White Paper

A Smart Grid Solution to Non-Technical Loss

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QinetiQ
North America

LineWatch™
Powering Grid Awareness

A Smart Grid Solution to Non-Technical Loss

Introduction

In the United States, non-technical losses (theft and errors) are a *$6.5B per year* problem [1]. In developing countries, the situation is just as extreme—for example, *$5B* per *year* in Brazil [2]. This white paper describes a solution for non-technical losses that combines QinetiQ North America's (QNA) cost-effective LineWatch sensors with analytics from "big data" heavyweight EMC, in the process leveraging the existing communications backbone of Advanced Metering Infrastructure from suppliers like Itron.

LineWatch Sensors

Sensors augment residential meter reads by collecting upstream energy flow information needed to perform energy balance calculations with customer meters.

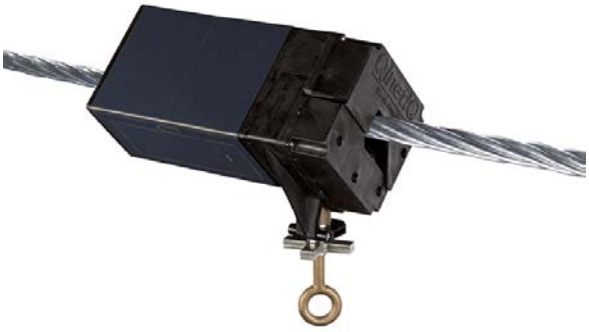


Figure 1: QNA LineWatch-M Medium Voltage Sensor directly monitors distribution feeders

Meters for this application need to have near revenue grade levels of accuracy in order to assure smaller thefts will not be lost in measurement errors. The sensor's total cost of ownership (initial cost, deployment cost and maintenance costs) must provide a compelling business case given that relatively broad deployment will be required to achieve the application objectives. Furthermore, the sensors should exploit existing communications infrastructure to reduce operational costs.

QNA's LineWatch sensors, pictured in Figures 1 and 2, have been designed to meet these requirements, with the theft detection use case as a defining requirement. Both of these sensors are certified as 1.0 class with respect to kWh measurement.

Figure 2: LineWatch-L Low Voltage Sensor monitors pole-mount and pad-mount

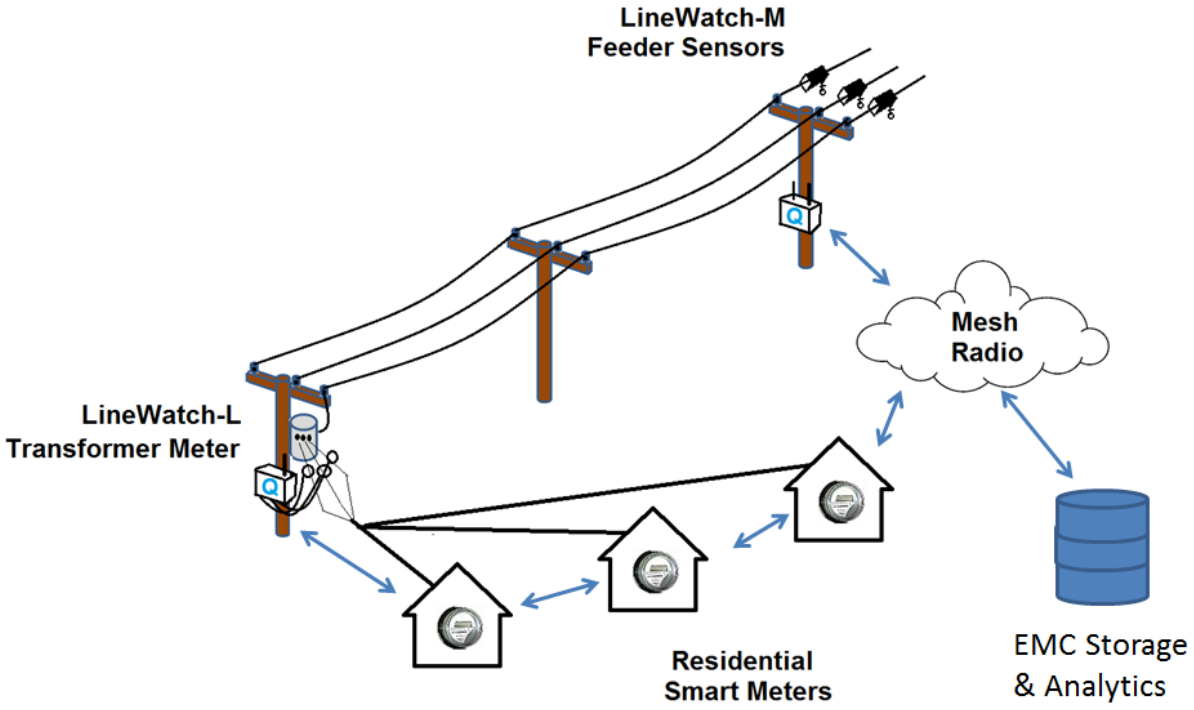
The LineWatch-M sensor installs directly on live medium voltage distribution lines via a hot stick. The sensors employ a novel method of capacitive voltage sensing that produces near revenue grade accuracies without a neutral connection, making installation easy, safe and fast while still meeting the needs for detecting non-technical losses. A complete three-phase installation takes about 45 minutes without service interruption to the customer.

The LineWatch-L sensor can install on either split phase or three-phase pole mount installation, or inside pad mount transformers. No additional current sensors are required—accurate Rogowski coils are built into the unit's integral clamps. Similar to the LineWatch-M product, the LineWatch-L meters are designed for rapid installation on live lines.

System Overview

The system has an essentially three-tiered measurement approach, as shown in Figure 3.

- LineWatch-M systems measure power flow along a medium voltage feeder. Direct measurement of power flow on the feeder facilitates the location of unauthorized taps on the feeder.
- LineWatch-L systems monitor the distribution transformers attached to the feeder. These measurements provide a basis for balancing the energy measured by AMI revenue meters downstream from the transformers.
- Existing AMI revenue meters supply localized measurements needed for energy balancing and other non-technical loss detection algorithms.



Where applicable, QNA's meters can use the existing AMI infrastructure. QNA's meters have been certified by Cisco for operation on their IPv6 Mesh Network, also used by Itron AMI Smart Meters. [3] If no compatible residential mesh infrastructure is in place, the LineWatch sensors can be delivered with integrated cellular routers.

The sensors can be polled at regular intervals to build up the data records needed to identify non-technical losses. QNA's sensor can communicate using DNP3 with Secure Authentication over either IPv4 or IPv6 networks using either a TCP/IP or UDP transport layer—this combination is compatible with many SCADA vendors. Alternatively, QNA can supply its Data Collection Engine (DCE). The DCE polls the LineWatch sensors at configurable intervals (nominally 15 minutes) and stores the results in an easily accessible standard database format. The data is available to other suppliers such as EMC for analytics and analysis. Lastly, the system is scalable to tens of thousands of sensors.

Energy Balance Analytics

Notionally, the idea behind identifying Energy Balancing is simple: add up all the energy going into and out of benchmark locations to find places where the energy does not total, or balance. However, practically implementing energy balancing is an involved undertaking. A detailed topological model of the distribution grid must be built and maintained so that the system can know which measurements should balance. A large volume of data must be received and processed from both QNA meters and residential meters. Balancing algorithms must take into account error sources like technical losses, temporary network communications issues, etc. The results must then be presented to system operators in a way that enables users to clearly visualize and investigate potential problem areas.

As shown below schematically in Figure 4, EMC has built a theft detection system that solves the hard practical issues, integrating location information and meter reads. The system also uses other algorithms in addition to energy balancing to identify anomalous behavior, *e.g.* comparing voltage drops at meter locations to expected line impedances to identify the presence of anomalous power draws. In the first few months of operation in a recent pilot installation, the EMC system has already identified a significant amount of non-technical losses.

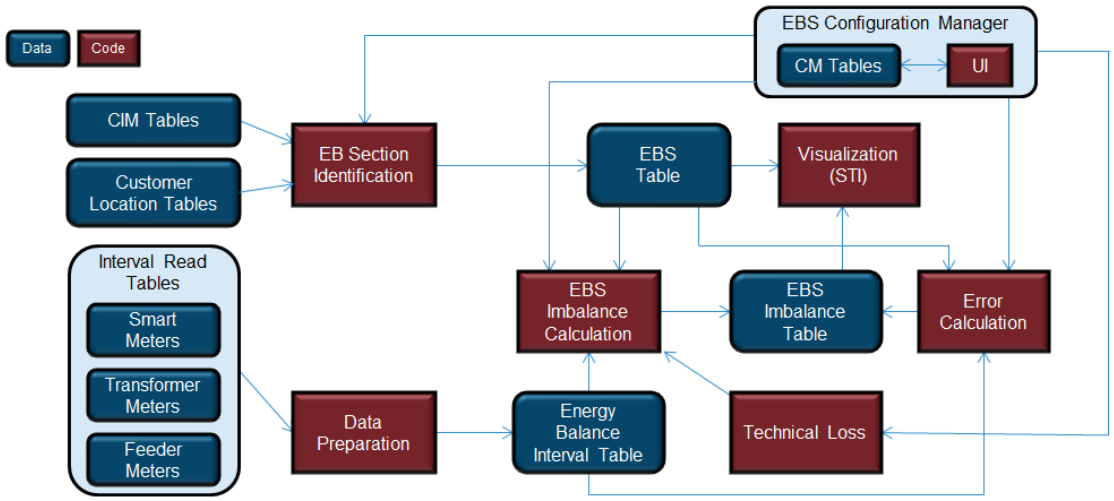


Figure 4: EMC Analytics combine vast repository of meter reads and location/connectivity information to identify and localize non-technical losses via Energy Balancing.

Conclusions

QinetiQ North America's LineWatch sensors, combined with powerful analytics from EMC, make a compelling mitigation to non-technical losses. The initial cost of this system is dwarfed by the potential revenue recovery gleaned by the elimination of theft and administrative errors as identified by the solution.

References

[1] "Advanced Metering Infrastructure Technology," EPRI Product ID: 1016049, Dec 8, 2008. http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001016049

[2] J. Deign, "Energy theft: Ending the toll from non-technical losses," *Smart Grid Update*, May 23, 2012. http://analysis.smartgridupdate.com/communication-data/energy-theft-ending-toll-non-technical-losses

[3] J. St. John, "Cisco adds distribution automation to its grid network," Greentech Grid, Jan. 21, 2014. http://www.greentechmedia.com/articles/read/cisco-adds-distribution-automation-to-its-grid-network

Company Background

QinetiQ North America is an engineering and technology development company. QNA maintains a staff of over 200 mechanical, electrical, thermal, chemical, nuclear, aerospace, software and materials engineers working in the areas of robotics, advanced materials, aerospace, homeland security, power systems, and transportation.

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