PROOF OF CONCEPT SMART METERING

Pol-Kumar Cuvelier
Sibelga - Belgium
pol.cuvelier@sibelga.be

Philippe Sommereyns
Sibelga - Belgium
philippe.sommereyns@sibelga.be

ABSTRACT

This paper outlines the smart metering proof of concept started in Belgium by Sibelga in 2008. The main goal is clarify the maturity of the new technologies involved: what can be included or not in a smart meter, is the technology strong enough to be deployed and achieve foreseen performances, can a "European" smart meter be easily used on the Belgian network, …

INTRODUCTION

New technologies such as Smart Metering, certainly deserve a great deal and attention, but it is advisable to analyze the advantages compared to the implied cost and the technical risks. It is important to make a good choice at the beginning, especially compared to the following points of attention: structure of the meter (capacity "IT"); communication: local and remote interface; media, protocol, safety and interoperability, the integration in the electricity networks. This is why Sibelga decided to examine more in details the problems of Smart Metering while launching a "Proof Of Concept". The goal is to acquire a concrete know-how, to validate a lot of assumptions: interworking, compatibility with networks, … The goal of the paper is to describe the approach of the proof of concept and to discuss the first results.

In the first part, we explain the general position of our project: technologically, economically and politically. Why use a "proof of concept" approach. Could we expect a clear go/no go signal to a roll out phase or should we wait for the next generation PLC communication?

To better acquire the knowledge, we decided to select three entire systems from three manufacturers. It gives us the possibility to compare different approaches: some uses DLMS/COSEM with narrow band transmission while others prefer wide band communication. The part section deals with these technical points, asking how one could manage the huge flow of information coming from the meter. Filters and statistical tools need to be developed to understand what happens behind the communication layer.

The third part treats the needs of a global flow from the meter to the front end. The system needs to be user friendly and all sub-parts need to be integrated. But for debugging and parametering the system, special tools are necessary. One point of view that is often forgotten is that behind this new communication architecture, there is a communication network that also needs tools to monitor, to simulate, and have critical security challenges.

The Belgian distribution network is quite different from other energy networks in Europe and reveals particularities that need special solutions. The last part describes two problems encountered in the filed test. Firstly, a large part of our network is a 3x230V without neutral. Knowing that the PLC signal is transmitted between one phase and the neutral, could the system work in this configuration without any adaptation? And secondly, some transformers are bi-voltage device (400V and 230V network on the output are used at the same time). For many manufacturers, only one data concentrator could be connected on the secondary of the transformer. Doing so, how should it be connected, and does it really work?

We conclude with the weaknesses and the strong points of the current solutions and give our vision on the future of the smart metering in Bruxelles.

PROOF OF CONCEPT

If we take a map of Europe and marking the countries that have rolled out, made a prove project or are preparing to do so, we see that the Smart Metering technology is widespread and mature. What do some countries or regions expect to launch Smart Metering? Here and there some argue that it will participate in solving tomorrow energy problems. When we have a closer look, it appears that reality is not that simple.

At the beginning of 2008, Sibelga, the distribution grid operator for gas and electricity in Bruxelles area in Belgium, started what we call a smart metering Proof Of Concept (PoC). The main goal of this PoC is to confront the current smart meter technology with the reality of the Belgian network and to reveal the difficulties and issues for a potential roll out.

As our goal is to acquire a nearly complete return of experience, we choose to select three different manufacturers and we ask them to give us a turnkey solution starting from the meter to the front end (management system). Doing this, we hope to obtain three functional systems that we can easily compare.

Two secondary goals are to test the interoperability and multi energies system, especially gas meter. For a mixed gas/electricity company like, it's mandatory to use both, otherwise a big part of the benefit will be lost.

Observations

Make some observations. In terms of reliability, it is very difficult to obtain specific and reliable data. There sometimes seems to be a willingness to distort reality. But the contacts we had, as well as the initial testing we have done show that the reality is different: for a PLC network, reliability is quite correct, at least for basic functions such as monthly statements or actions at a distance where a delay is acceptable. For GPRS, on the other hand, most of the elements we could gather, and field trials, showed that the reliability is lower than the PLC.

PLC

Manufacturers specify that a meter could be reached without any repetition up to 300m, bringing the maximum distance with 7 repetitions more or less at 2,5 km.

On a first site, we put 1 concentrator and 10 meters; distances between 100m up to 450m (from the concentrator).

In an ideal case we hope that nearly all meter are connected without any repetition and far meters with one repetition. But the reality is quite different and surprising.

The nearest meter communicates directly as expected. But in the other cases, when repetition is needed, the number of repetitions could easily achieve 5 and could frequently change on a day as shown on the below picture.

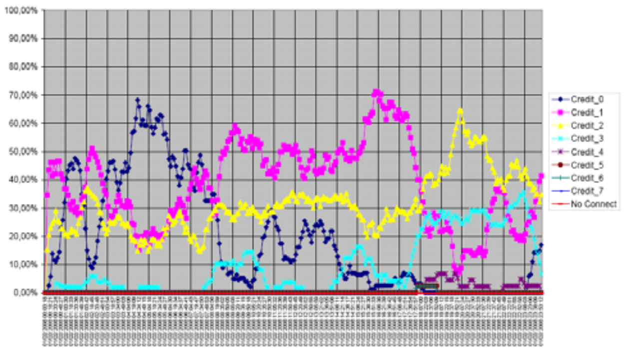

Figure 1 : Daily credit (repetition) for a meter

The communication life of a meter is not a long and peaceful river!

We also observe that the meter at a middle range (260m) has the worst communication.

It seems that the noise level on energy network is not constant and has a great impact. To illustrate this point, take a look at the picture below where we superpose the credit (repetition needed) history of a meter and the street lighting ignition and extinction (magenta curve).

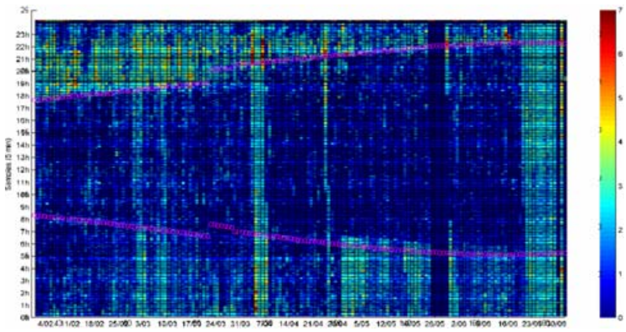

Figure 2 : Influence of street lighting noise

We see that, in this case, there is a strong correlation. This means that sources of noise need to be studied more deeply.

To conclude this point, there is a lot of unknown behavior of the communication path in the PLC network. Long term analyses are needed. We could also conclude that there is a lack of tools. None of our manufacturers in the PoC have developed tools to really analyse statistically the behavior of the PLC system.

GPRS

Although the GPRS is often used as intermediate between the concentrator and the front end, only a few communication characteristics are known. From our point of view there are two main points that need to be focused on.

The first one is the availability to check the connection when installing a meter or a concentrator. Some manufacturers propose to know the signal strength. But is it really enough? Of course it could be, but only when the connection is perfectly working. But we could establish that in the most cases there is a lack of tools to diagnose when you're confront to a failure. Even a simple ping message to test from the remote system to the network, to check the access point network is not always available and certainly makes the debugging difficult.

The second point is the quality of the signal. Usually, if you can read the index for a meter, the connection is labeled "working". But is it really enough to ensure all the functionalities? Some people are talking about smart grid and real-time operation. Is the GPRS connection enough available to fulfill these requirements?

As far as we know, only few measurements are done and are not adequate. We decide to measure the GPRS communications availability to answer this question. We use the simple ping command to test if the communication is working or not.

Since December 2008, we check the connection on 60 points. Today we can say that on our GPRS network, remote systems are available between 60% up to 99%, with an average of 94%. We notice that most of the systems have frequent short interruptions. Based on these measurements, we will calculate precise characteristics of the available time and the failure time.

Of course, long term measurements are needed to be statically acceptable. So the current results will be validated at the end of the PoC to know what functionalities could be used on our GPRS network.

Financial aspect

On the other hand we have to make a difference between smart meter and remote reading. Today when we talk about smart meter we mean smart meters, ie a system that uses intelligent measures and actions allowing remote (opening, closing functions, budget meters, etc.). It should be noted that many drivers or existing Roll out are often only the remote reading with no tariff duties. Today when we speak a Smart Meter, we think about more sophisticated functions in energy management.

In terms of Roll Out drivers, they greatly differ from one region to another. At Business case, they vary widely because the drivers are very different. In a number of cases where the smart meter is imposed, there is no positive business case. In other words, there is a tariff that allows the costs.

The financial aspects are very important. Making a Smart Meter roll out is a significant investment and the risk not covering the expenditure is far from negligible. Usually the installation of a smart meter impacts a change in pricing for the counting, an increasing of the tariffs. Those who believe that the costs will be covered by the reduction of costs in meter reading, manually to remote, are wrong.

In order limit the risk one could choose to use smart metering only for special cases: for example, social clients where a power limitation is applied. But using such strategy will compel to use a GPRS technology. The reason is that the PLC requires enough smart meters to be placed to guarantee the communication. The drawback of GPRS is a higher operational cost: in Belgium, it could be 3 times more than a PLC meter due to communication fee.

ANALYSIS PROBLEMS

As far as we have shared experiences with other distributors interested in the smart metering, there is a lack of tools to thoroughly analyse the behaviour of the communication flow. This is true for the PLC communication but also for the GPRS.

It is not easy to compare the communication efficiency between two manufacturers. The first difficulty is that the PLC communication technologies are different. Some are adept of a DLMS/COSEM narrow band transmission while others prefer to use a wide band technology; the bitrate can be fixed or dynamic, etc.

The two most important things when you talk about the efficiency of a communication media, is the real average bandwidth and the availability of the communication media.

We don't find an answer to our questions, so in our PoC we analyse the plc communication using internal tools.

The thing to keep in mind is that each repetition is equivalent to divide the theoretical bandwidth by the level of repetition. So for a meter with a credit of 7, the practical bandwidth is divided by 8, that makes only 12.5% of the theoretical bitrate.

This analysis requires special tools and will be further analyse in the next months.

THE NEED OF A GLOBAL FLOW

As we have seen in the previous part, the smart metering is composed of three main parts. The first is the historical and necessary part: the metrology! The second is the communication path from the meter to the front end. And the third is the management system. In fact, the first part is known and strongly regulated. But the second and the third one becomes more important when adding functionalities. With the smart meter, the communication network takes a challenging position.

Since the beginning of our experiments, we have noticed that it isn't so easy to start the entire flow. The team needs to be multi-disciplinary!

Talking about the smart metering flow is talking about an entire communication network. It becomes equivalent to a distributed sensors architecture that needs specialised tools to manage it.

Starting from the metering area, a complete and complex system like the smart meter seems to be new and not yet mature.

Our first impression is that all the current systems have been developed as a “deployed and functional” system. It means that most of the systems are functional and as long as everything is working fine. But what happens when there is an error in the communication path? Only few tools are available for debugging: making “a quick and good diagnostic” is nearly impossible. A good monitoring of events is required to highlight urgent actions.

It is, for sure, a point that needs to be focused on and keep in mind for future development.

Security

Another important aspect is the security. There are two directions where a distributor can focus on.

First there is the possibility that a user tries to hack his meter to change his consumption. And secondly is that the following: with the possible remote disconnection, a terrorist can cut the power of an entire city with a simple command.

These two cases require to look at the global security of the system: each sub-part needs to be secured with a predefined level.

Even if every manufacturer is aware of this problem, proposed solutions are not yet mature.

SPECIAL BELGIAN ISSUES

Besides the financial aspects, there are also a number of technical issues to solve that may have an indirect impact on costs. Belgium is particular in this regard. We detail below three significant technical problems to solve.

The first is that we still have (more than 50%) 230V networks with 3 wires. But in the PLC transmission, the communication uses the neutral as reference. It is therefore necessary to solve this technical problem, if we want to use a PLC system. From our initial testing done with manufacturers, it appears that solutions are possible. But, at least at this stage of our studies, a loss of efficiency is to be foreseen.

The second problem is that we have simplified the protection of connections since long: we have a connection breaker who is protecting the connection (network) and is also used for general protection (and switch) for the user. Moreover this protection is installed before the meter. In other words, when this breaker is off, there is no communication with the meter. It initially has a negative impact on the effectiveness of Smart Meter. Partly because in some cases, it is not possible to act remotely.

Third problem, since several years we have, standardized installation in a meter box. The reason is that it would simplify the wiring on the spot by the use of all pre-assembled circuit breaker, meter and remote control receiver. Generally one feature of the smart meter is to have a button for some functions (confirmation closure for example). This will impact the complication facilities of the smart meter, not forgetting the need for a connector to the local user.

CONCLUSIONS

Sibelga has started a smart metering Proof of Concept in 2008. This is the occasion to make the point about the technological limits of the current technologies and highlight the improvement needed for a real deployment.

The experiment is still going on to achieve relevant statistic analysis. But we can already focus on one result. Communication is a key point and is generally quite unknown. This is the reason why we make our own tests. It is shown that all the characteristics could significantly differ from the ideal cases. Depending on the foreseen functionalities, the PLC and GPRS network could fulfil the requirement or not. At the end of our study, we will be able to give quantitative values while currently only qualitative values are known.

Multi-energy and interoperability tests will be done in 2009. These two points are very important for a future deployment.

If you simply want to read meter indexes once a month and dispose of one week to do it, the PLC technology is strong enough for urban area. But this wouldn’t be the case for rural region where distance could be greater.

The GO/NO GO signal clearly depends on what you are expecting from the smart meter! But up to now, real time operations need more investigations on each part of the system.