Power Grid Substation Communication for Fault Location, Isolation, and Service Restoration Schemes

Suthasinee Virnig, Electrical Engineering

Zachary Cheben, Jessica Ilagan, Joshua Miller, Long-Giang Nguyen, Kevin Steidel, Jose Ventura

Mentor: Dr. Ha Le

Kellogg Honors College Capstone Project

Background

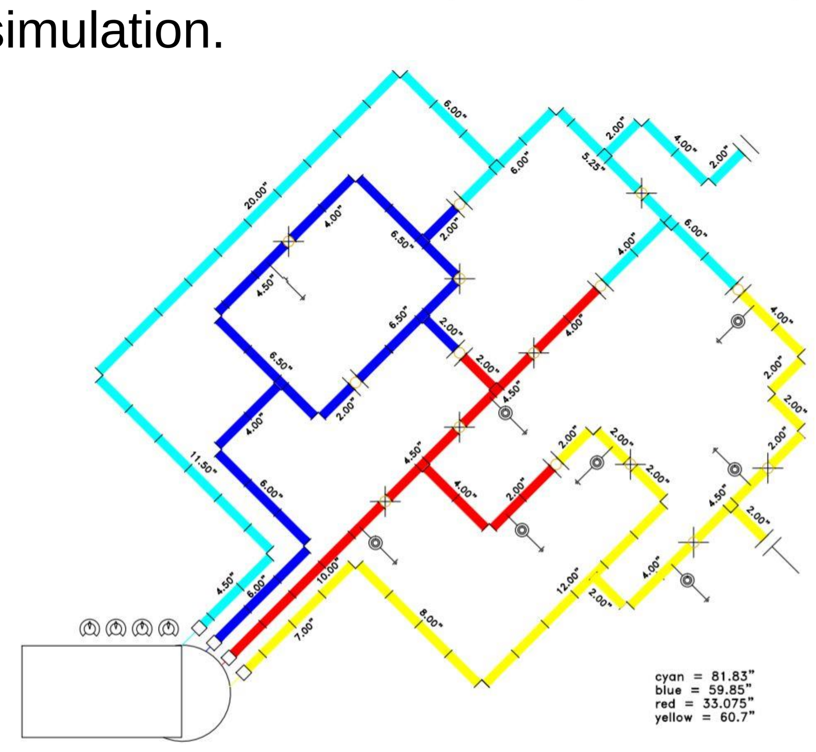
The power grid is the network of transmission lines, substations, and equipment that can transfer power from generation plants to homes and businesses. To increase safety and reliability, the Smart Grid utilizes technologically advanced digital devices and computers to automate and manage the grid without human intervention. The benefit of a Smart Grid is to create a more reliable, efficient, and safer grid that reacts and adapts to potential problems quicker due to digital devices controlling all aspects of the grid. [1] Communication between substations and power lines is implemented in a Fault Location, Isolation, and Service Restoration scheme during fault occurrences.

Objective

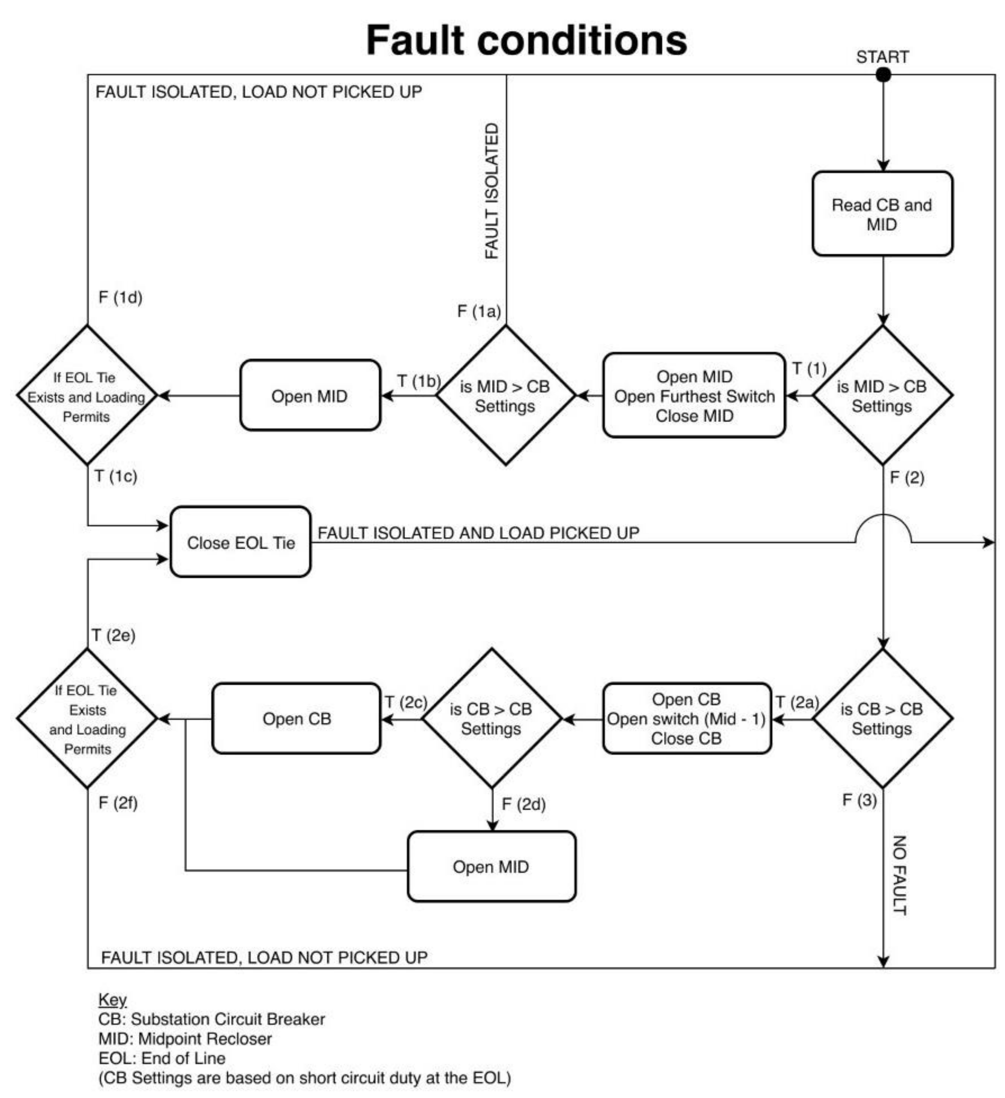
Based on simulated load, generation, and user input, we will be able to demonstrate the benefits of a Smart Grid and educate the general public.

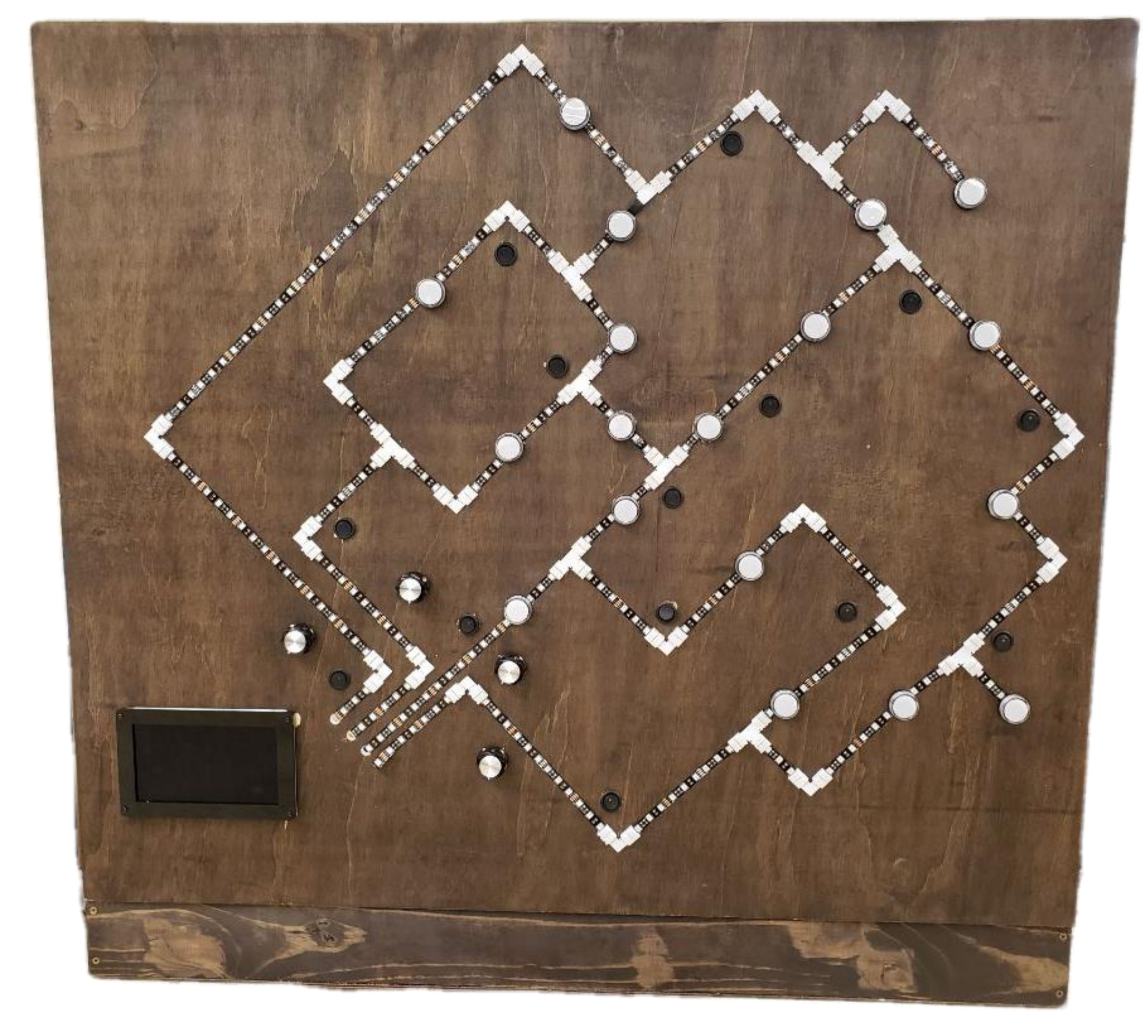
Material & Methods

- The project simulates the logic of a Smart Grid on a 12V DC system, using LED's to visually show the power flow, fault indication, self-healing, and rerouting capabilities. The model also includes current sensors throughout and an LCD screen for user input and data display. Connections are made with a Raspberry Pi 3 B+ microcontrollers and 8-channel relay boards to provide smart grid communication along the grid for logic simulation.



- The grid will deliver to different groups of residential, industrial, commercial, and mixed (commercial and residential).
- The design includes 16 switches throughout, with some set to be closed and while others open to segregate the different groups within the community. This segregation is for the different distributions of power that is being delivered based on required consumer loads.
- The current fault detection and isolation design utilizes different schemes to isolate faults and recover as much of the circuit as possible.





Results & Discussion

Hardware implementation was completed successfully. This included building the board box, component placements, and electrical circuit wiring, The hardware implementation phase took longer than expected due to issues that occurred as we were working on the project. The hardware design needs to be modified due to the high temperature that the resistors emitted. Additional heat sinks and fans are required to be able to dissipate the heat. Another issue that occurred is that the wooden top of the board is too thin. This may cause it to break once we implement the cabinet hinge. Framing is required in order to strengthen the board. Testing, which is the final phase, will take place once the software implementation is complete.

Conclusions

The hardware implementation of the smart grid simulation is completed and the project requirements were met. Additional testing will be required to validate the effectiveness of the system.

Future Work

More testing is required to ensure that the simulations function properly. Additional fault location may be implemented to increase the functionality. Other technical documentation such as the user manual will be required for other users to operate the simulation.

References

[1] "What is the Smart Grid?,." *Smartgrid.gov*. [online]. Available: https://www.smartgrid.gov/the_smart_grid/smart_grid.html. [Accessed: 28-Feb-2019].

Acknowledgement

- My team members for all their hard work and dedication throughout the life cycle of this project
- Dr. Ha Thu Le for the advice and academic support
- Southern California Edison (SCE) for the financial support.