ASSET MANAGEMENT BENEFITS FROM A WIDE AREA POWER QUALITY MONITORING SYSTEM

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ABSTRACT

Advanced sensors and monitoring are a key element in any intelligent network. However, simply monitoring and reporting key attributes of a piece of equipment does not constitute intelligence. Providing data in a method that allows users to make decisions is a step closer to intelligence, but still relies on the user to perform the analysis. A solution that uses advanced sensors to monitor equipment, provides data that can be easily analyzed, and also provides analysis and suggested problems is a truly intelligent system. Today's vision of the smart grid can be realized with existing technology. This paper will describe a wide area power quality monitoring system and summarize the experience of one utility in utilizing advanced sensors to monitor high voltage transformers. The data gathered from the sensors is automatically processed and analyzed. Alarms are generated to alert maintenance personnel that an eminent failure condition exists. Examples of actual experience and benefits from this system will be detailed, along with estimates of cost savings and outage reduction times. This paper will answer the question: What will be the Asset Management benefits of Smart Grids?

INTRODUCTION

Jacksonville Electric Authority (JEA) operates generation, transmission, and distribution assets to serve more than 360,000 customers in the city of Jacksonville, Florida, USA and surrounding areas. Known in the North American power industry as a leader in adopting technology to provide reliable and low cost energy to it's customers, JEA has been utilizing smart grid technologies like advanced metering infrastructure, computer automated work force management, and active outage notification and management to improve system performance and personnel response time in an effort to mitigate outage times to improve key performance indicators such as SAIDI and CAIDI.

THE POWER QUALITY SYSTEM

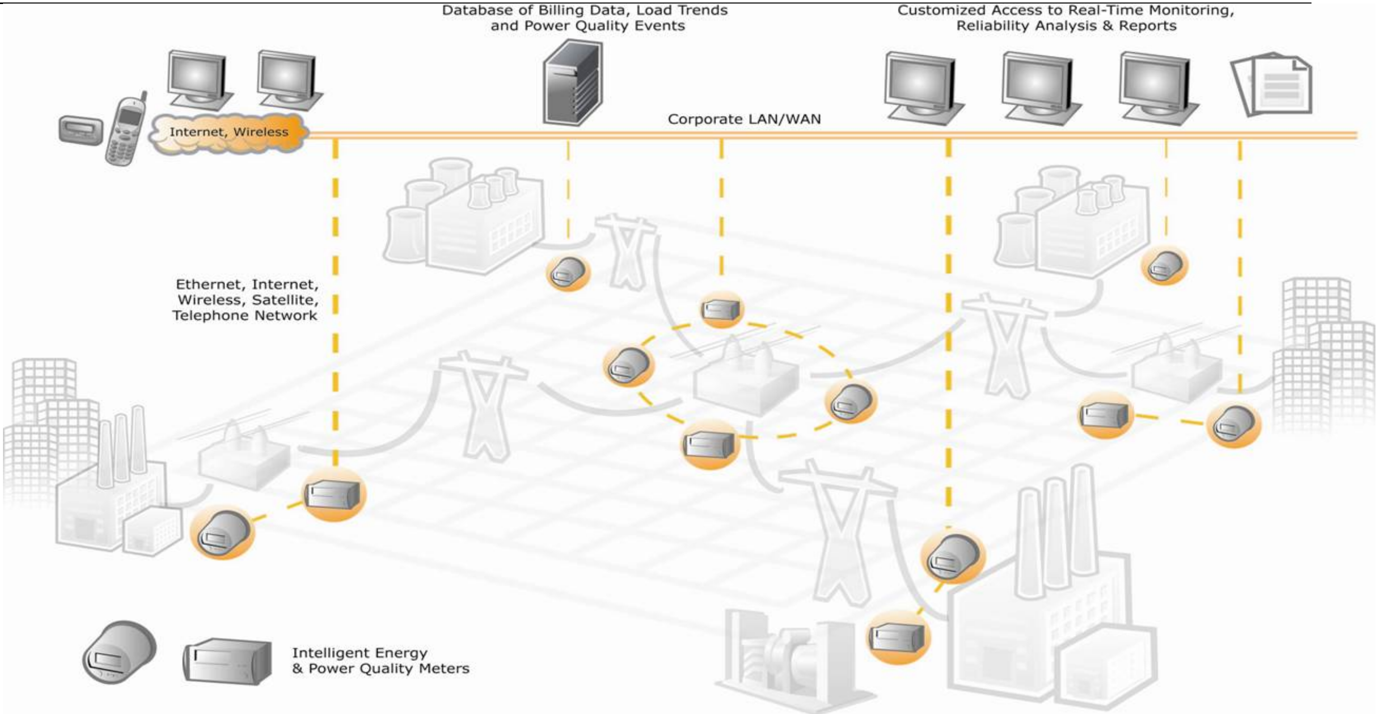
JEA decided to install a wide area power quality monitoring solution to ensure they were delivering the clean power required for a twenty-first century economy. Initially, the system was limited to monitoring equipment and data collection software. JEA quickly became aware that manually pouring through thousands of records generated by the power quality monitors was not efficient. Useful information was lost among the forest of waveforms and alarms. JEA decided to enhance the PQ monitoring system by installing a reporting tool that could roll up data based on known events, summarize statistics, and provide a dashboard view for multiple users based on a specific area of interest. An architecture for the system is shown below.

Hardware

At the writing of this paper, the hardware in the system consisted IEC 61000-4-30 Class A compliant power quality monitors located at interties between generation and transmission, transmission and distribution, and on large industrial sites. The monitors are ION7650 or ION8600 devices provided by Schneider Electric. Revenue data is also utilized for billing and SCADA purposes. The breakdown of total monitors is as follows: 17 Generation; 73 Transmission and Distribution; 92 Industrial

Communications

As with most systems utilized by electric utilities, the PQ system has grown and will grow over time. Availability of communications infrastructure varies with location and time of installation. One requirement for the system was to handle multiple forms of communication seamlessly while allowing for easy upgrade as new technologies were introduced. Today, JEA has devices communicating with software with multiple protocols and through multiple media simultaneously. For example, in the Distribution substation, a device will use DNP3.0 over Ethernet to communicate with SCADA while allowing a MODEM connection to the billing software, a GPRS connection to the Power Quality Analysis software, and serve as a gateway for SCADA to master local devices over a serial connection.

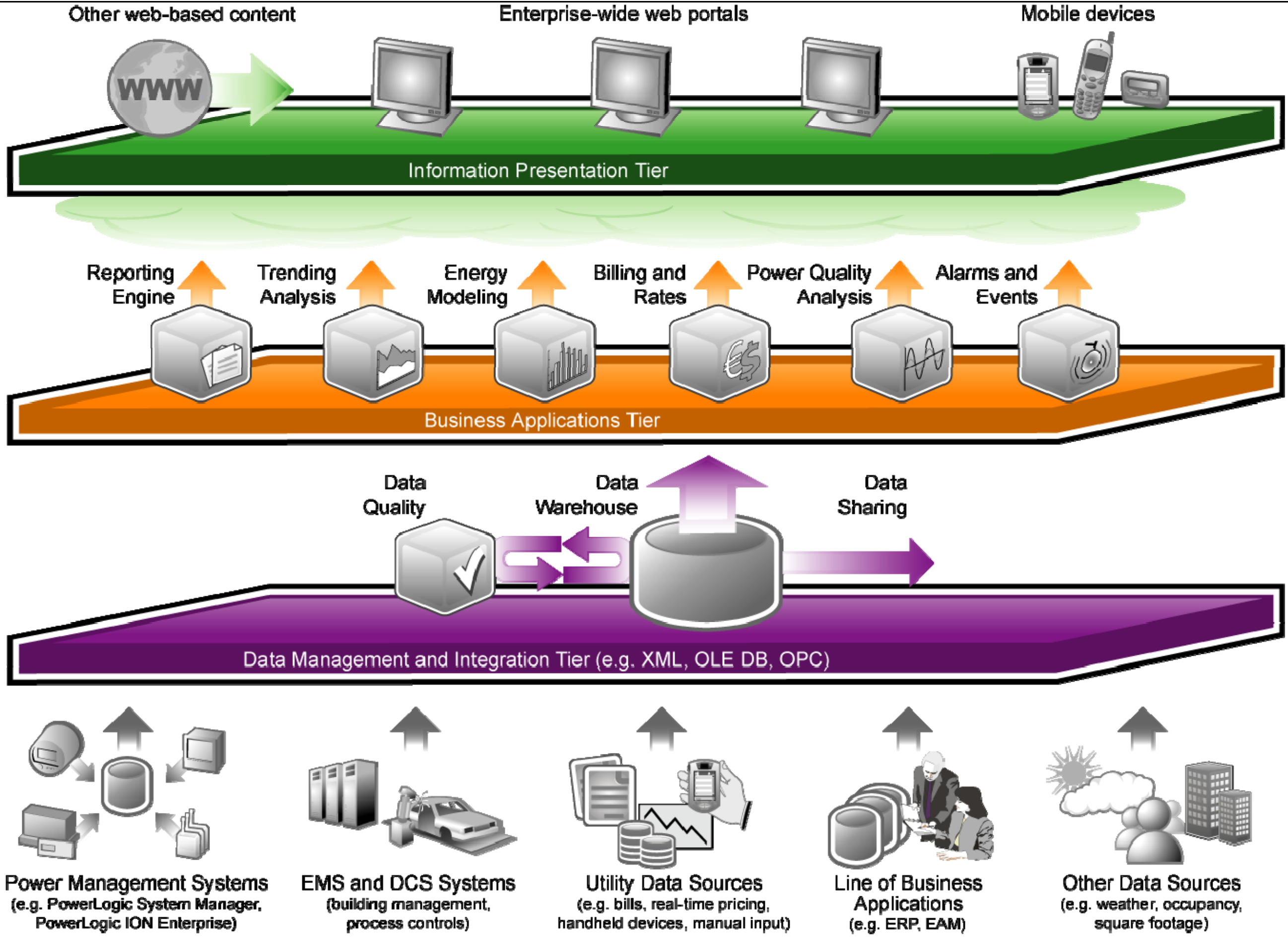


Software

Initially, the system consisted only of data collection software that allowed viewing and analysis of waveforms and data. Reporting existed but the system was dedicated to one vendor. Use of the system was limited to compliance monitoring for quality of supply and post-mortem analysis of problems. As the system grew, the ability of the reliability engineers at JEA to review all of the data and make decisions was restricted. Also, while the value of the system for customer service was meeting the intended ROI, JEA felt there were better uses for the data to make informed asset management decisions BEFORE there was a problem that caused an interruption.

Knowing that further growth of the system was certain, a requirement for the software was to be easily scalable from the current size to many hundreds of devices more. Also, an "open" platform was required, as JEA wanted to bring data from multiple sources into the system and to not be tied to one hardware vendor, one protocol, or one communication media. Understanding that different stakeholders in the utility needed to see the data in different ways, JEA required that the system allow configurable dashboard views over the web to allow users to see the data in a manner that helped them make decisions. These dashboards should include the ability to see the data in a geographical view, via the web, to run user-defined reports, to classify event data, and to perform analysis.

Simply presenting data is a common feature in many software packages and would not benefit JEA beyond the existing software they were using. The final requirement for the software was to have the system present information based on algorithms used by the JEA engineers. For instance, as the engineers classify events (tree, animal, lightning, etc) the engineers can see over time that more transients are being caused by trees and perhaps the line should be inspected. Another use is breaker timing analysis, the system can monitor the number of cycles for a breaker operation and alarm if the time is slowly increasing. Transformer monitoring is the application we will describe in more detail with a real benefit realized.



BENEFIT

While reviewing individual records before implementing the new software system, JEA engineers recognized an anomaly that required further investigation to understand. At the Northshore substation, the monitor on Transformer 1 was showing a loss of current on one phase for less than one cycle. The anomaly occurred several time per day. Figure 1 is an actual view of the waveform.

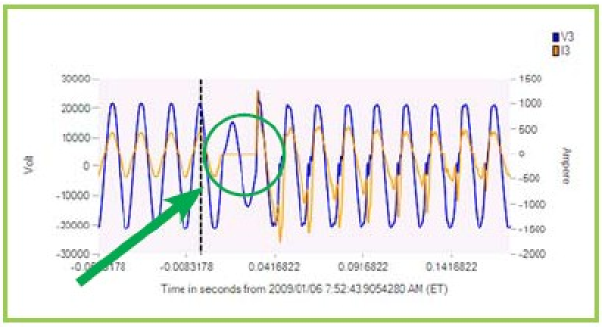


Figure 1: Captured disturbance waveform showing fault on Phase C (flat line) leading to the discovery of melting metal in tap changer.

Further analysis showed that the duration of the zero current was increasing over the several days the engineer monitored the situation. A maintenance outage was scheduled and technicians were sent to investigate the cause of the anomaly. When technicians inspected the load tap changer (LTC) on Transformer 1, they discovered a pin that was shearing and causing arcing during the travel of the LTC. Technicians believe the transformer would have been destroyed within two weeks if the arcing had not been detected and corrected.

After installing the new system, JEA configured the software to recognize and report anytime this signature was detected. Since then, 3 other instances have been detected and alarmed automatically leading to the prevention of the failure of 3 more large power transformers. JEA estimates the avoided cost of the transformer damage at four million US dollars.

CONCLUSION

JEA was aware that data overload was causing them to miss important information that could help them operate their electrical system more reliably, efficiently, and with greater quality of supply. A wide area power quality system was installed that had immediate benefits. Four power transformers were saved from failures due to damaged load tap changers and countless customer minutes interrupted were avoided. The productivity of the engineers has increased allowing them to spend more time on deeper analysis and creative solutions. What once took three days to analyse now takes 1 hour. JEA plans to find more signatures for detecting problems on high-value assets before they occur.