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The Evolving World of Substation Asset Data

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SUMMARY

The need for a transition from a traditional maintenance practices to a dependency around data that uses analytics to alter maintenance practices has the potential to add value while creating new rewards and challenges to the utility world.

KEYWORDS

condition based maintenance, data analytics, value added

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INTRODUCTION

Are you looking for the end all be all solution to knowing if your substation assets are healthy? Do the pressures of spending less maintenance dollars get you stressed and wondering how to maintain and keep reliability indexes high? Are you concerned with the wealth of knowledge within the subject matter experts who are retiring? Does this sound familiar? These issues are common in the utility industry today. These concerns are also apart of the drivers that are causing the need for change within the traditional utility maintenance arena.

This change is propelling the utility world into exploring data analytics. Data analytics is not to replace the retiring subject matter experts with computers. These analytics could be used to determine substation equipment health, maintenance priority, and capital replacement projects.

Exploring the term data analytics is providing answers using data [1]. The potential of analytics with the substation domain has the potential to be a game changer even though data analytics in general is is not new but applying it for achieving a deeper understanding of substation equipment is relatively new. The need to make the shift into analytics is challenging; however, there are a lot of prospective opportunities within the process.

SEEING THE OPPORUNITY

One opportunity would be capturing asset health from the eyes of an expert. This process for Southern Company Operations in the focus of transmission assets has included several rounds of meetings with asset experts. The goal has been to learn what data and matrixes do they use to access the condition of a given asset. For example, a team of circuit breaker experts created circuit breaker health algorithms based on the questions what keeps you up at night, do we collect that data today, and what would you like to know that you do not know today [3]. For example, one request was the need for SF6 data instead of just a low gas pressure alarm. This process gave insight into what data we have available today and what data or monitoring equipment could be valuable in the future.

Another opportunity is to move from time-based maintenance to condition based maintenance (CBM). Most traditional utility maintenance practices have focused on the time-based interval maintenance process. The interval span varies for assets and typically based on the knowledge and lessons learned from subject matter experts. CBM is using data via online monitoring data to determine the condition of the asset. CBM would allow for moving away from the focus on predictive maintenance as well as reduce or eliminate emergency maintenance work and focus on corrective maintenance. This would be the goal would be focusing operation maintenance dollars on those “squeaky wheels”.

An additional potential opportunity of analytics is the ability to conquer data silos with bridges between the silos. Substation data does not reside in one database and the need to have access to multiple data sources is necessary for successful data analytics. The ability of analytics allows for the ability to reduce manual reports into automated reports and dashboards.

NOTING THE CHALLENGES

The application of analytics in this environment does sound appealing but it is not an easy process. Proving the necessity and value is not an easy task [2]. There is a degree of change management that needs to be applied. First within the important of accurate data which can be as simple as the nameplate data entered correctly into the asset management system all the way to trusting the data provided from an online monitor. Applying data analytics is a process and does not occur quickly.

Most traditional utilities have performed time-based maintenance practices for a long time. A move away from this method is a slow process that involves validation and trust that the analytics must earn for the utility to move away from the time-based approach. This is also a phased approach. Looking at one class of an asset at a time. For example, one approach could be to perform CBM analytics to

115kV SF6 circuit breakers to determine health and maintenance needs based on data analytics instead of a fixed six-year cycle.

The challenges with data analytics are also the need for resources. To fully gain the value of analytics people need to be dedicated to the effort. The business case for dedicated resources is not easy and has proven to be a difficult sell. The true potential of analytics cannot be realized without a team to support and provide analytics to those who make the maintenance and capital replacement decisions. The value in improving substation safety, reducing OPEX, and improving reliability has its value and as well as the vison what questions analytics will answer to questions yet to be asked.

CBM DEVELOPMENT

The investigation into CBM within Southern Company from a transmission perspective began with the addition of online monitoring equipment. Particularly in the area of online dissolved gas analysis (DGA), bushing monitoring, and battery monitoring during the Smart Grid Investment Grant in 2010. The question was raised in 2011 around the value of this monitoring equipment which lead to the investigation into CBM. This investigation let to the conclusion online monitoring equipment is important as well as the asset information around testing, maintenance history, and nameplate information. Also to note that the importance of quality data is required for CBM to be successful. The perspective of this paper is not from the abilities of online monitoring equipment but through the eyes of those that collect and analyse the data from these devices. The goal of CBM or asset analytics is not to replace a subject matter expert but to enhance their abilities by adding another tool in their toolbox. This to so that those entering a substation will be equipped for any situation so they can perform their job safely and more efficient.

An early catch for CBM was with relay data for a capacitor bank that was reading an abnormally high neutral current. See Figure 1 for the trend data. The issue was there had been several pack failures in the capacitor bank causing the neutral current reading to rise. At the time the trend was discovered the neutral current was reading approximate 2.8A. No confirmation of alarm notification was received by the traditional system and this alert through CBM allowed for resolution before peak season occurred.

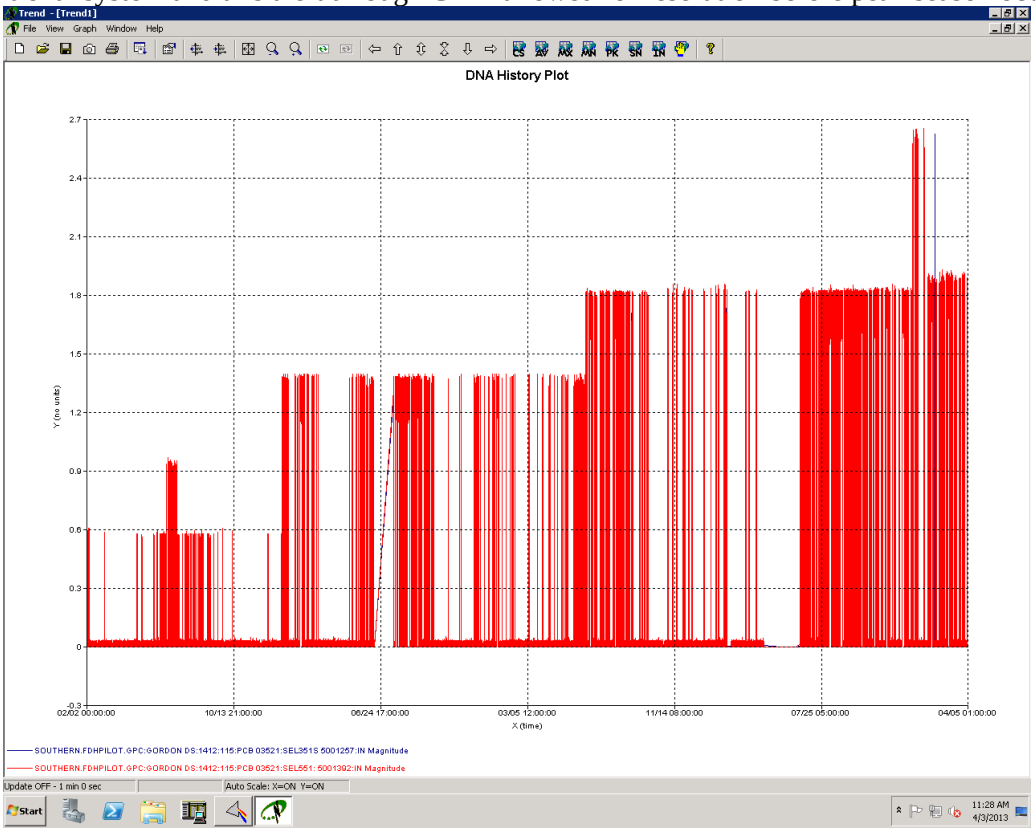

FIGURE 1

In the time since the initial CBM catch there has been growth around online monitoring data. The growth has also allowed for with additional catches around transformer dissolved gas analysis (DGA) and bushing monitors. Figure 2 gives an example of a transformer catch with a DGA monitor following a hurricane while the transformer was not under load.

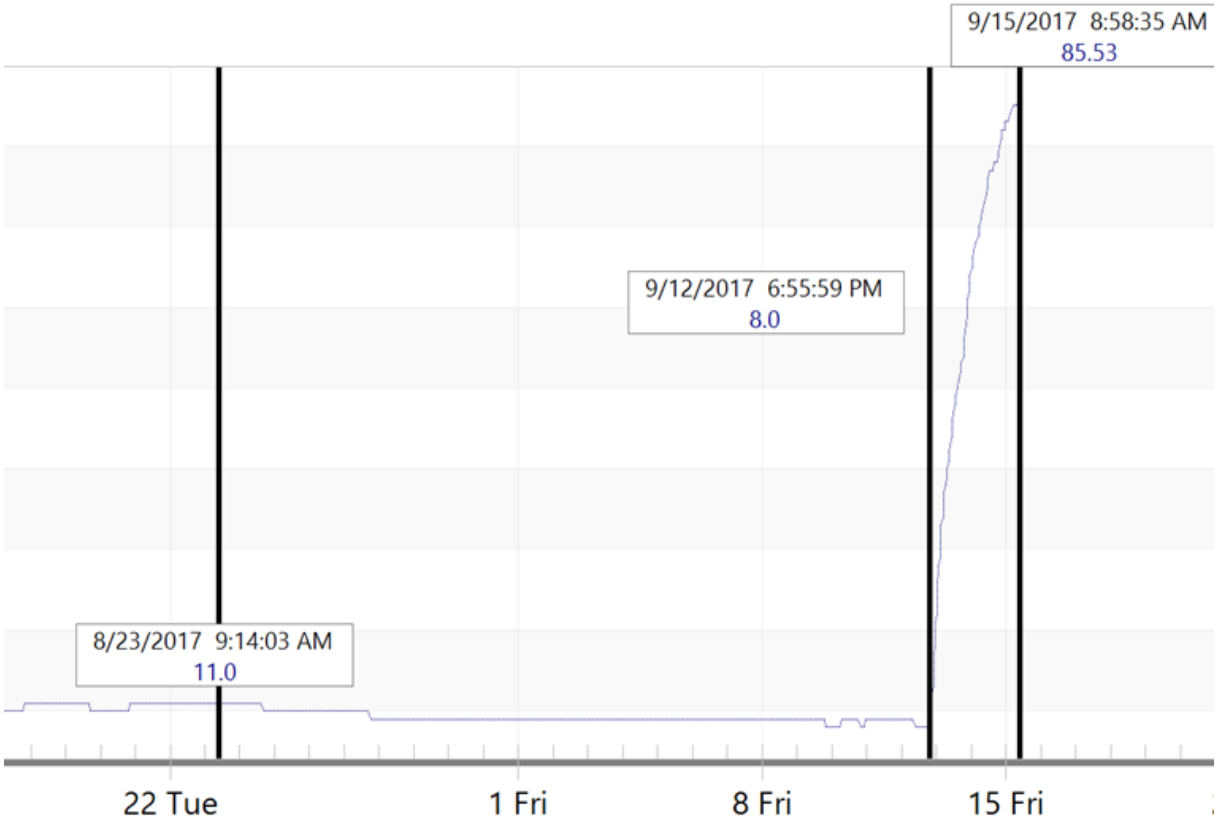

FIGURE 2

This catch allowed for a scheduled replaced and potentially saved extending storm restoration.

The ability to show value with online monitoring equipment has opened a door to the potential value of breaker relay data. The challenges with circuit breaker data includes the evolving rules around NERC CIP as well as limitations of the data historian to store the exact time stamp of each breaker operation. To overcome this challenge the opportunity is to explore the breaker event files. To the tune of approximately ten plus years' worth of these files exist. Granted there has been relay and asset replacements during this time but the data exist and digging into the fault information captured in those files has huge potential in value added to move to CBM. Currently relay data is stored in an ASCII formatted file. There has been work done to parse these files for specific data such as electrical trip times, fault magnitudes, and last operation. The parsed data is stored in a database for use within the data historian for calculations as well as dashboards for subject matter experts to leverage. This process is just beginning. The full value of this data is yet to be realized.

The ability to correlate data between data sources such as breaker events and transformer oil temperatures, DGA, bushing capacitance or bushing power factor changes will bring change in how we see our substation assets. This value added only can occur with advancing analytics.

WHERE ARE THE ANALYTICS

Analytics in use today exist in a small variety. There are simple analytics that calculate 24hr rate of changes, 48hr rate of changes, gas daily averages, and notify when data is stale. More complex analytics revolve around correlating data sets. Using advanced pattern recognition software allows for data with strong correlation to be used for predictive modelling to be flagged on abnormal situations.

Not all data that one would think to correlate actually correlate. Meaning that one must dig deeper to determine the proper analytics balance.

This balance may also come with the introduction of machine learning. The area of machine learning and artificial intelligence are unchartered territory and the potential sounds appealing and promising. This unchartered territory will be explored in a matter of time. There are opportunities with circuit breaker data and other unmined data resources that could provide insight into our substation situational awareness and bring value to change how this utility operates its substation assets in the future.

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