CASE STUDY

ELECTRICA SA

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Electrica SA, the Romanian electric power supply and distribution company, has undertaken a pilot programme that will help it go beyond the minimum European Union goal of installing smart meters in 80% of homes by 2020.

Working with Ormazabal, a provider of distribution smart grid solutions, and systems integrator Flashnet, Electrica is the first company in Eastern Europe to demonstrate how a smart grid system based on the Powerline Intelligent Metering Evolution (PRIME) standard will enable the utility to cost effectively connect it with its customers, assets, and acquire grid intelligence, using metering, sensing and communications solutions within a unified architecture.

THE PILOT PROGRAMME TAKES OFF

In mid-2010, Electrica decided to undertake its first smart grid pilot programme in Brasov, Romania. While the primary goal was to find a solution that would enable it to meet the European Union's regulations calling for 80% of consumers to have smart meters in their homes by 2020, Electrica was interested in deploying technology that went beyond metering. Ultimately the utility wanted to improve its connectivity with customers and assets and gain "actionable intelligence" to improve the reliability of the grid. The ultimate goal was to design a fully functioning smart grid system that would use medium voltage (MV) as a backhaul pipe, pulling voltage and current measurements to detect grid events on the low voltage (LV) lines and read meters using simple powerline communications (PLC) networking technologies. Ormazabal was selected as the vendor of choice based on its installations with PRIME technology, and Flashnet was the chosen system integrator based on its history of providing integration and implementation of public administration solutions within the telecommunications industry in Romania. Flashnet was able to leverage its experience in telecom by providing the backhaul communications and integrating the Ormazabal Smart Transformer Station (STS) solution within the network. The STS is a solution that gathers information from the grid and carries that information between substations and ultimately back to a central data centre. The first step in the process was to define the area where the pilot solution would be deployed – ideally an area that contained elements representative of a typical distribution network. Electrica identified an area that encompassed transformer stations covering approximately 5,000 residential and industrial customers in Brasov to test the smart grid solution.

Next came the planning phase, in which the companies aimed to create an intelligent distribution transformer station, in which the Ormazabal STS was selected. The solution would use a communications system based on the PRIME standard for reading meters, an IP-based backbone communications system using MV broadband over powerline (MV-BPL) network, and a comprehensive suite for sensing solutions to monitor grid information and events, as well as station monitoring for movement, humidity, temperature, smoke and flooding.

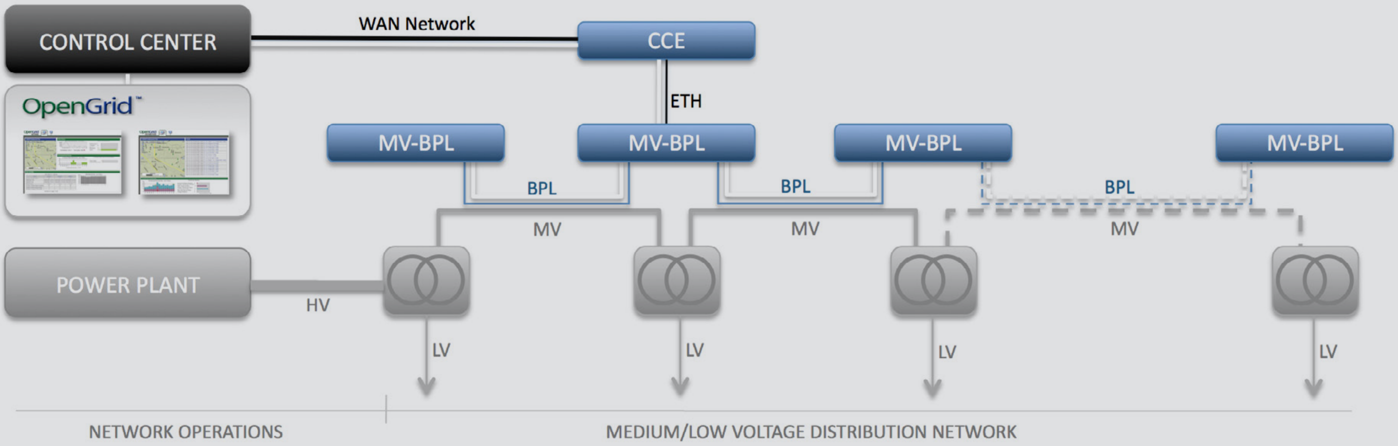

Figure 1 – Schematic of Electrica's MV connections

THE BENEFITS OF PRIME

PRIME is a standard-based, non-proprietary telecom solution that not only focuses on interoperable smart metering, but also provides a path to the smart grid using PLC to support communications even in complex electricity grids. Electrica and Flashnet chose PRIME because of the economics associated with its use and interoperability – it is the most cost effective solution that uses existing PLC infrastructure and can reach the largest number of homes, compared to other smart grid communications solutions. PRIME is already being used in Western Europe, and Electrica sought to demonstrate how this technology could work successfully in Eastern Europe.

So how does PRIME work? It defines PHY and MAC layers of a PLC narrowband data transmission system over the electric grid. The PRIME PHY layer is based on OFDM multiplexing in the CENELEC A band and reaches up to 130 kbps raw data rate. The PRIME specification also includes a convergence layer for integration of available protocols with PRIME. The convergence sublayer is comprised of a common part and a service specific part. Common part sublayer supports generic powerline specific adaptation functions such as segmentation and reassembly while the service specific part is defined for every protocol that needs to be integrated with PRIME. For example, there is a service specific layer for integrating IPv4 protocols and another one for integrating IEC 61334-4-32. It is likewise possible to define a service specific layer for IPv6, and the forthcoming release of the specification is expected to cover this. Meters and data concentrators using PRIME are inherently interoperable at the communications layer while protocols like DLMS/COSEM define the data transfer methodology.

THE ELECTRICA SMART GRID DESIGN

When designing this solution, Ormazabal and Flashnet decided to take advantage of the existing MV connections between Electrica's substations and deploy an IP-based BPL (Figure 1).

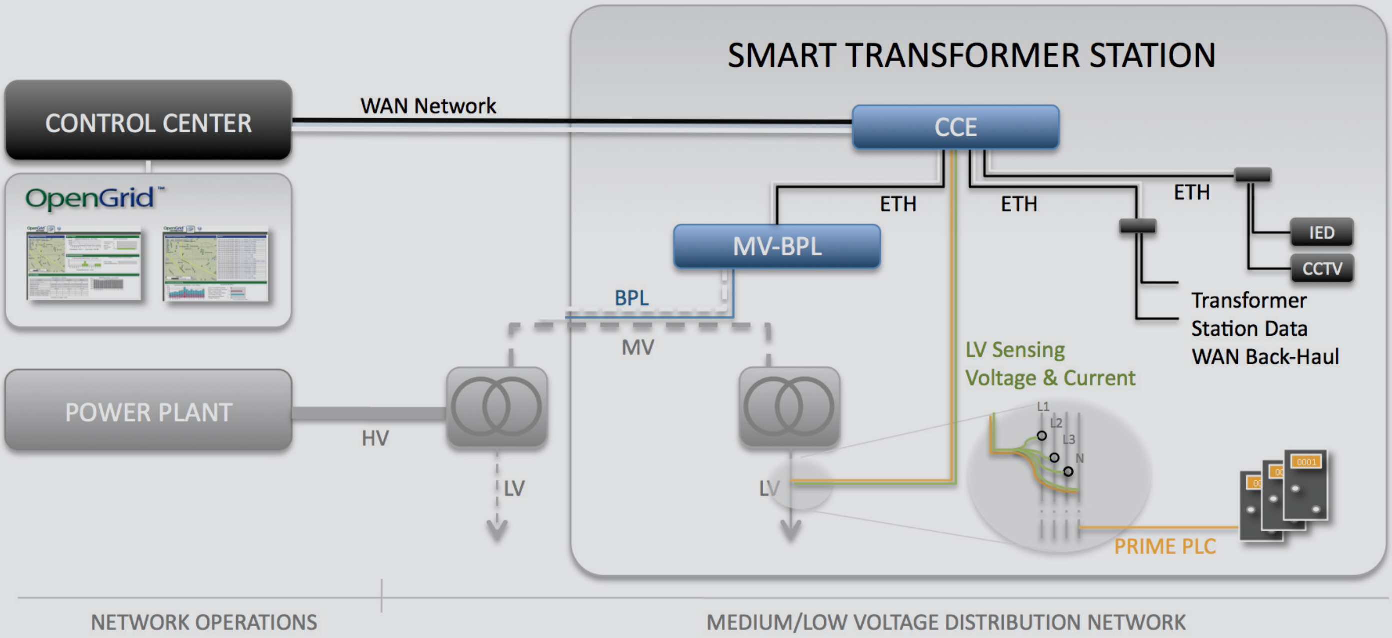

Figure 2 – Schematic of smart transformer station

CLOSING THE COMMUNICATIONS GAP

The most critical events on the grid require immediate recognition and response. Consequently, communications is an essential element to a smart grid deployment. To be most effective, the communications capability should provide a low latency link to the real time events being measured, such as system stability, equipment health, outages, faults, and demand response coordination and events. MV-BPL devices were installed in each of the designated substations, and are coupled onto the MV lines to establish a communications path with the device located in the adjacent substations. By using this architecture, Electrica does not need to overbuild a separate substation communications network using other technologies, such as general packet radio service (GPRS), ultimately saving future reoccurring operational expenses. This ultimately saves the utility money because additional communications infrastructure is not required.

Now, by having a cost effective network connecting substations, the smart grid design could include the ability of establishing a reliable central communications hub at one of the central station locations. All traffic from each substation would be transported to this location, aggregated, and then sent back to the data centre. This central communications hub further reduced costs for wide area network (WAN) backhaul – requiring just a single wireless link to the data centre, instead of separate wireless links from each substation. Within the substations, Electrica needed the ability to gather data from the grid in order to manage its assets, identify critical grid conditions and read individual meters, among other tasks. This is where the STS concept was further leveraged. At the central communications hub was placed a Ormazabal Communication and Connectivity Engine (CCE) with two functional modules, the station data concentrator (SDC) and low voltage analytics (LVA) (Figure 2).

The SDC is located in the distribution transformer station and functions as the gateway to meters and other in-premise devices. It acts as the head-end of the PRIME PLC system on each low voltage secondary, and also manages the higher layer advanced metering infrastructure (AMI) functions for each connected meter, including meter data collection, control and configuration. The SDC utilizes the PRIME communication technology to “talk” to PRIME modules located within the meters. With the LVA modules integrated into the CCE product, the STS delivers comprehensive sensing of the low voltage grid. The LVA solution offers advanced metrology capabilities, providing current, voltage and power (real, reactive and apparent) measurements, as well as advanced power quality measurements, such as THD and harmonic analysis. However, simply providing sensor data from a multitude of points can overwhelm a utility’s ability to process and make sense of the information to improve the reliability of the distribution system. True situational awareness cannot be achieved by simply collecting sensor data. Instead, a utility needs to be able to analyze the data and extract meaningful information from it. Through a combination of intelligent sensing solutions, edgebased software analytics and enterprise software analysis, the STS solution allows analysis to be located both centrally and at the point of sensing, giving Electrica distributed control and automation of present and future network activity, such as recloser operation, distributed generation control and demand response.

MOVING FORWARD

Electrica expects the next phase of this project to include installation of smart meters in all homes in Brasov, which is estimated to cost approximately €5-7 million. The ultimate goal is to extend this smart grid implementation to over one million of Electrica South Transylvania’s customers within the next 10 years. Electrica’s smart grid deployment demonstrates how European utility companies can meet regulatory mandates in a cost effective way, while gaining more actionable, real time intelligence from the grid to improve reliability and connectivity. Pilots like Electrica’s are important for a variety of reasons and serve as proof points to market viability of smart grid deployments in the Central and Eastern European (CEE) marketplace. Aside from clear government legislation that mandates better grid operations and incorporation of new technologies, the addition of renewable energy sources will create issues surrounding reliability in the grid that need to be managed on a real time basis. There will be a sharp increase in market growth, as well as demand for smart grid infrastructure solutions as noted by Frost & Sullivan in its report “Smart Meters Market: Electricity Demand Forecasts for CEE through 2017.” In addition to these findings, Frost & Sullivan suggests that a “…rising electricity demand in CEE regions has exceeded grid capacities. The grids’ modernization is limited in CEE countries and energy losses are high especially in countries such as Estonia and Romania (up to 10%). Utilities are looking at how to manage the grid properly and reduce electricity consumption among end-users.” While more work needs to be completed before a fully upgraded grid is achieved, the CEE market is clearly poised for growth. By investing in a unified solution that incorporates PRIME technology, leveraging existing MV power lines for communications, and recognizing the need for edge-based actionable intelligence gained through sensing, utilities will be able to deploy cost effective solutions that improve reliability and connectivity and make smart grid a reality in the European markets.

Figure 3 – Installed Sensors providing actionable intelligence