Self Healing "Single Phase Looped" Network

AUTOMATED RECONFIGURATION FOR POWER OUTAGE MANAGEMENT

Team Members

Lamine Bassene
Damel Goddard
Oluwabunkunmi Olusanya
Chibuzo Ononiwu
Luan Watson

TABLE OF CONTENTS

BACKGROUND

- Smart Grid
  - Uses artificial intelligence & communication technology
- Self Healing Network
  - Automatic system response & reconfiguration
- Automation
  - Improves reliability
    - Real-time monitoring & intelligent control
- Distribution Network
  - Radial Network
    - One source supplying various customer loads

BACKGROUND

Advisor

- Mr. Carlton Blue, Georgia Power Smart Grid Project Manager

- Lack of SCADA automation on the power grid for underground single line to ground fault

BACKGROUND

- Faults often occur on power distribution networks
  - Disrupts the customers' electricity supply
- About 92% of faults occur on single phase radial distribution lines
  - Residential & Small commercial
  - Decreases Utility Reliability Index
- $119 billion annually
  - Reported by Electric Power Research Institute

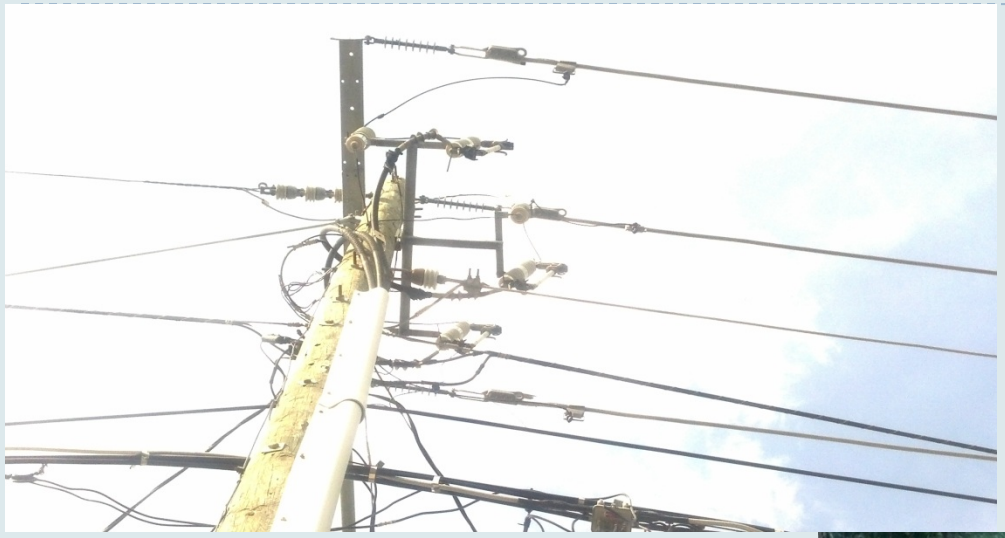
CURRENT STATE-OF-ART

- Self-healing techniques
  - 3 Pha
  - Improv e
- Radial open switch
  - Manua
  - Back- outages
- Crew workers pinpoint and isolate fault
  - Perform manual switching to isolate & minimize outage spans

CURRENT STATE-OF-ART

- Self healing automation
  - Eliminates major impact of underground line faults
- Separate automated normally open switch
  - Reduce extended duration customer outages

CURRENT STATE-OF-ART



Single Phase Tap into a Large Apartment Complex

Single Phase Pad Mounted Transformer in Large Apartment Complex

PROBLEM DEFINITION

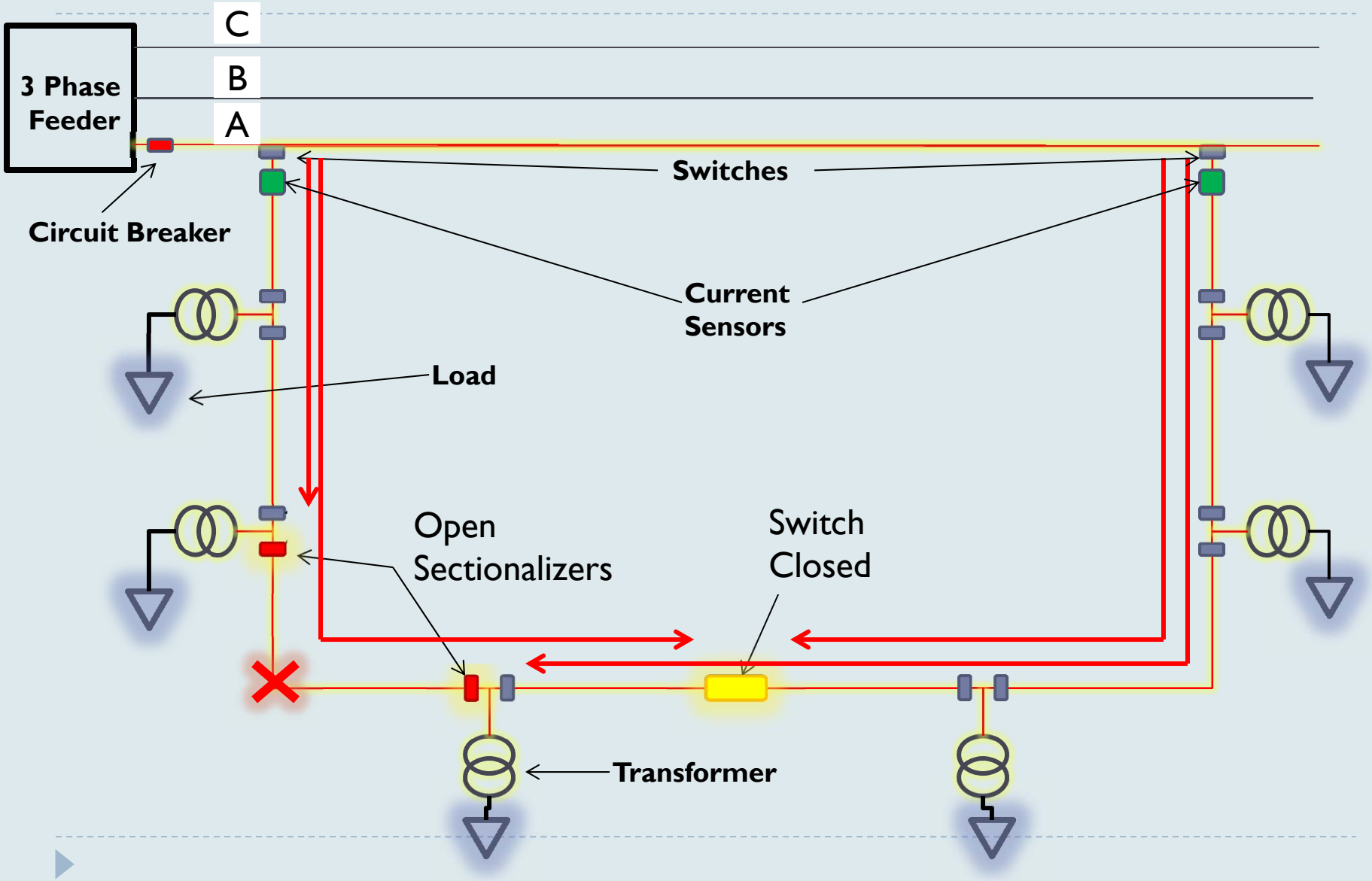
Design and create a software that would utilize Intelligent Electronic Devices (IEDs)

1. Sense & identify location of a single line to ground fault on a single phase radial network with fault
2. Isolate faulted line section
3. Reconfigure the network through the normal open to minimize the customer impacted by a forced outage

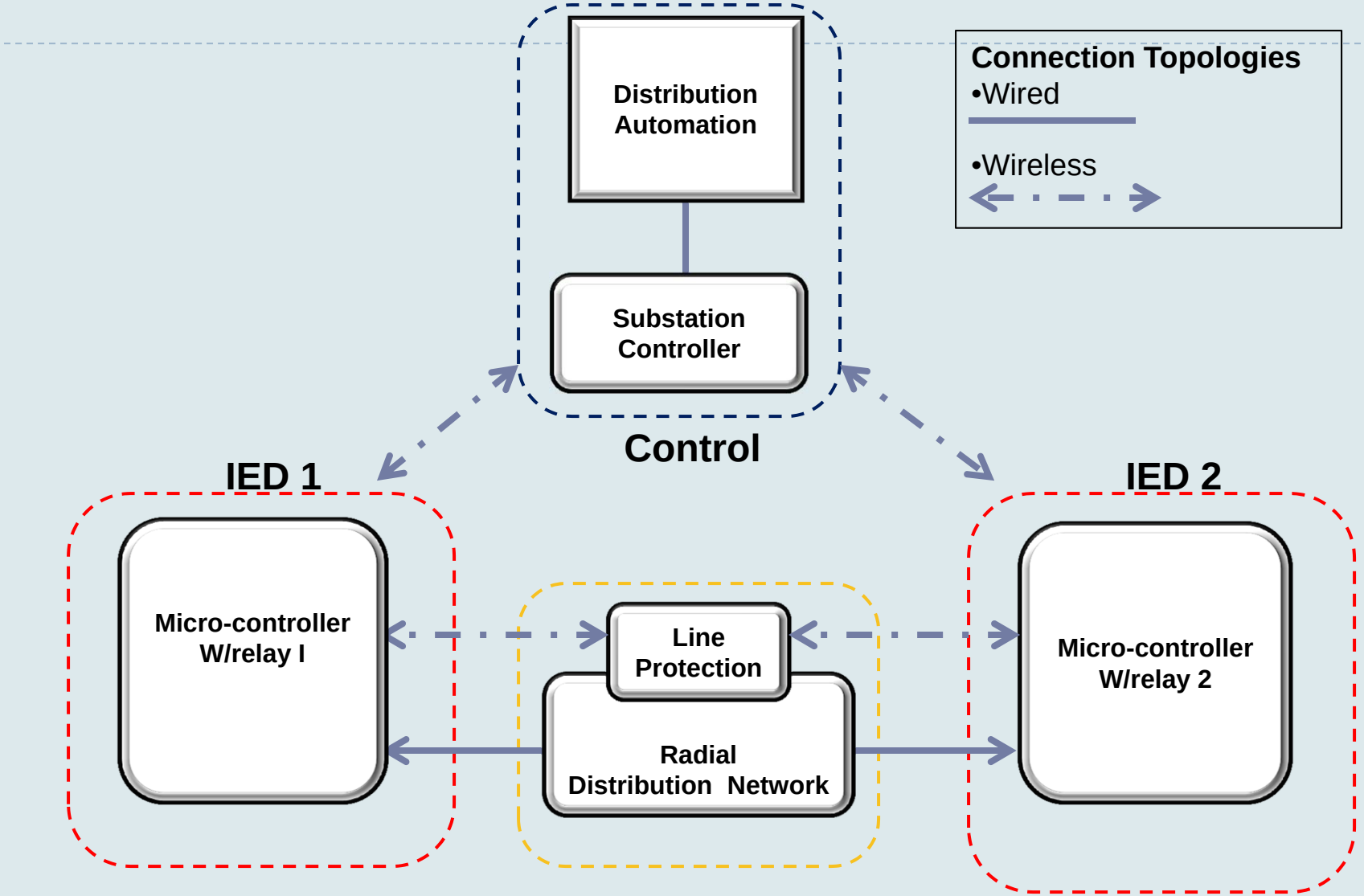
DESIGN REQUIREMENTS

Function	Description
Fault detection and location	System must detect and locate single line to ground fault within t≤10ms
Line isolation	Relays must isolate faulted lines through circuit breakers within 1min
Communication	Scheme must be operated wirelessly IED to Substation
SCADA	Continuously monitor network

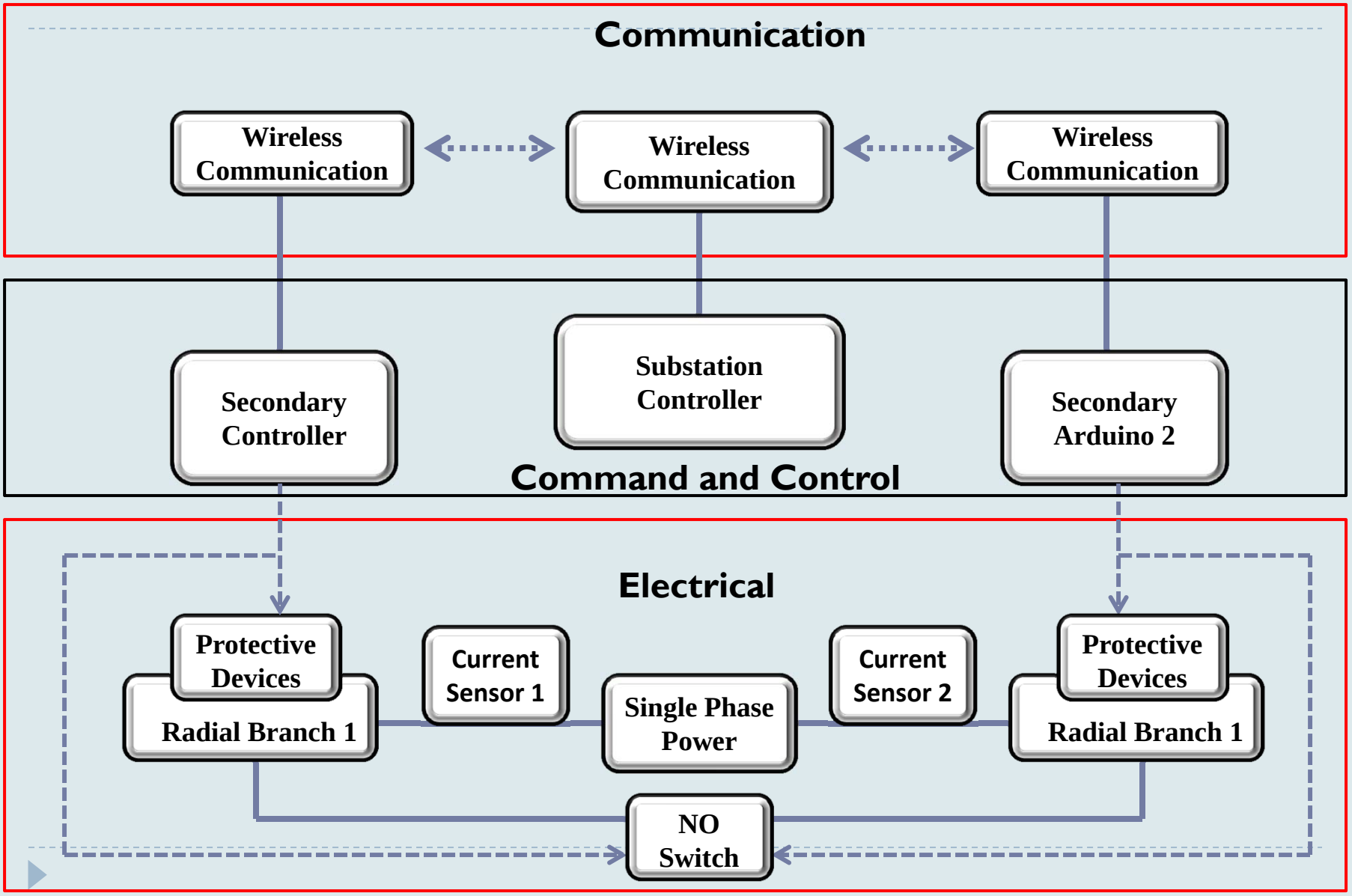
SOLUTION APPROACH



SYSTEM STRUCTURE



SYSTEM INTEGRATION



BENEFITS OF AUTOMATED RECONFIGURATION

- 5 faults in the year 2012
  - 3 faults on the transformers & 2 faults on the line
  - Average of 15 c.p.t. (5 transformers in the line)
  - Total Number of customers = 75
- Time to find a fault = 120 minutes (on average)
- Time to restore a fault = 120 minutes (on average)
- Customer Minute formula
  - Customer Minute = 120 x Total # of customers
  - Customer Minute = 120 x 75 = 9,000 minutes (before fault location)
  - Customer Minute = 120 x 45 = 5,400 minutes (after fault location)
  - Total Customer Minutes = 14,400 minutes

TEST & EVALUATION

- Without Our Automation
- SAIDI = $\frac{Sum\ of\ customer\ interuptions\ durations}{total\ number\ of\ customers}$
- CAIDI = $\frac{Sum\ of\ customer\ interuptions\ durations}{total\ number\ of\ customers\ interruptions}$

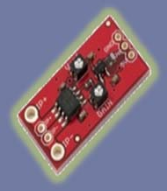
- **SAIDI = $\frac{(120x75)+(120x45)}{150}$ = $\frac{14{,}400}{150}$ = 96 minutes**
- **CAIDI = $\frac{14{,}400}{75}$ = 192 minutes**

TEST & EVALUATION

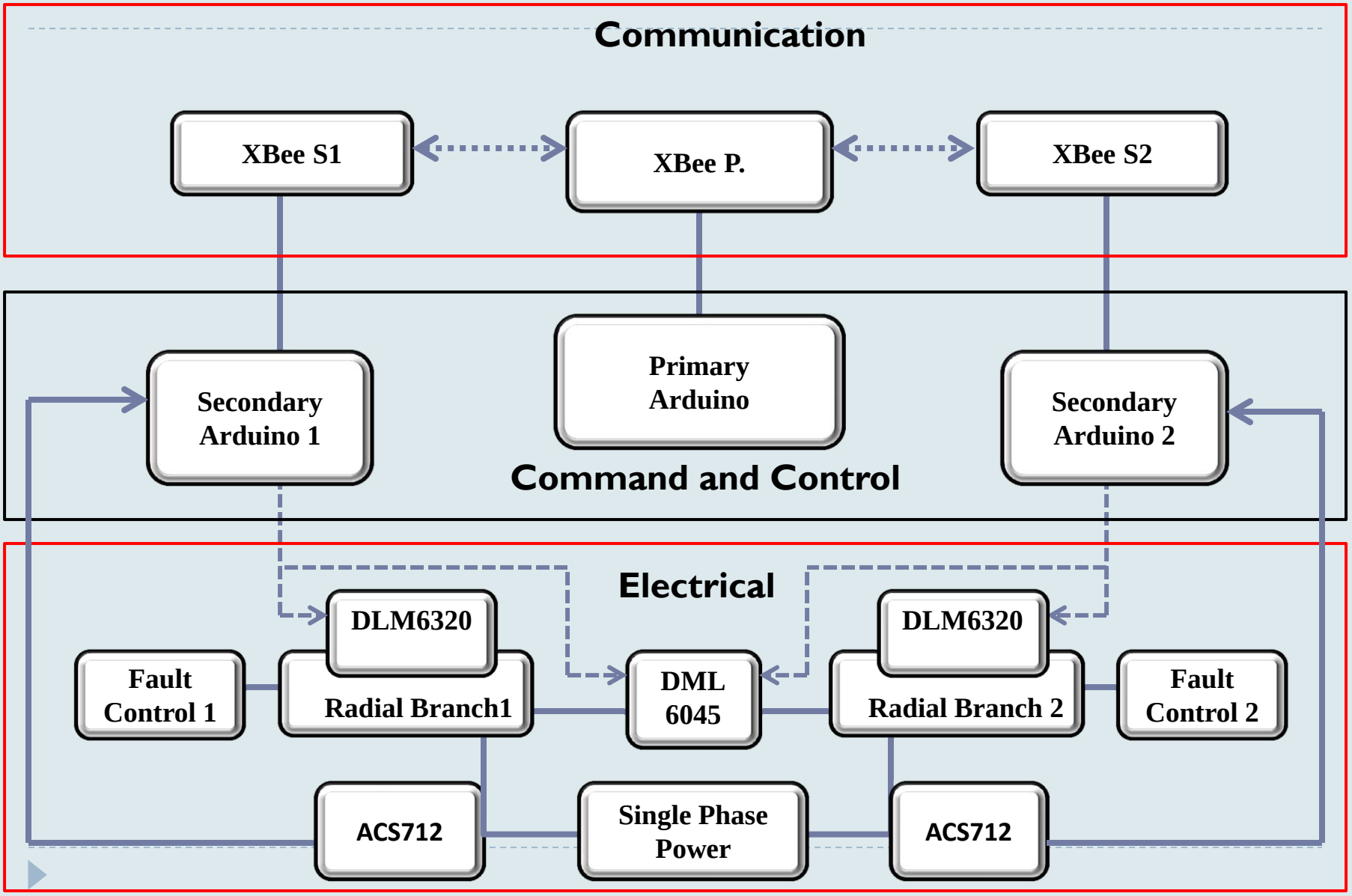
- With Our Automation
- SAIDI = $\frac{Sum\ of\ customer\ interuptions\ durations}{total\ number\ of\ customers}$
- CAIDI = $\frac{Sum\ of\ customer\ interuptions\ durations}{total\ number\ of\ customers\ interruptions}$

- **SAIDI = $\frac{120X45}{150}$ = $\frac{5{,}400}{150}$ = 36 minutes**
  - **-63%**
- **CAIDI = $\frac{5{,}400}{45}$ = 120 minutes**
  - **-39%**

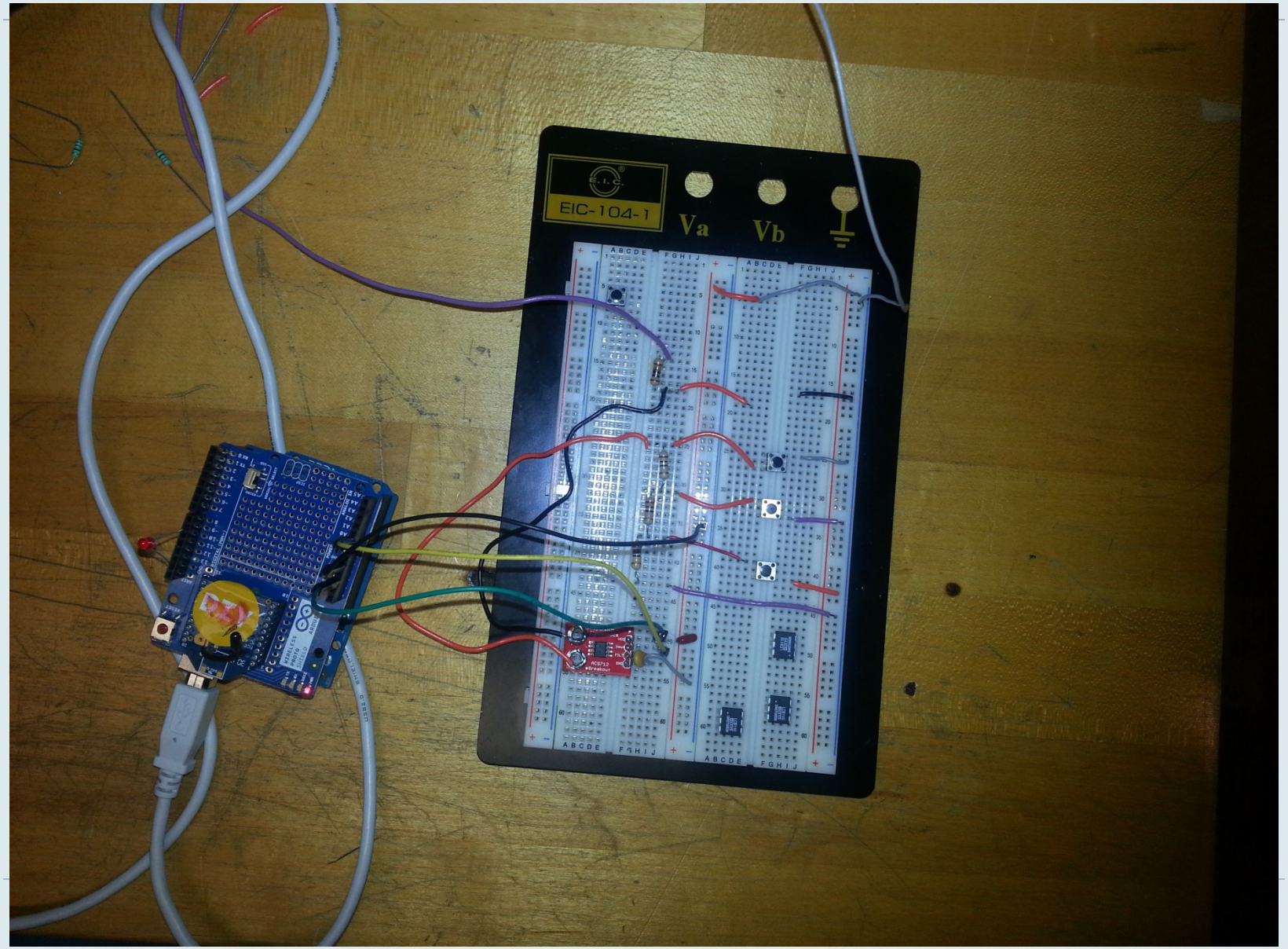
MAJOR COMPONENT & FUNCTIONS

Compnts.	XBee Pro	ACS712	Arduino Uno	DLM6320	DML6045	Intel Atom
						
Category	•Wireless Transceiver	•Current Sensor	•Micro-controller	•Digital Switch NC	•Digital Switch NO	•Micro-Computer
Function	•Comm.	•Fault current reader	•Fault Detection, Isolation ,& Network Config. CTRL	•Line Protection	•Network Loop CTRL	•Network Analysis

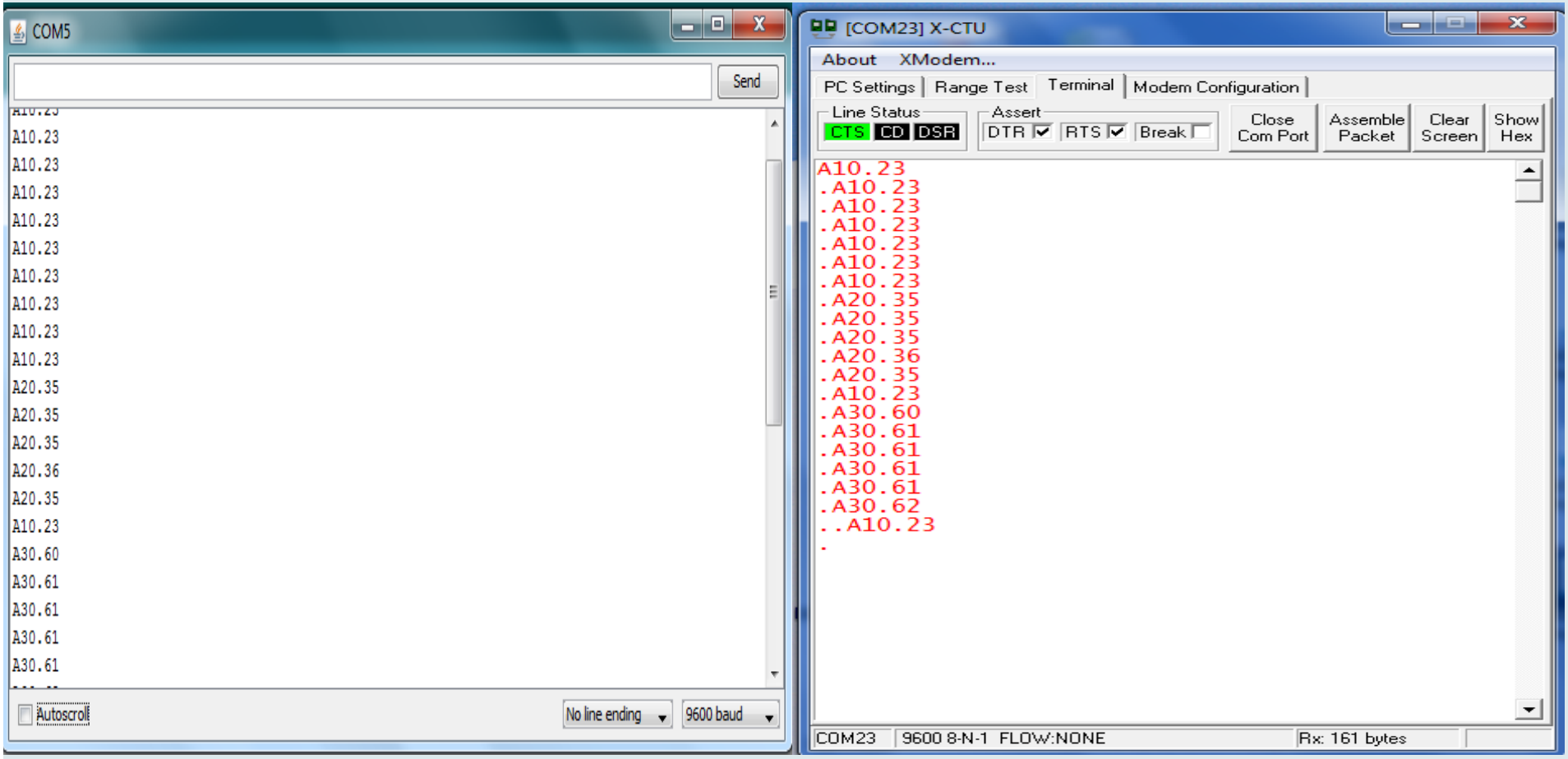
DEMONSTRATION APPROACH



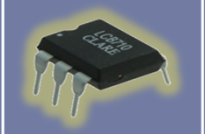
TESTING & EVALUATION



TESTING & EVALUATION



PARTS AND PRICES

	XBee Pro Kit 	ACS712 	Arduino Uno 	DLM 	DML 	Intel Atom 	Wireless XBee Shield 	Others .Rs,Cs .Wires .LEDs
Part No.	Kit-C-Xbee.24	BOB.08882	DEV.09950	LCB110	TLP222GF-ND	Intel Atom	MG.A00065	N/A
Qty	1	2	2	14	2	1	3	N/A
Vendor	Trossen Robotics	Spark fun	Digikey	Digikey	Digikey	Dr. Kim	Newark	Lab
Price	$79.95	$9.96	$24.95	$5	$3	$0	$24.95	$0
Total	$79.95	$19.92	$49.90	$70	$6	$0	$89.85	$0

Grand Total	**$315.62**

CONCLUSION

- Benefits
  - Improve utilities SAIDI & CAIDI
  - More reliable & robust distribution system
  - Faults isolate & reconfigure during reclose cycle
- Future Work
  - Ability to tap different phases (phase switching)

QUESTIONS?