Department of Electrical and Computer Engineering
Howard University

Senior Design Final Proposal

Fault Location by Utilizing Smart Meters

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1. Introduction

The objective of our senior design project is to develop and implement a method of fault location utilizing smart meter technology. Our goal is to have a physical prototype in order to display how a fault can be located on an electric power distribution circuit by ECE day in April. Smart meters have the ability wirelessly transmit and receive information. Examples of information that can be transmitted are the power consumption of the load it is electrically connected to, the bill information of that load, and much more. The most valuable information we need to implement our project is the alert that the load the smart meter is connected to is about to or has lost power. By using this data we hope to create an algorithm that can locate a fault by pinpointing which smart meters indicate they are still operational versus those that are not operational. This proposal intends to propose the idea of fault location by utilizing the information we can obtain from smart meters that utilities can possibly use to locate faults on a distribution circuit.

2. Problem Definition

Utility companies rely primarily on phone calls from customers to alert them of faults in the power distribution networks. Once enough calls have been received to estimate the location, a crew is sent to manually locate and repair the fault. There are several problems with this current approach that lead to the need to develop a new fault location algorithm. Customers often do not call utilities, or they may be at work and unaware of the outage until the evening. Thus, utilities are provided with very little information necessary to locate the fault. This causes lengthy power outages, unhappy customers, lost profits and potentially damage to the power system.

It is necessary to design a new fault location algorithm utilizing the availability of smart meters. The system must be able to automatically find the GPS coordinate of faults based on “last gasp” data sent by the smart meters. Once the coordinates are located, the address is located on a map and provided to repair crews. This entire process must be completed in no more than 5 minutes, and the location identified must be accurate to within four city block.

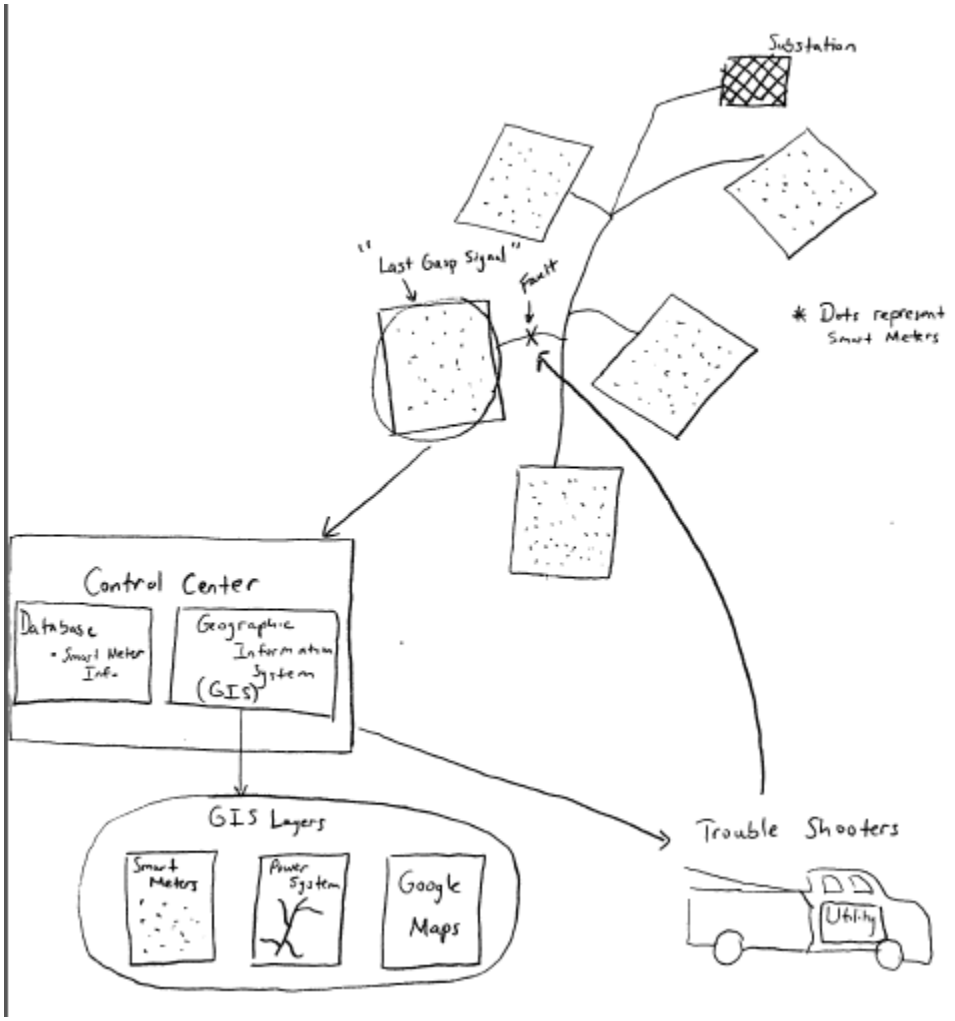
3. Current Status of the Art

In this current day in age, the fault detection method is simple, yet very tedious. As of right now to even know when a fault has occurred, we have to wait for a customer to report that their power is out. Depending on the severity of the situation, dictates when crews are sent out to that respected fault line. Once crews arrive to the fault line, they then have to start at the beginning of the fault and travel along the entire line until we reach the fault. The only problem with this is that a single fault can stretch over counties at a time. Once the fault is reached, we must go over the rest of the line to ensure that there are no other faults on the line. Once this is done, we then report back to the customer to let them know that the fault is fixed and to see if the electricity is back on.

This process is very tedious and time consuming and any given scenario can impact searching for a fault such as, if there are two different faults. If there happens to be two different faults you spend twice as long on the line because you do not know that there are two different faults at the same time because there is no way of telling other then power outages. The same goes for if there are two different locations without power, if an entire neighborhood goes out, so on and so forth. The list of different scenarios is great, so there needs to be a more effective way in detecting faults that is more time effective and more dependable.

4. Engineering Approach for Solution Generation

When a power outage occurs, smart meters in the affected area will send a “last gasp” signal containing their identification numbers to the distribution management system. A database within the management system will contain address data for all the smart meters on the grid. The address of the affected meters will be layered on top of a map of the power grid to identify the location of the fault.



The key component to our solution is the way in which smart meter addresses are stored. Because faults can occur along distribution lines, it is necessary to address smart meters based upon their location on the power line rather than their longitude and latitude. Several other

algorithms define this location as a distance from the nearest substation, however several locations meters may be at the same distance from the substation, thus causing an ambiguity. Our smart meter addresses will be stored in the following format:

ID number	0123456789
Latitude	38.920455
Longitude	-77.024653
Street Address	2251 Sherman Ave NW
Neighboring meter ID 1	1111111111
Neighboring meter ID 2	2222222222
Neighboring meter ID 3(if existing)	3333333333

This format will allow us to first plot the longitude and latitude location of each smart meter, and then fill in the power lines connecting one meter to the next. This format simplifies the process of determining between which meters a fault occurred, and the possible power line that it could have occurred on. After, this is determined, the address of nearby smart meters will be sent to repair crews so that they can find the precise location of the fault.

5. Tasks and Deliverables

November

- Revise solution for locating faults by utilizing smart meters
- Meet with individuals from industry that have experience with standards/regulations, smart meters, or anything else that can assist with the successful completion of this project

December

- Familiarize selves with Standards and Regulations of NERC and FERC with regards to gathering information from electric grid technologies (smart meter)
- Familiarize and implement PSSE, Power World, or PSAT leading to indication of fault by smart meter
- Algorithm and method for model prototype

January

- Begin implementation of solution

January/ February

- Continue construction of project

February/ March

- Completing construction of project by March 21st, 2012
- Begin practicing presentation
- Make any minor changes to project

March

- From March 21st until ECE day practice presentation

6. Project Management

Group Work

- Familiarize selves with Standards and Regulations of NERC and FERC with regards to gathering information from electric grid technologies (smart meter)
- Familiarize and implement PSSE, Power World, or PSAT leading to indication of fault by smart meter
- Algorithm and method for model prototype

Kevin Peynado

- Research General Electric as it pertains to fault location
- Implement algorithm into a VHDL code to work with

Kelvin Goodman

- Research Honeywell Technologies as it pertains to fault location
- Look up any other software or distribution fault locator technology

Andrew Ellis

- Look up Schweitzer Engineering (Fault Indicator) and inquire about getting sponsorship
- Stay in contact with Clarence Bell
    - May be able to provide contact/possible advisor for our group

7. Conclusions

Overall, we propose to design and implement an algorithm to locate a fault in an electric distribution system by utilizing smart meters. The main aspects needed are the “last gasp” information from the smart meter when the load they are connected to is about to lose power.

Our engineering solution consists of taking the “last gasp” signal information from the smart meter and immediately matching the smart meters ID number with its physical address on the electric distribution system. Afterward the computer systems of the distribution management system will use the algorithm proposed in our solution approach in order to pinpoint the location

of each non-powered smart meter on a geographical map. The computer system will then determine the location of the fault.

At this point we will begin implementing this design in early January, or the middle of January at the latest. Over the break we will continue to look for sponsorship for our project, preferable a utility that would be interested in our algorithm, and make amendments to our design so that we can begin implementation when we return from the break.

8. References

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[2] Salant, Katherine. (2010). *Smart-grid technology gets electric utilities and consumers interconnected.* The Washington Post. Retrieved from http://www.washingtonpost.com/realestate/smart-grid-technology-gets-electric-utilities-and-consumers-interconnected/2011/05/23/AGNf2wOH_story.html

[3] Schweitzer Engineering Laboratories. (2011). Fault Indicators and Detectors. Retrieved from http://www.selinc.com/FCI/FaultIndicatorsandSensors/.