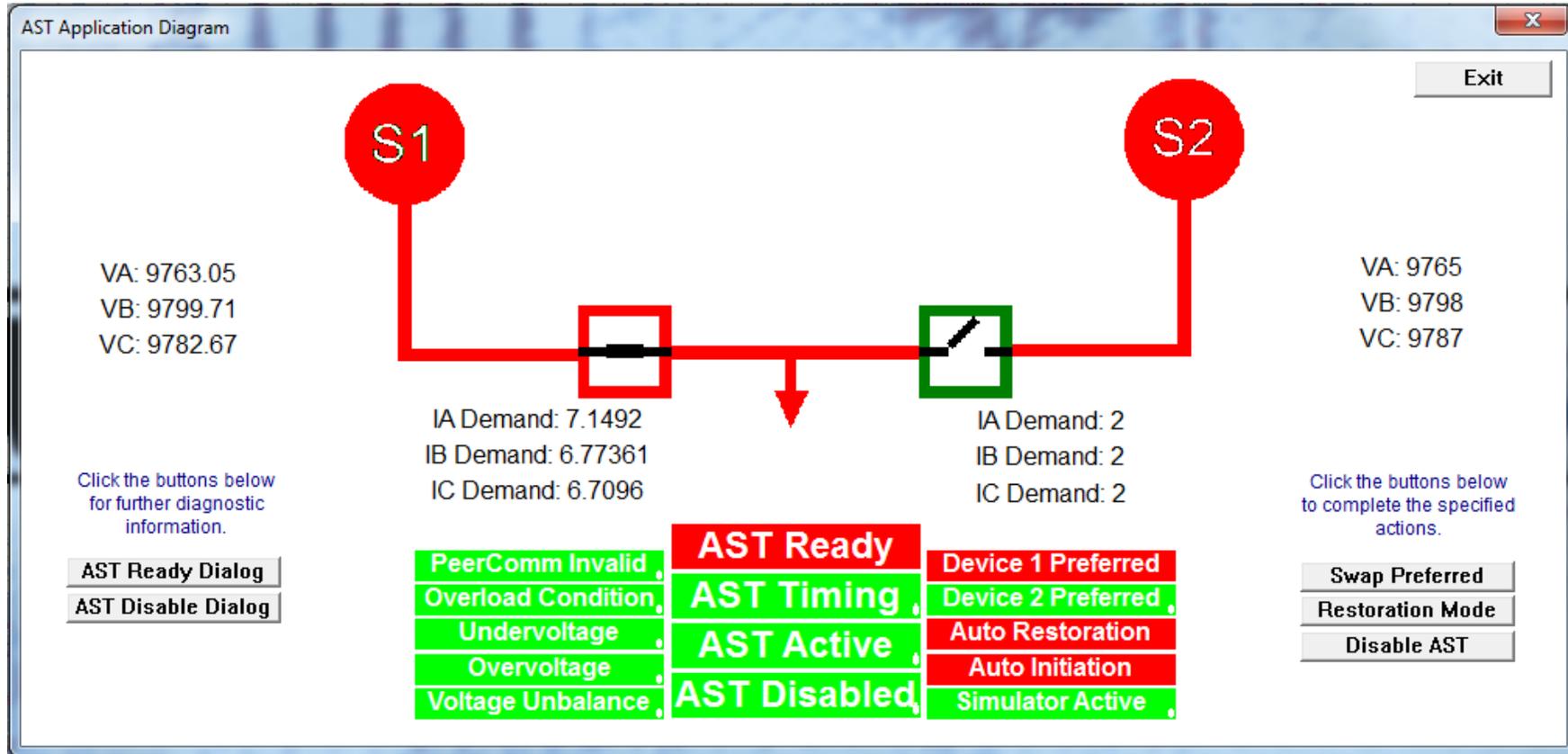
Auto Restoration with Manual Initiation

- Manual initiation will restore to the AST ready state with the operation of one of the reclosers – either opening the closed recloser or closing the open recloser
- The one method results in a parallel or MBB operation and the other results in a non-parallel or BBM operation
 - MBB (Make Before Break) – synced sources
 - BBM (Break Before Make) – non synced sources

AST Form 6 front panel



AST Application Diagram



AST Application Diagram

- AST Ready Dialog
 - Great for diagnostics

Click the buttons below for further diagnostic information.

AST Ready Dialog

AST Disable Dialog

IA Demand: 18.623

IB Demand: 18.7047

IC Demand: 18.6499

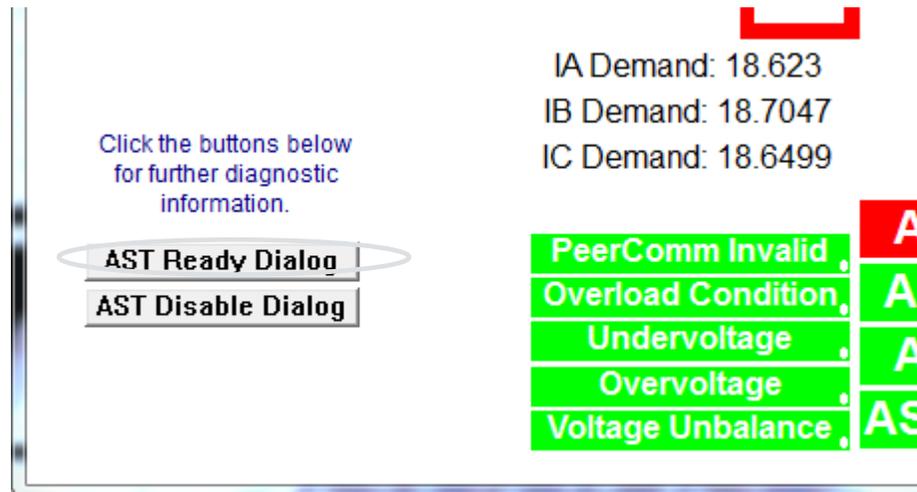
PeerComm Invalid

Overload Condition

Undervoltage

Overvoltage

Voltage Unbalance



AST Ready

AST will not be READY unless all of the following signals are asserted (red).

Device 1 Voltage OK

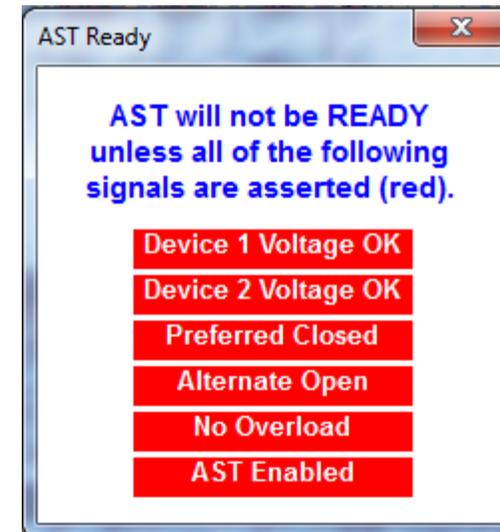
Device 2 Voltage OK

Preferred Closed

Alternate Open

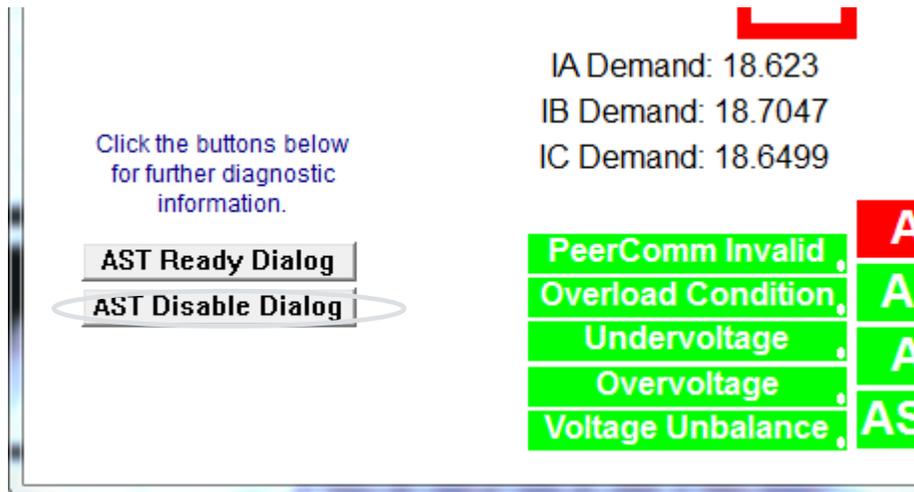
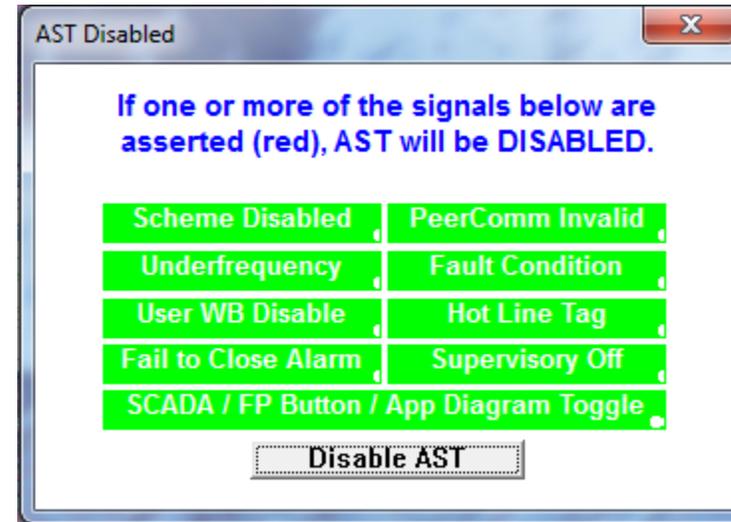
No Overload

AST Enabled



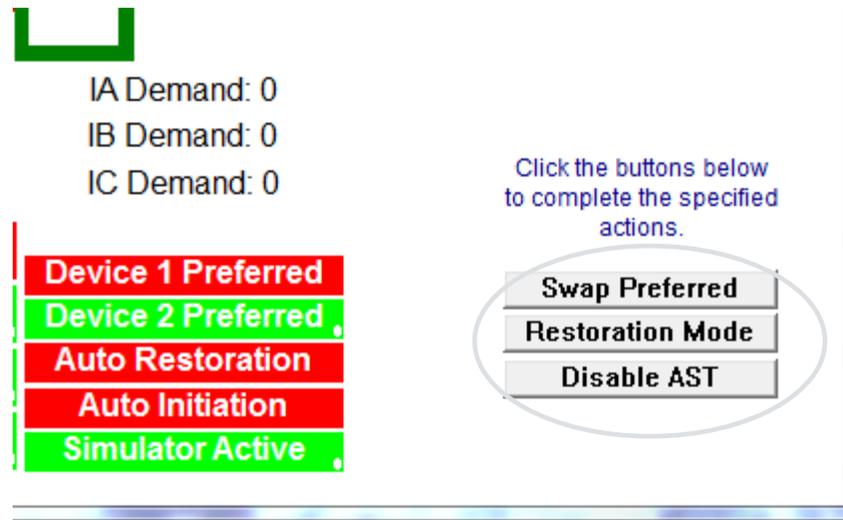
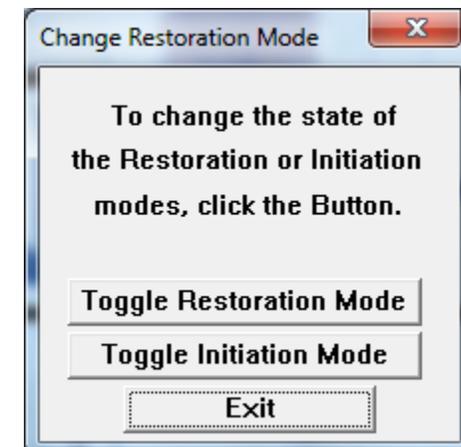
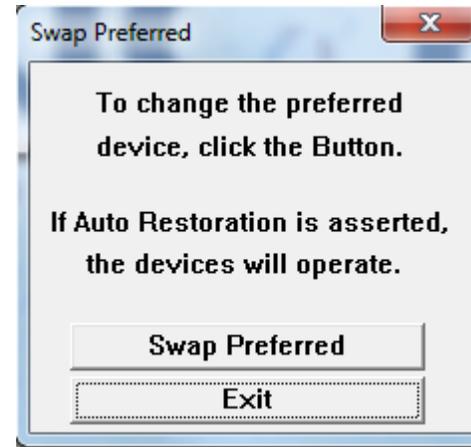
AST Application Diagram

- AST Disabled dialog
 - Good diagnostics tool
 - Can be used to disable the AST from ProView



AST Application Diagram

- AST Controls
 - Control States and Modes from ProView



Voltage Simulator

AST Voltage Simulator

Toggle Source 1
Source 1 ON

S1

Toggle Simulator
Simulator Active

Toggle Source 2
Source 2 ON

S2

Exit

VA: 9768.76
VB: 9783.81
VC: 9777.12

IA Demand: 20.0384
IB Demand: 20.1802
IC Demand: 20.0622

VA: 9759
VB: 9793
VC: 9775

IA Demand: 0
IB Demand: 0
IC Demand: 0

Click the buttons below for further diagnostic information.

Click the buttons below to complete the specified actions.

AST Ready Dialog
AST Disable Dialog

PeerComm Invalid
Overload Condition
Undervoltage
Overvoltage
Voltage Unbalance

AST Ready
AST Timing
AST Active
AST Disabled

Device 1 Preferred
Device 2 Preferred
Auto Restoration
Auto Initiation
Simulator Active

Swap Preferred
Restoration Mode
Disable AST

Note: When using the Voltage Simulator to test Form 6 controls and reclosers that are energized and in service, the voltage simulator will actually send Trip and Close signals to the recloser. Ensure that the two feeders can be paralleled or tied together. To avoid nuisance outages, bypass reclosers.

Voltage Simulator

Great commissioning tool to ensure the system is operating as expected in the field

- Simulates loss of voltage of either source to easily commission and test an AST system
- Resets itself in 5 minutes if not used
- Need actual reclosers or recloser simulators (KMET) to operate correctly
- This simulator will operate the reclosers on the system! Be sure to bypass the reclosers on an actual system before using the voltage simulator!

Sequence of Events (SOEs)

AST Ready ↔ AST Not Ready

AST Active ↔ AST Not Active

Load Served ↔ Load Not Served

Local Preferred ↔ Remote Preferred

Device 1 Valid ↔ Device 1 Not Valid (Comms)

Device 2 Valid ↔ Device 2 Not Valid (Comms)

AST Enabled ↔ AST Disabled

Auto Rest ↔ Manual Rest Mode

Auto Init ↔ Manual Init Mode

Simulator On ↔ Simulator Off

Overload Condition On ↔ Overload Condition Off

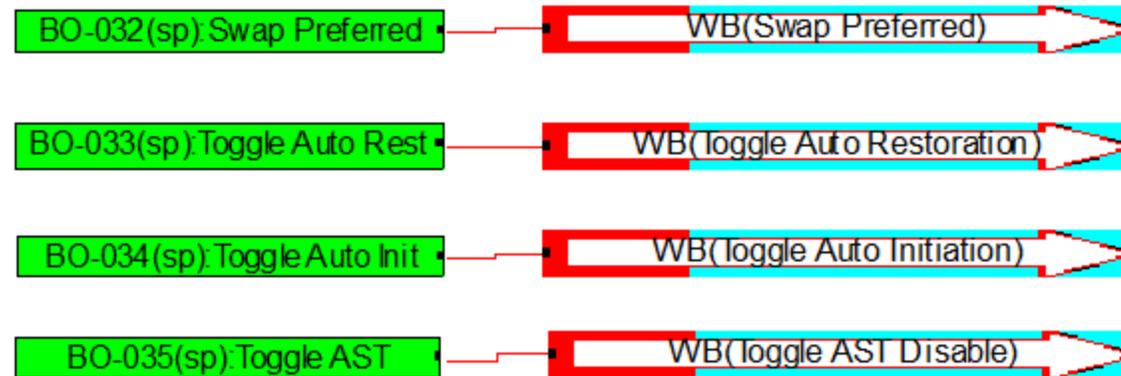
Underfrequency Disable

Manual Disable

DNP Binary Inputs



DNP Binary Outputs



Latest Version

AST jumped from PV 5.1 to PV 5.5

- “Non-parallel restoration” was augmented to “Enforce non-parallel while AST enabled”
- “AST Fast Mode” can only be enabled when configured for “parallel restoration”
- New MMI messages and DNP points to indicate when a device can’t be closed due to Non-parallel restrictions
- New MMI messages to assist use to help identify why AST is disabled
- Additional hardware failures added to the automatic AST disabled logic
- New setting instructs AST to control the GTB when performing a parallel restoration
- PeerComm invalid logic improved to ensure both communications paths are available

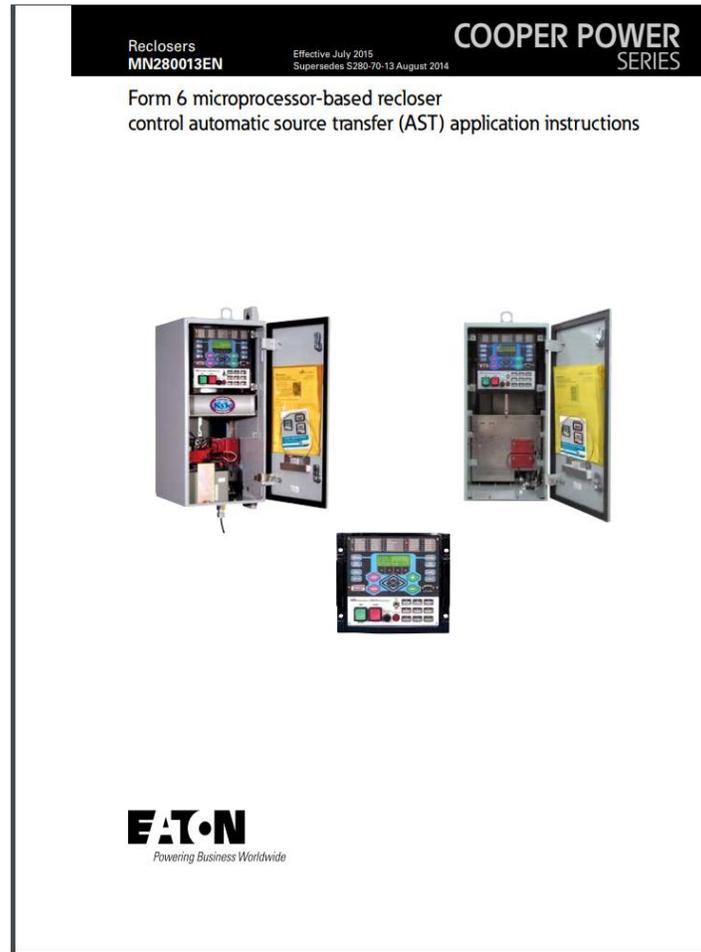
AST with Generator Start-up

Opens device 1, closes a contact to start the generator, closes Device 2 after a delay period and sufficient voltage achieved.

Only available in Ethernet PeerComm version

Only for 3 phase ganged products

AST Literature



- Refer to instruction document MN280013EN for details
- Complete State Transition tables

Feeder Automation Solutions

Jasmin Giroux-Maltais

May 10th 2023



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What does Feeder Automation do?

- Improves reliability
- Turns sustained outages into momentary outages
- Drives down SAIDI and SAIFI
 - Common measures of system reliability
- FA can do FLISR
- FA can do Voltage loss management
- FA can do Load management



What is FLISR?

F ault

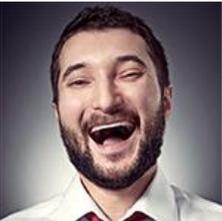
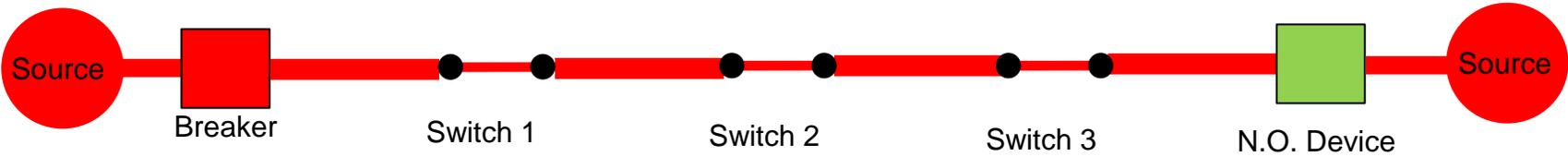
L ocation

I solation

S ervice

R estoration

FLISR basics



Zone 1
Customer



Zone 2
Customer

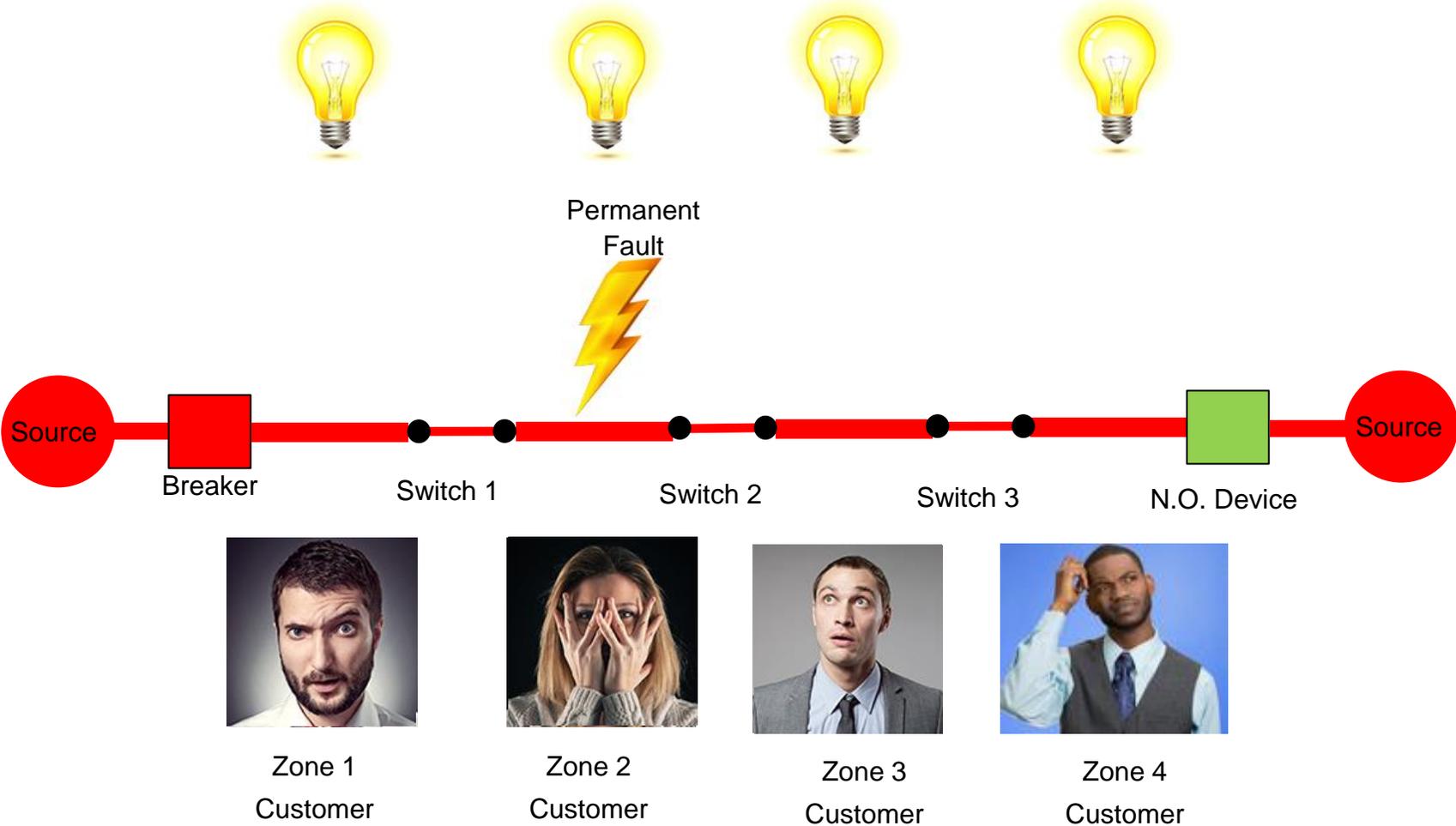


Zone 3
Customer

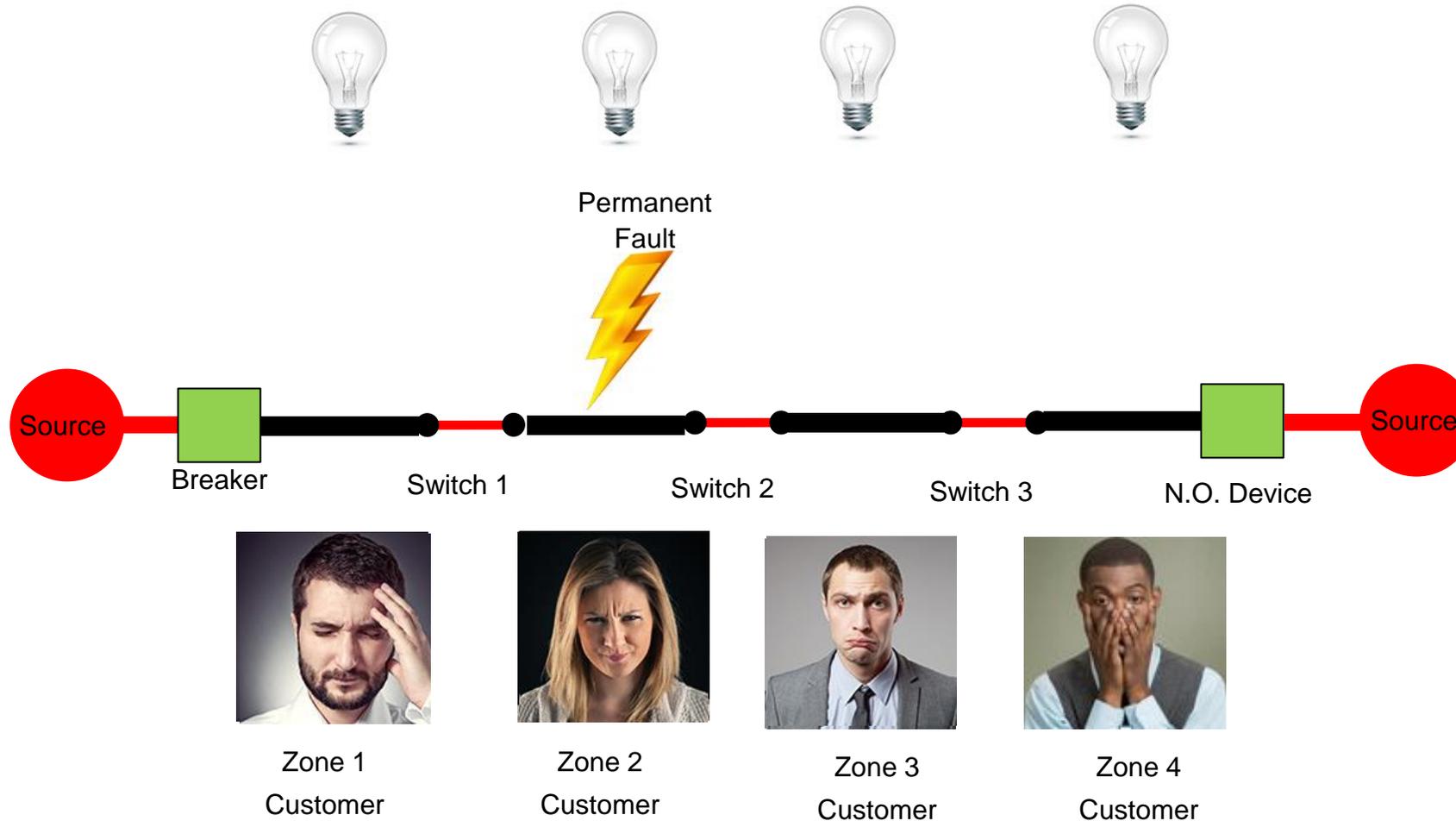


Zone 4
Customer

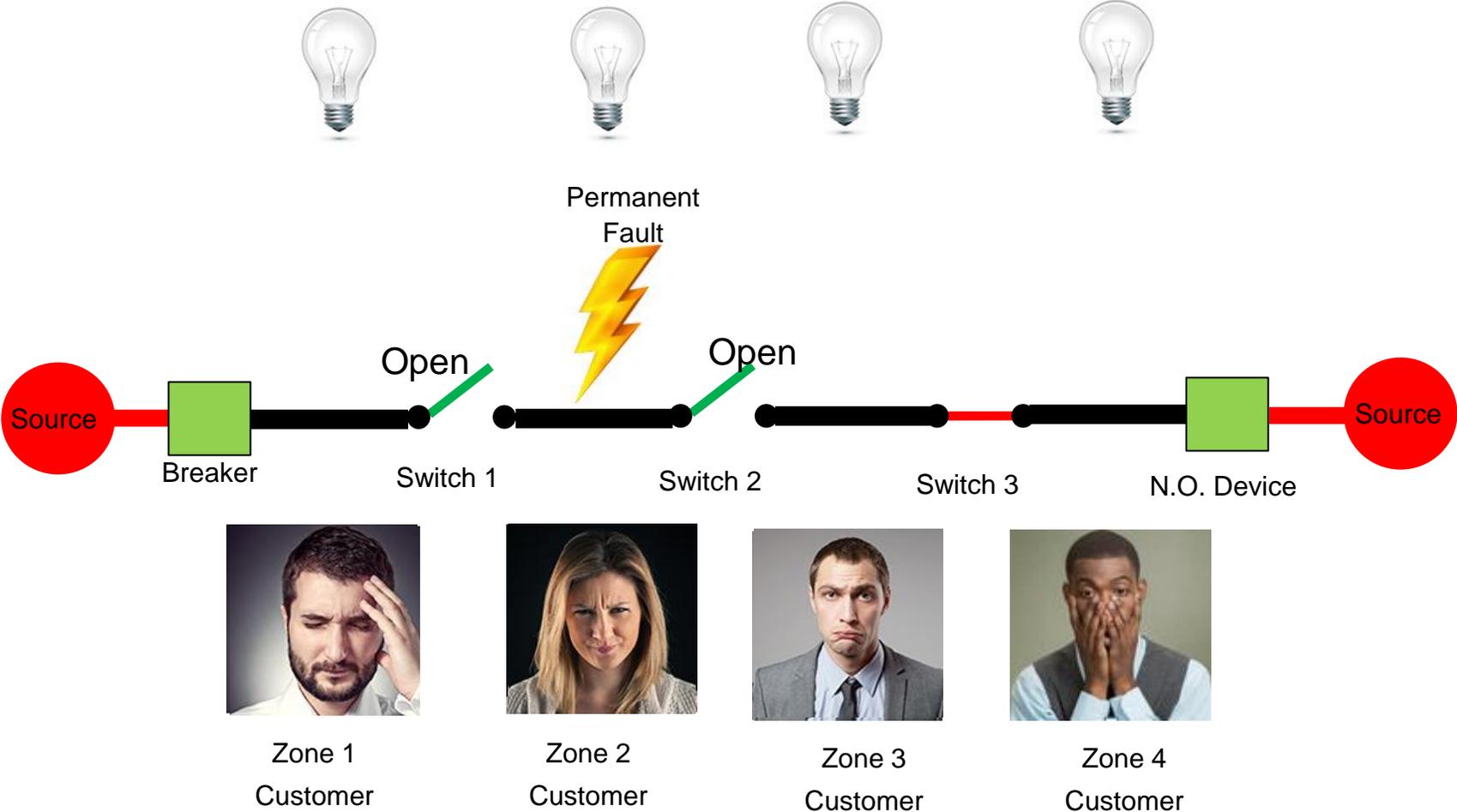
FLISR basics



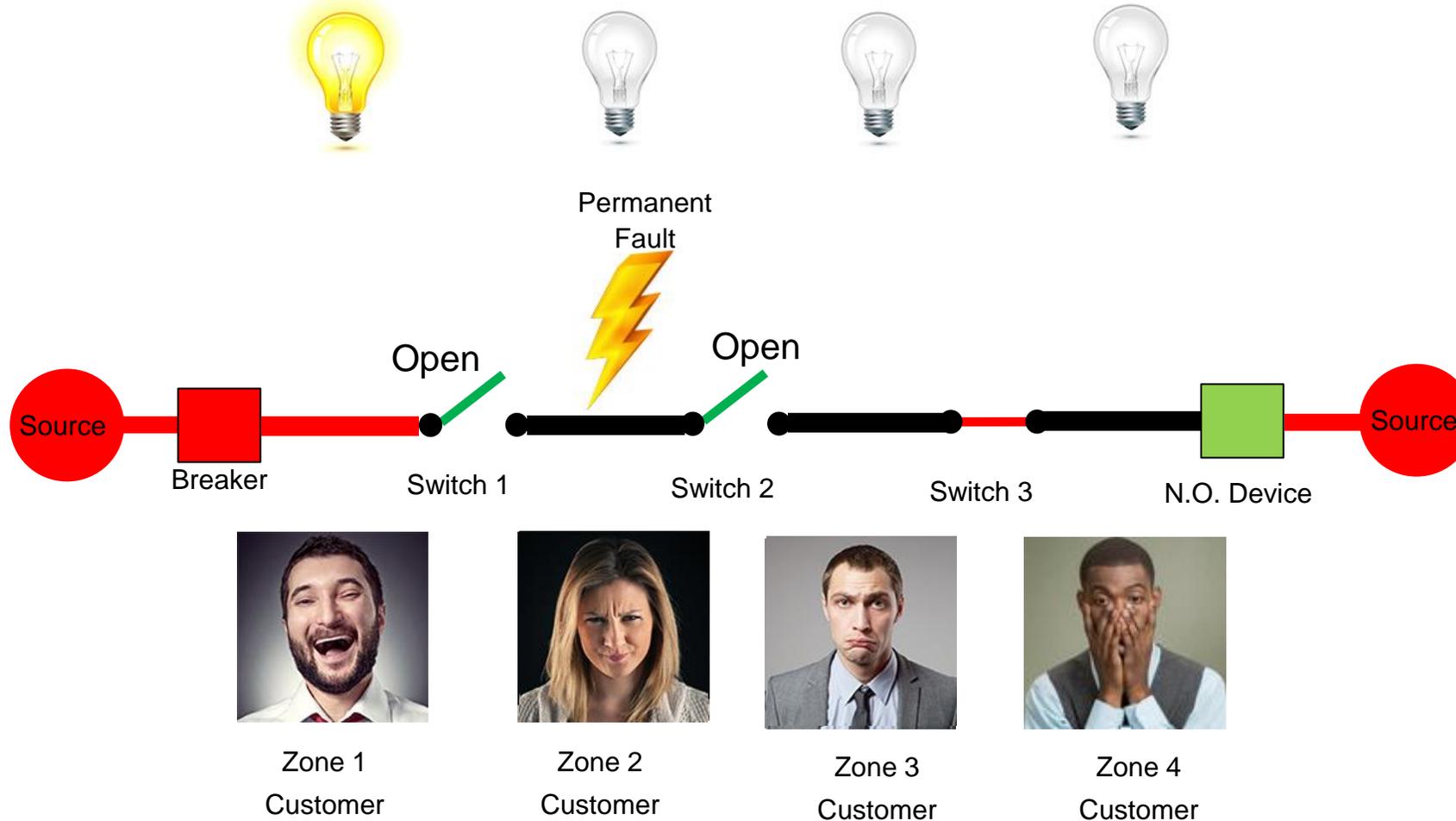
FLISR basics



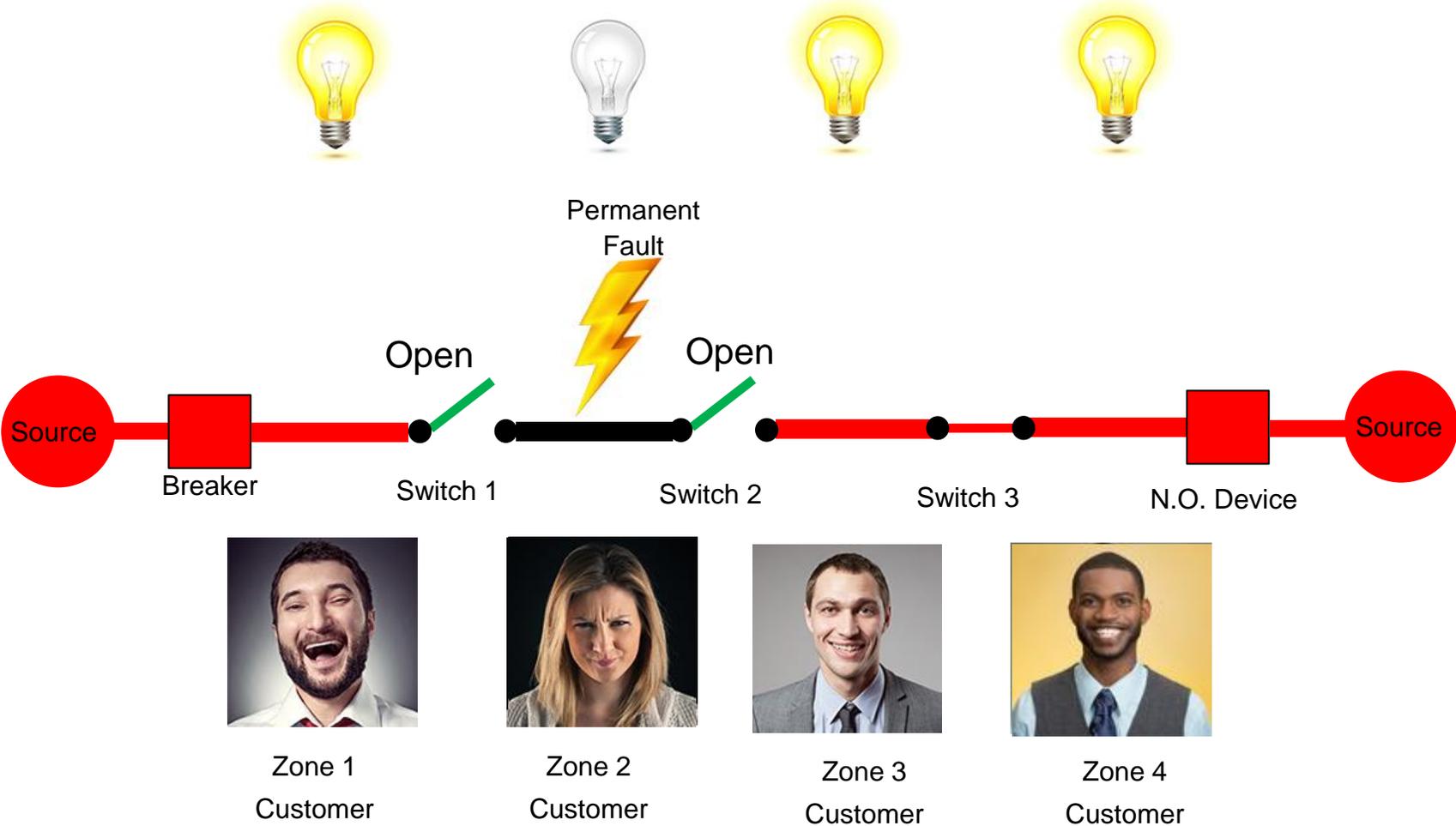
FLISR basics



FLISR basics



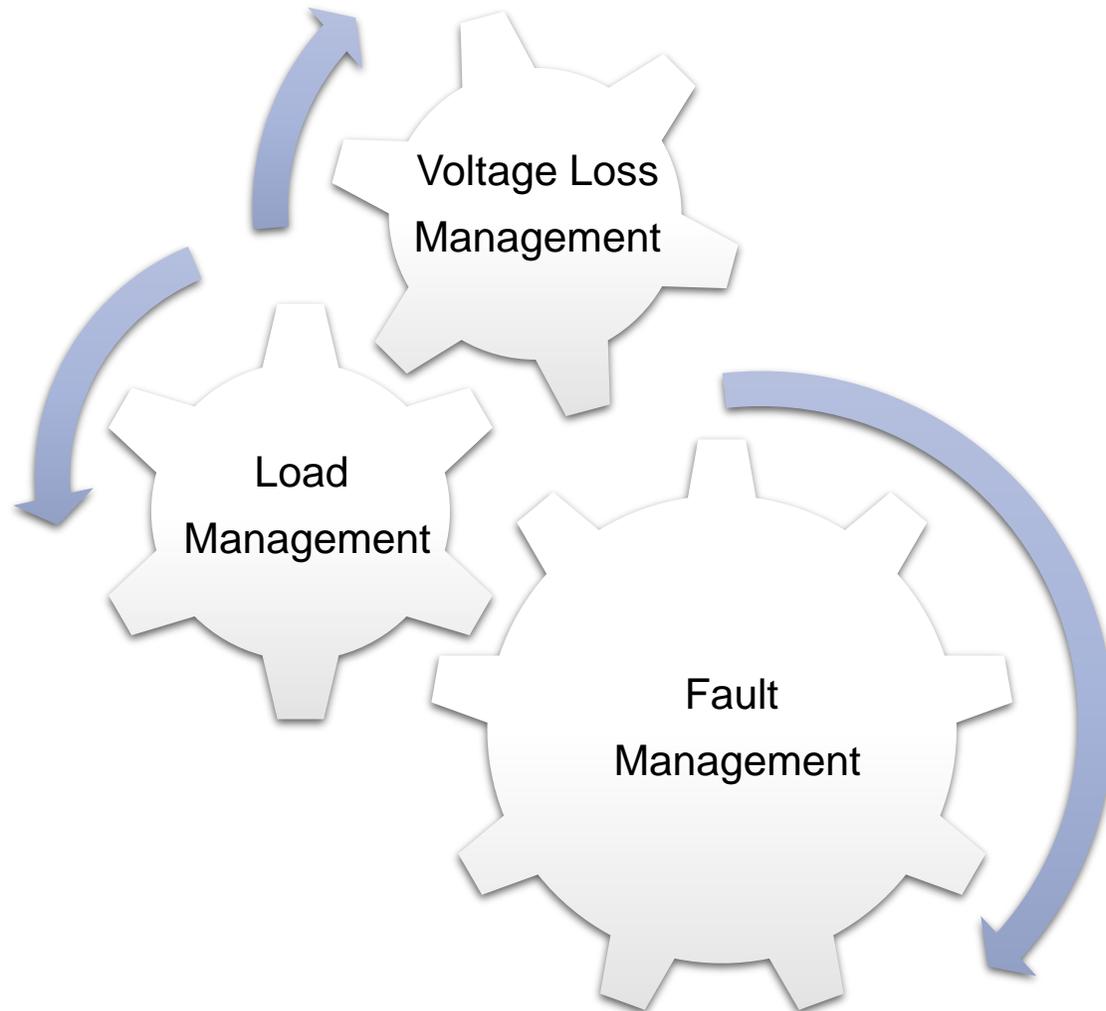
FLISR basics



What is FA ?

- Server-based application
- Performs FLISR, Voltage Loss and Load Mgmt
- Centralized communication architecture
- Restorations between 30 seconds to 2 minutes
 - Communication dependent

FA Primary Functions



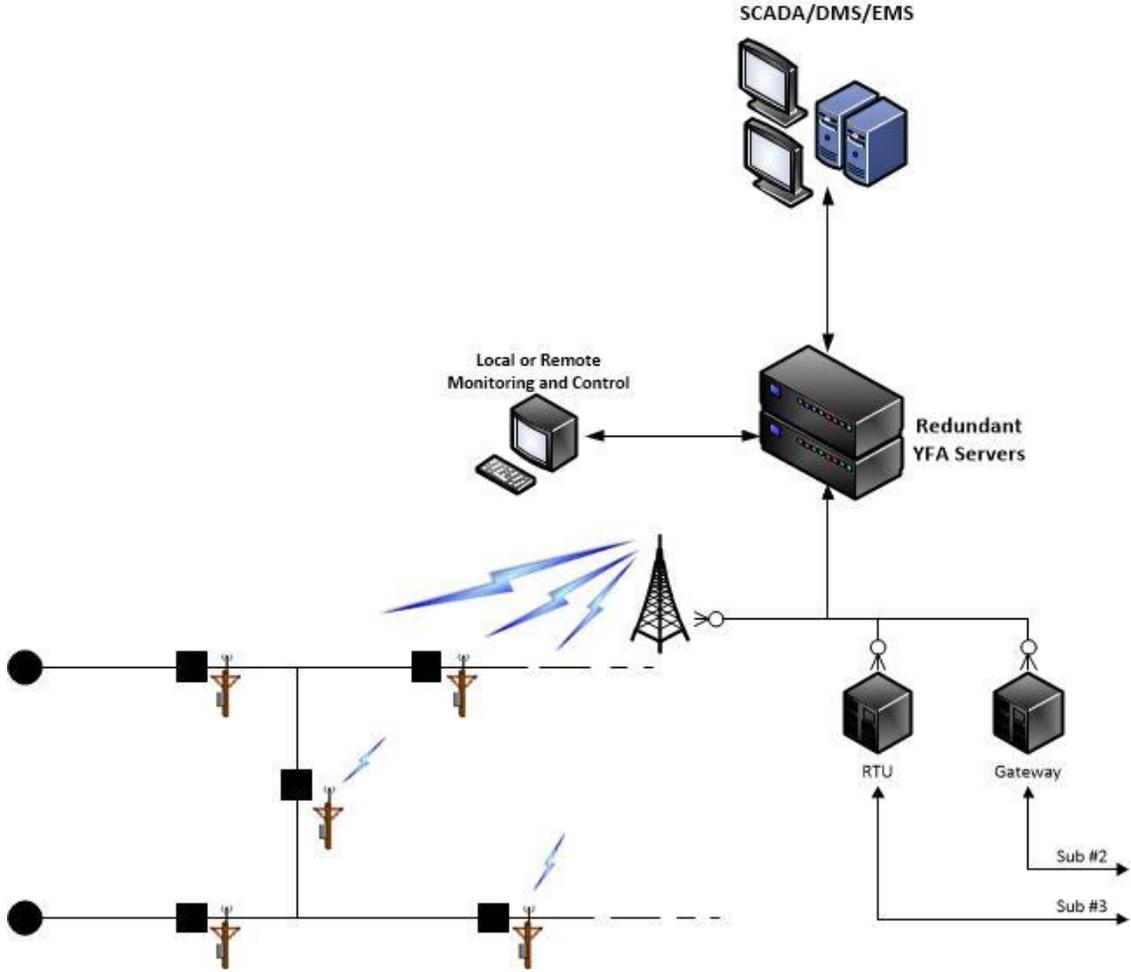
FA Strengths

- Easy device integration
- Open protocols
- Flexible communications
- Minimal linemen training
- Dynamic
- Simulator
 - Supports desktop and hardware-in-loop (HIL)

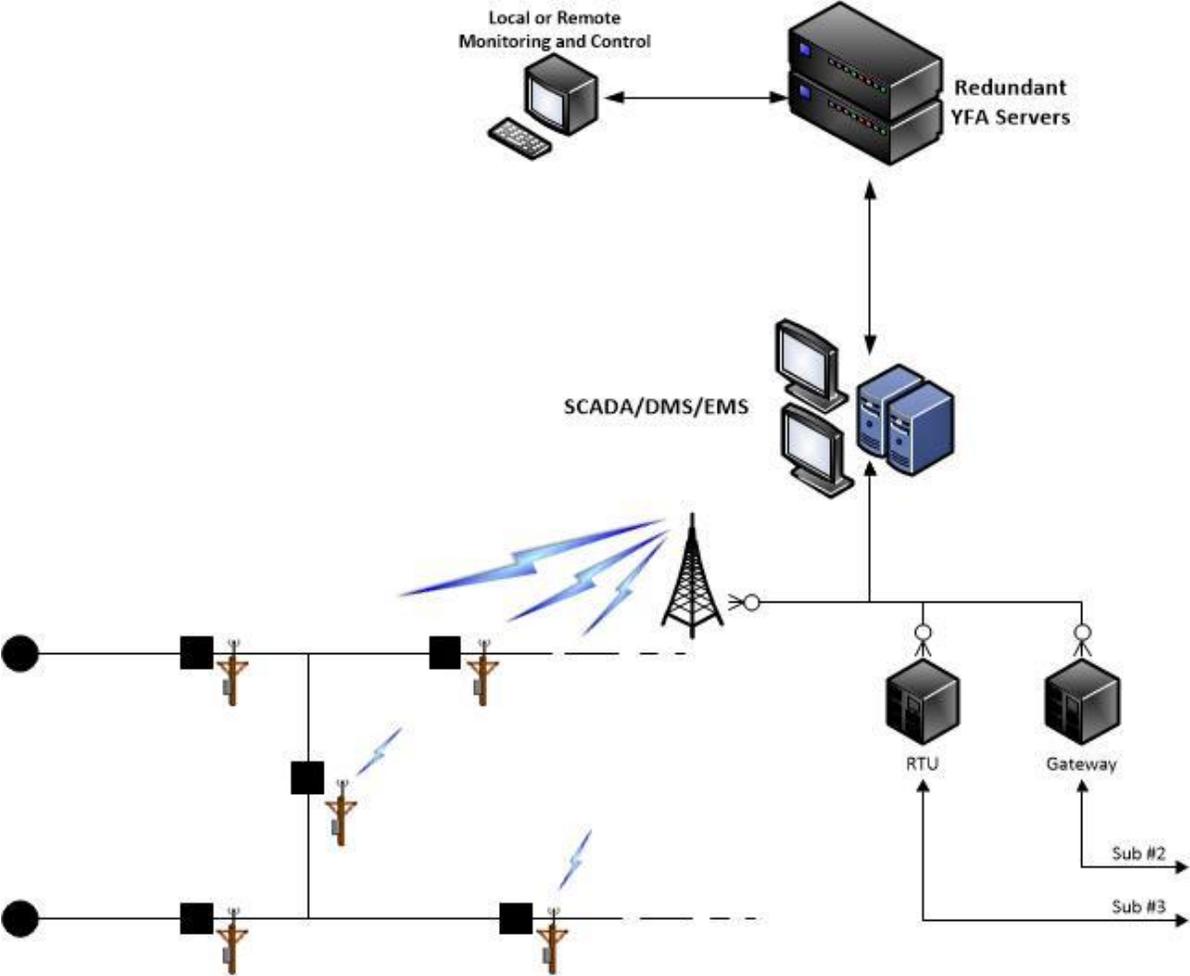
FA Strengths

- Distributed Energy Resource (DER) integration
- Overload protection including substation Xfrm
- Simple configuration
- Scalable
- Automation trace – detailed feedback
- Event/Health report – executive feedback
- Complete system ownership

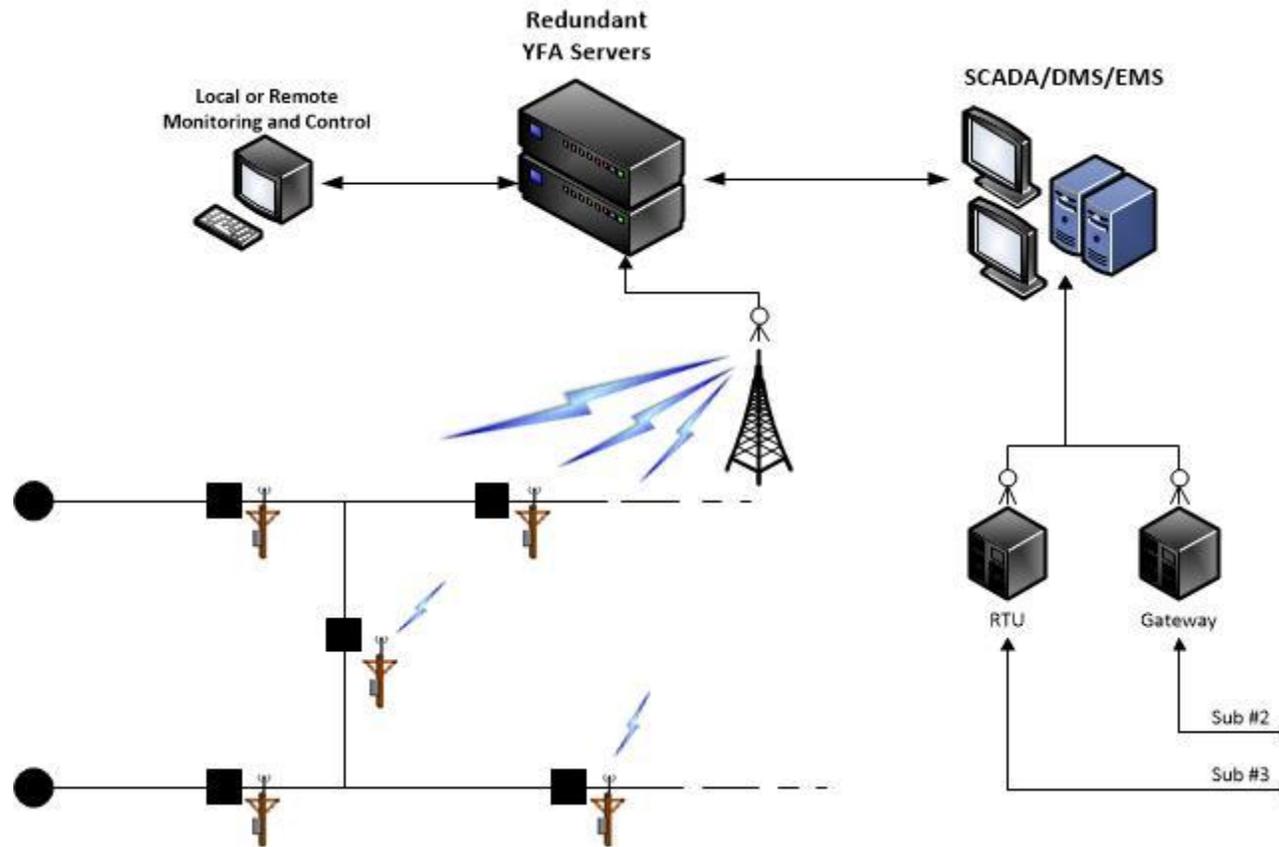
In-Line Network Architecture



Bolt-On Network Architecture



Mixed In-line and Bolt-on Architecture



FA functionality

Device integration

Integrate nearly any existing control into automation that supports a standard communication protocol without need for additional hardware or protocol converters. Ensure compatibility with next generation of controls.

- Eaton/Cooper – 11 devices
- SEL – 5 device
- S&C – 8 device
- GE – 2 devices
- ABB – 1 device
- Nulec - 1 device
- Noja – 1 device
- Telvent – 1 device



Topology Editor – Configurable control

FA Editor - Feeder Automation Demo

File Help

FA System Configuration

- Device Types
 - Switching Device
- Load Conditions
- Default Load Management
- Default Timeout Values
- Default Automation Values
- Default Voltage Management
- Data Concentrators
- FA Subsystems
 - Sub
 - Substations
 - Feeders
 - F1
 - Switching Devices (N/C)
 - Line Transformers
 - All Devices
 - Zones
 - F2
 - Switching Devices (N/C)
 - Line Transformers
 - All Devices
 - Zones
 - F3
 - F4
 - Switching Devices (N/O)
- Simulation Configuration

FA System Configuration \ DefaultAutomation Values

Define default automation values in this table. Note that default values c

Disable Automation

- After First Event
- After Manual Operation

Re-enable Automation : Manually

Device Automated Operations

- Automated
- Control Retry : 0
- Manage Faults : Enable
- Miscoordinated Fault Transfer : Enable
- Maximum Link Fragmentation : Enable
- Use GI : Enable
- Block Reclose : Disable
- Block Ground Trip : Disable
- Manage Sectionalizer Mode : Enable
- Line Transformer Backfeeding : Enable
- Reconnect Distributed Generation : Enable

Display and simulation: Validate configurations



COOPER POWER SERIES

Yukon™ Feeder Automation

Yukon Feeder Automation Demo

System Information

- A device has been operated by YFA
- A device has been externally operated
- Miscoordinated fault detected

Automation: **Enabled**
Simulation: **Started**

Automation Monitoring

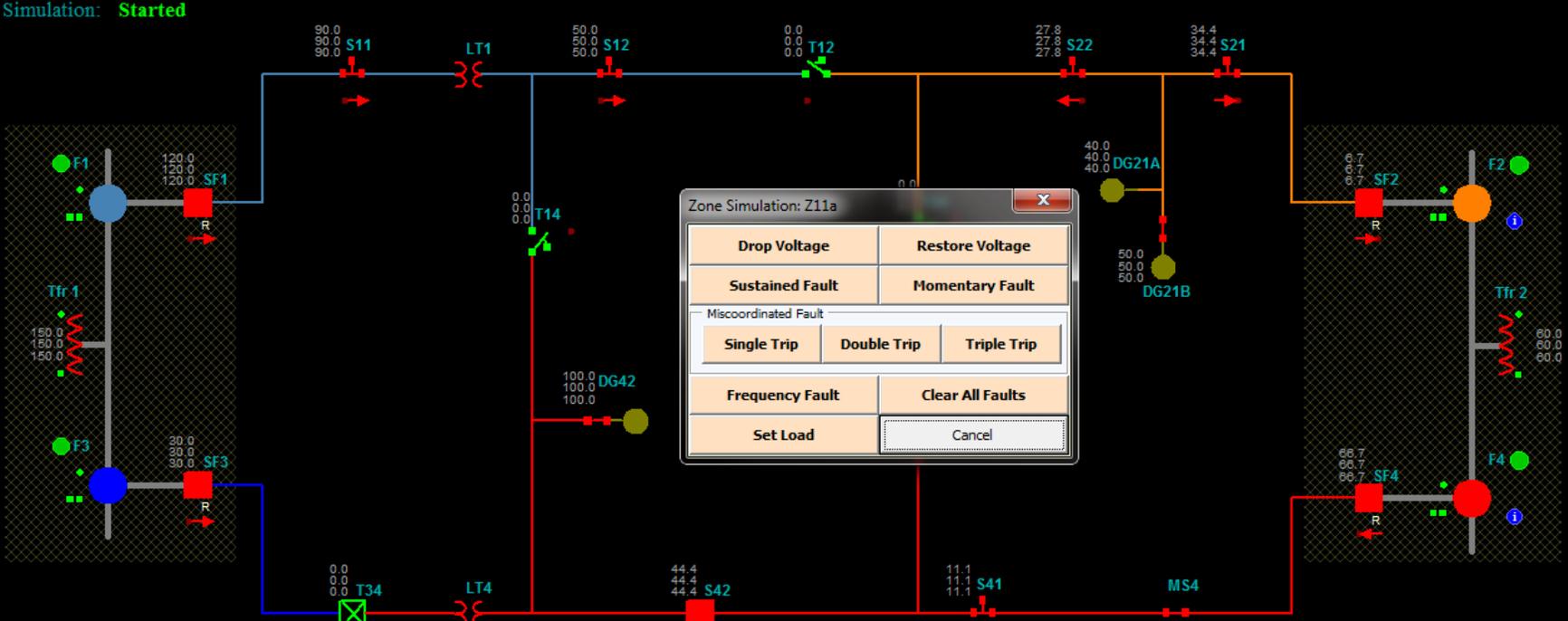


Zone Simulation: Z11a

Drop Voltage	Restore Voltage
Sustained Fault	Momentary Fault
Miscoordinated Fault	
Single Trip	Double Trip
Triple Trip	
Frequency Fault	Clear All Faults
Set Load	Cancel

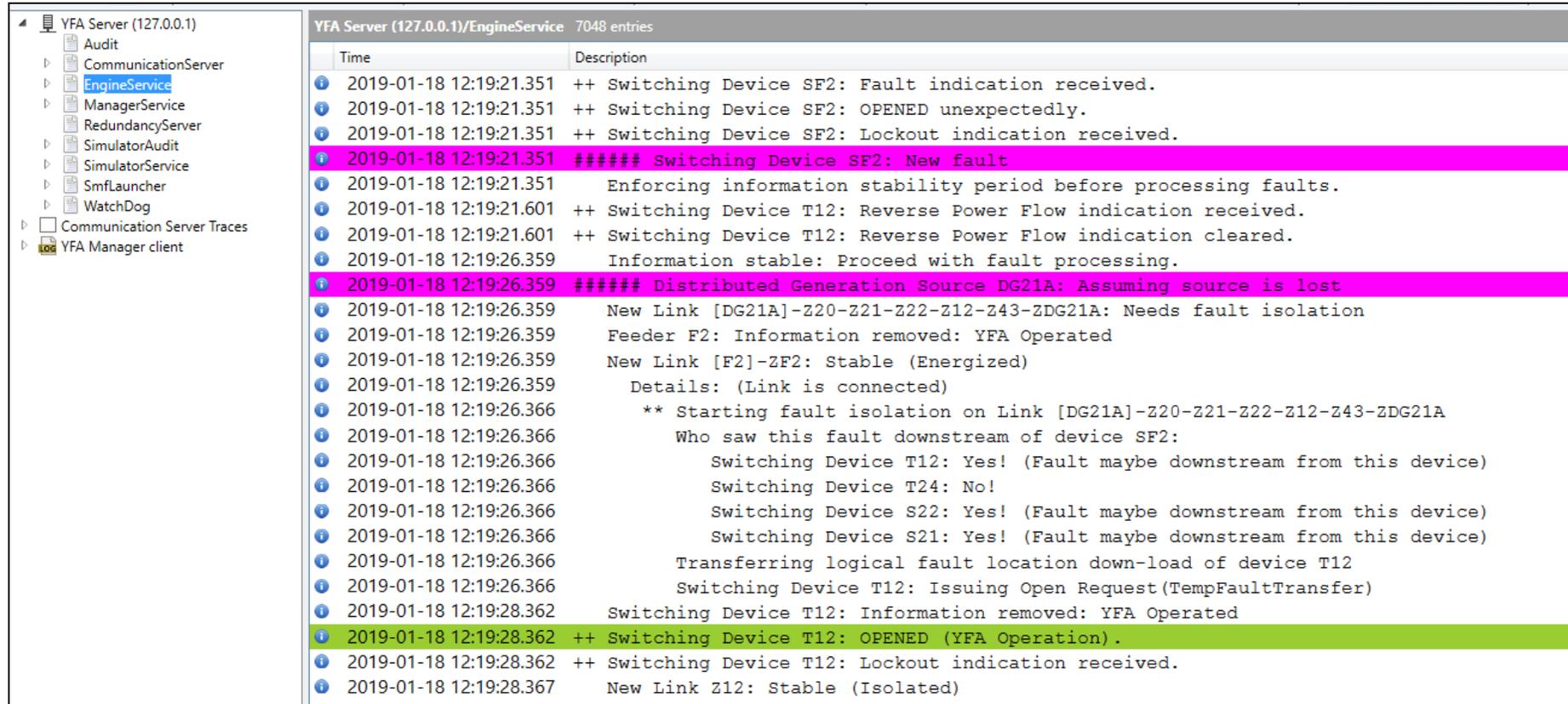
Object Information

- Phase A instantaneous current (A)
- Phase B instantaneous current (A)
- Phase C instantaneous current (A)



Reduce Configuration, Testing and Model Verification

Automation logic trace



The screenshot displays an automation logic trace interface. On the left is a tree view of the system components, with 'YFA Server (127.0.0.1)' expanded to show 'EngineService'. The main area on the right is a log table titled 'YFA Server (127.0.0.1)/EngineService 7048 entries'. The table has two columns: 'Time' and 'Description'. The log entries show a sequence of events related to a fault on Switching Device SF2, including fault indications, lockouts, and subsequent actions like enforcing stability periods and processing faults on other devices (T12, S22, S21). Key events are highlighted in pink and green.

Time	Description
2019-01-18 12:19:21.351	++ Switching Device SF2: Fault indication received.
2019-01-18 12:19:21.351	++ Switching Device SF2: OPENED unexpectedly.
2019-01-18 12:19:21.351	++ Switching Device SF2: Lockout indication received.
2019-01-18 12:19:21.351	##### Switching Device SF2: New fault
2019-01-18 12:19:21.351	Enforcing information stability period before processing faults.
2019-01-18 12:19:21.601	++ Switching Device T12: Reverse Power Flow indication received.
2019-01-18 12:19:21.601	++ Switching Device T12: Reverse Power Flow indication cleared.
2019-01-18 12:19:26.359	Information stable: Proceed with fault processing.
2019-01-18 12:19:26.359	##### Distributed Generation Source DG21A: Assuming source is lost
2019-01-18 12:19:26.359	New Link [DG21A]-Z20-Z21-Z22-Z12-Z43-ZDG21A: Needs fault isolation
2019-01-18 12:19:26.359	Feeder F2: Information removed: YFA Operated
2019-01-18 12:19:26.359	New Link [F2]-ZF2: Stable (Energized)
2019-01-18 12:19:26.359	Details: (Link is connected)
2019-01-18 12:19:26.366	** Starting fault isolation on Link [DG21A]-Z20-Z21-Z22-Z12-Z43-ZDG21A
2019-01-18 12:19:26.366	Who saw this fault downstream of device SF2:
2019-01-18 12:19:26.366	Switching Device T12: Yes! (Fault maybe downstream from this device)
2019-01-18 12:19:26.366	Switching Device T24: No!
2019-01-18 12:19:26.366	Switching Device S22: Yes! (Fault maybe downstream from this device)
2019-01-18 12:19:26.366	Switching Device S21: Yes! (Fault maybe downstream from this device)
2019-01-18 12:19:26.366	Transferring logical fault location down-load of device T12
2019-01-18 12:19:26.366	Switching Device T12: Issuing Open Request(TempFaultTransfer)
2019-01-18 12:19:28.362	Switching Device T12: Information removed: YFA Operated
2019-01-18 12:19:28.362	++ Switching Device T12: OPENED (YFA Operation).
2019-01-18 12:19:28.362	++ Switching Device T12: Lockout indication received.
2019-01-18 12:19:28.367	New Link Z12: Stable (Isolated)

- Enables a continuous improvement process around the automation system

Event reports

Events							
	Date/Time	Site Name	Subsystem	Duration	Type	Outcome	
✓	1/18/2019 2:48:26 PM	Feeder Automation Demo	Region1	54 seconds	Voltage Loss/Return	Fully successful	^
✗	1/18/2019 12:56:44 PM	Feeder Automation Demo	Region1	54 seconds	Fault	Unsuccessful	
⊖	1/18/2019 12:53:21 PM	Feeder Automation Demo	Region1	52 seconds	Fault	No automation possible	
✓	1/18/2019 12:41:47 PM	Feeder Automation Demo	Region1	67 seconds	Return to Normal, Voltage	Fully successful	
✗	1/18/2019 12:28:55 PM	Feeder Automation Demo	Region1	52 seconds	Fault	Unsuccessful	
⊖	1/18/2019 12:27:56 PM	Feeder Automation Demo	Region1	< 1 second	Fault, Voltage Loss/Returr	No automation possible	
⊖	1/18/2019 12:25:13 PM	Feeder Automation Demo	Region1	55 seconds	Fault	No automation possible	
✓	1/18/2019 12:21:50 PM	Feeder Automation Demo	Region1	60 seconds	Load Management	Partially successful	∨

Properties - [Feeder Automation Demo/Region1] - 1/18/2019 2:48:26 PM

General Activities Statistics

Site: Feeder Automation Demo
Subsystem: Region1
Date: 1/18/2019 2:48 PM
Type: Voltage Loss/Return
Initial Condition: Voltage loss detected on switching devices SF4, S42, S43
Outcome: Fully successful
Outcome Explanation: Automation completed successfully

Event reports



Summary

Site	Feeder Automation Demo
Subsystem	Region1
Start Time	Jan 18 2019, 02:48:26 PM (-06:00)
Duration	54 seconds and 271 milliseconds
Type	Voltage Loss/Return
Outcome	Success
Outcome details	Automation completed successfully
Initial condition	Voltage loss detected on switching devices SF4, S42, S43
End Time	Jan 18 2019, 02:49:21 PM (-06:00)

Activity Details

02:48:26 - Start of event		
02:48:26	00:00:00	Start of event
02:48:26 - Voltage management (1718 milliseconds)		
02:48:26	00:00:00	Voltage loss detected on switching devices SF4, S42, S43
02:49:21	00:00:00	Feeder FA Completed Detected

Event Playback

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Yukon™ Feeder Automation

Playback: **Running**

System Information

- A device has been operated by YFA
- A device has been externally operated
- Miscoordinated fault detected
- Last automation event outcome

Yukon Feeder Automation Event Playback

Application Playback View

Event Information

Type: Fault
Date: 2021-10-18 11:30:06
Duration: 51 seconds and 799 milliseconds
Outcome: Fully successful
Outcome Explanation: Automation completed successfully

Event Moments

Time	Description
11:24:34.089	Recording start
11:30:06.443	Automation activity: Start of event (last 0 millisecond)
11:30:06.450	Automation activity: Fault isolation (last 1002 milliseconds)
11:30:07.449	R2S1 position set to open
11:30:07.453	Automation activity: Restoration (last 506 milliseconds)
11:30:07.954	RS1S2 position set to close
11:30:07.959	Automation activity: Wait for stability (last 50 seconds and 283 milliseconds)
11:30:58.243	Automation activity: End of event (last 0 millisecond)

YFA demonstration / Sub 2021-10-18 11:26:51.589

• Replay the event with field devices data



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Health reports

YFA Manager

Server Regions Events **Health Reports** Options

Delete View Download Request

Manage

Health Reports

Generation Time	Comm Problems	Region Name	Major Problems	Minor Problems
2021-10-12 07:53:43	0	Feeder Automation Demo	0	0
2021-10-12 07:54:09	0	Feeder Automation Demo	0	0

- Report any problem that can impact customer restoration

Health reports



Summary

Sub

[Problems](#)

[Ties](#)

[Links](#)

[Transformers](#)

Summary

Region	Feeder Automation Demo
Generated	<i>In Previous Report</i> 0 2 AM (-04:00)
Communication Problem	1
Major Health Problem	0
Minor Health Problem	0
Compared Report	Aug 02 2022, 10:59:07 AM (-04:00)

Sub

Informations	No information
Load Alarm Level	Normal
Not Automated Reasons	Fully automated
Has Communication Problem	True
Has Health Problem	False
Persisted Point Issues	n/a
Disconnected Devices	n/a
Blocking Devices	n/a
	Last load pickup evaluation at 09/21/2022 11:09:06

Proven technology

- IOU Customers

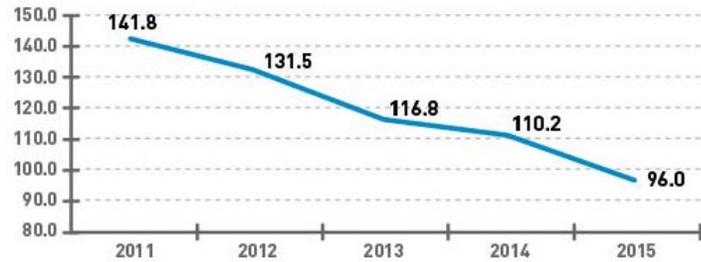
- Pacific Gas & Electric
 - 940 feeders
 - 4400 controlled IEDs
- Duke Energy
 - 5300 controlled IEDs
- Exelon - Pepco
 - 6000 controlled IEDs
- Fortis Alberta
 - 650 Controlled IEDs

- Public Power

- Delaware Electric
- Hendricks Power
- Carroll EMC
- Owen Electric
- Adams Columbia
- CHELCO
- CBEC

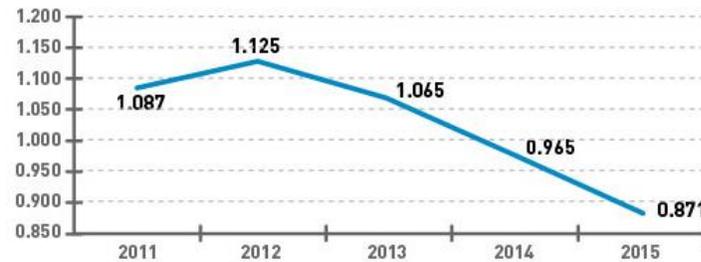
Large West Coast Utility Reliability with FA

SAIDI performance results



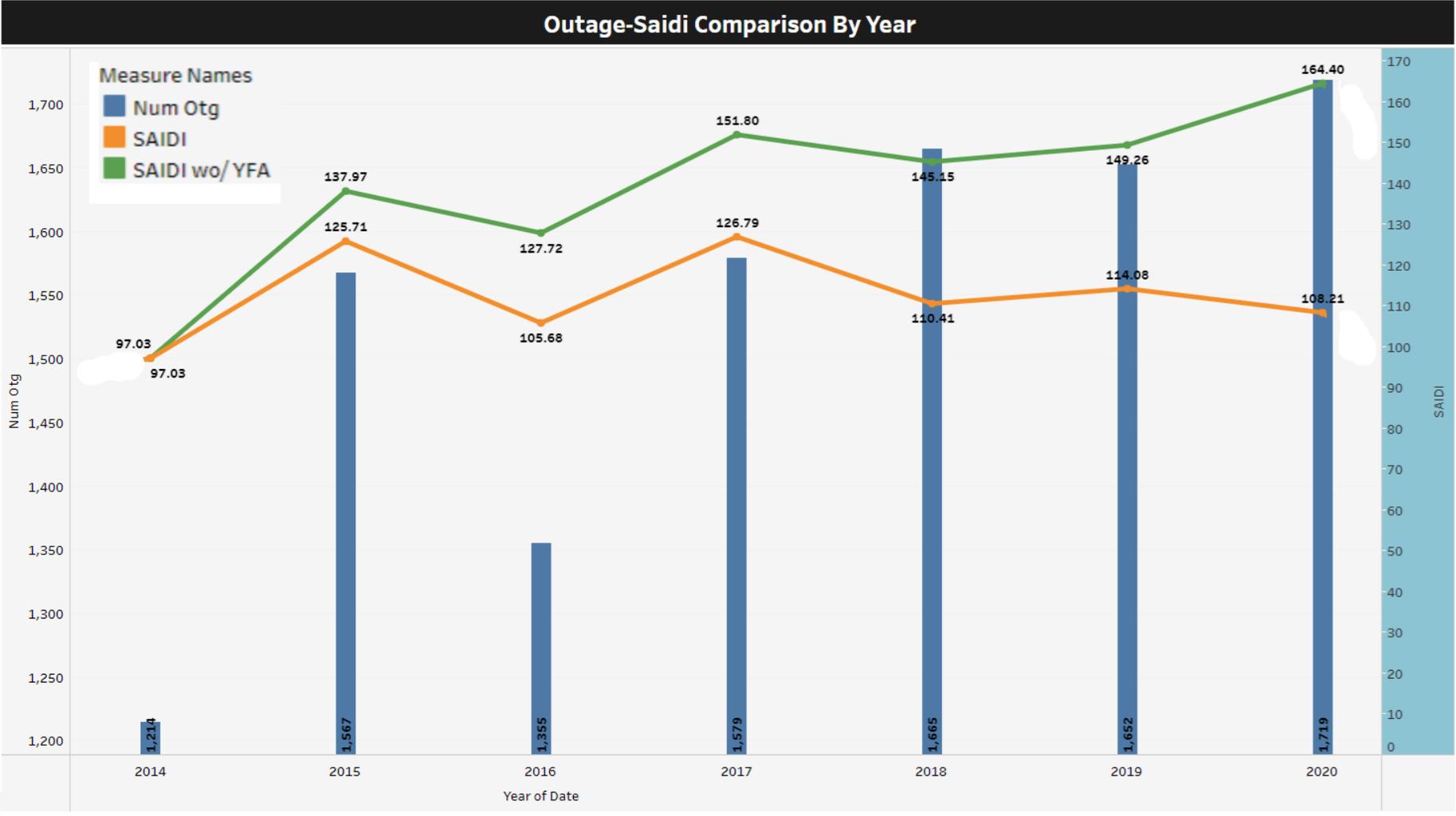
32% SAIDI Reduction

SAIFI performance results



20% SAIFI Reduction

Georgia Utility Reliability with FA



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