INTEROPERABILITY OF AMI SYSTEMS

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ABSTRACT

Last decade brought important developments for the energy/power market all over the world [1]. In Europe, transforming local markets into regional energy markets is on the agenda[5]. The idea of EU Directive 72 [2] to develop Smart Metering systems for 80% of the customers raises some stakeholder responsibility and ICT (information and communication technology) issues. This article analyses actual stage in AMI (advanced metering infrastructure) development and advocates the need for a CDCO (Centralized Data and Communication Operator).

INTRODUCTION

The investigation in this paper is done within the context of regulation and standardization requirements that are in force now. With the market development, the volume of data handled and the way these data flows became more complex. Metering stakeholders as individuals or groups that are likely to affect or be affected by the data flows. Most of EU countries, Romania included, have a national metering system developer for the AMR systems. This operator deals with wholesale market.

For the retail market, each of the eight licensed distributors in Romania manages local dedicated systems AMR/AMI. The actors involved in AMI system interconnection are: the Metering Operator, the DSO, the Supplier and the Customer as could be seen in figure 1.

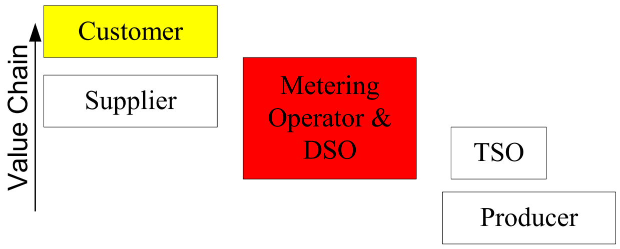

Figure 1 AMI interoperability actors

The domestic customer participates to the energy market through digital services. The Supplier and the customer are the ones to define and negotiate the way digital services are working based on metering data. As could be seen in figure 2, the development of digital services is based on the systems managed by the Metering operator (AMI and MDM). These systems feed also the DSO's WM (workforce mobility), DMS (distribution management system) and OMS (outage management system).

On the other hand, external parties, like the Supplier has to get the information from the DSO into the billing system. The customer (another essential stakeholder) interacts with the energy flows through CRM. It is obvious from the general system architecture (figure 2) that stakeholder’s interoperability is more than connecting systems together.

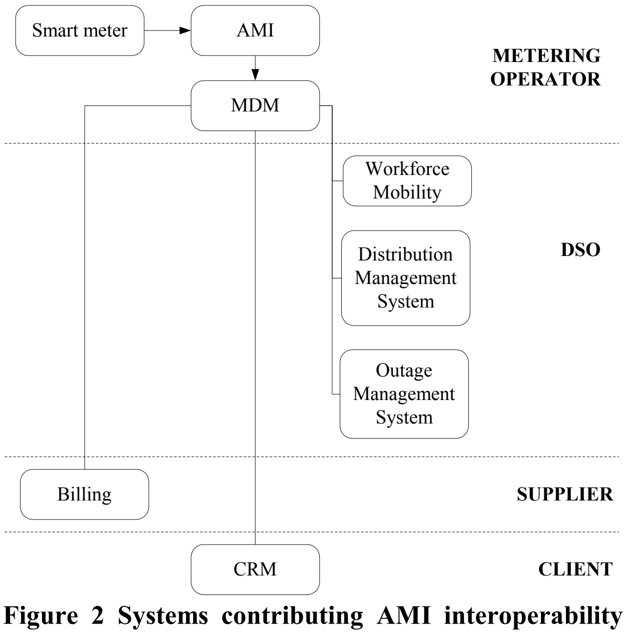

Figure 2 Systems contributing AMI interoperability problem

By interoperability usually is understood the ability of diverse systems and organizations to work together (inter-operate). In this paper, the concept is analysed in a broader sense taking into account social, political, and organizational factors that impact system to system performance.

AMI INTEROPERABILITY IN THE CONTEXT

OF THE ENERGY MARKET

The development of Smart Metering and AMI together with integrating energy markets at EU level is an action that has side impact to main actor(s) involvement and technical problem solving. A holistic analysis takes into account social, organizational and political aspects.

If we treat AMI system as a service delivering tool for the energy market, then we should use an interoperability model that takes into account three flows.

The main flow is the one dealing with energy. It goes from the producer to the customer and in between there are actors that were presented in figure 1. This flow follows the typical value chain [6] of the industry. The second flow is the one of the metered data. This flow allows the survey of the energy flow and supports the operational control for the balancing process. The money flow as the third one describes the economic impact of the energy trade/retail and enables the market. The three flows are interacting through existing systems to keep the market on. As presented in Figure 3, it is expected that energy flow changes determined by EU policy will have social impact. To manage the social impact it's obvious that some operational action should be taken and the results have to be measurable in terms of financials.

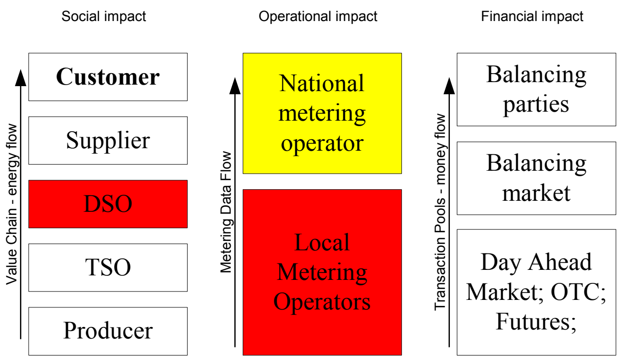

Figure 3 Interoperability concept applied to actual form of the market flows

The key concept about putting all the systems behind the three flows together is the interoperability as ability of diverse systems and organizations to work together (inter-operate). The term interoperability is often used in a technical systems engineering sense, or alternatively in a broad sense that allows survey, evaluation and enhancement of social, political, and organizational system performance. In our case, the simplest interoperability problem that needs to be solved during AMI developed was when unbundling was done. Separating Distributor from Supplier allowed the identification of more than 20 data exchange processes only for billing. Without MDM as presented in Figure 2 the solution was a complex one (**case A**).

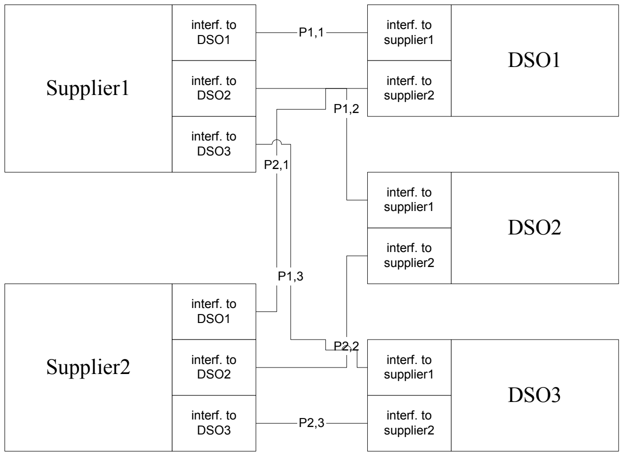

Figure 4 AMI Interoperability without Central data and communication operator

One level up in complexity of interoperability problems comes from the Customer Switching (CuS) process. This process involves two Suppliers, the Customer and the Distributor. Developing a standard model for CuS would be beneficial for well-functioning of retail markets. If an over-the-border extension of the electricity market is meant the common EU CuS model is a must. This means that systems have to be interoperable from the data root (AMI) (**case B**). Even higher complexity in interoperability could appear in the Balancing market. Scenarios of dispatched customers and renewable energy producers grouped over multiple distribution areas into one balancing party are analysed in FP7 projects [7,8,9] (**case C**).

A common enhancement to case A, case B and case C, interoperability problem could appear from comparing two architectures: One based on the principle of data delivery responsibility is associated with DSO's (figure 4); the other based on dedicated operator at national level [4] (figure 5). Central operator makes data transfer easier and allows better management of the data and communication processes.

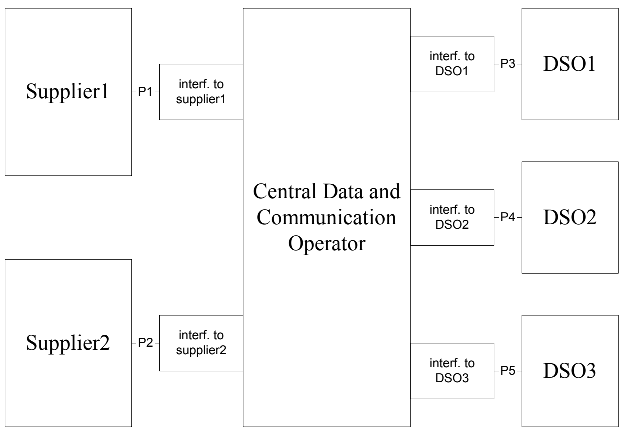

Figure 5 AMI Interoperability using CDCO

From the 12 interfaces needed for the architecture presented in figure 4 the use of CDCO lowers the need to 5 and from six data exchange process dealing with one to one communication we now have only five. As the number of DSO's and Suppliers increases, the efficiency of the CDCO

is more obvious. With CDCO, there are also advantages related to investment policy.
If we think at interoperability as a problem that has a syntactic solution we could rely on the architecture in figure 4. That means each of the systems involved are capable of communicating and exchanging data. For the syntactic level of interoperability the data formats and the communication protocols are fundamental. XML or SQL standards are among the tools of syntactic interoperability. This is also true for lower-level data formats, such as ensuring alphabetical characters are stored in a same variation of ASCII or a Unicode format (for English or international text) in all the communicating systems.
At the moment, there is no standard in force for AMI data exchange, and most of the vendors are promoting MDM like solutions for DSO system interfacing. On the long run, solutions inspired from SOA like MDM solve most of internal operator activities. The problem of syntactic interoperability is that the changes determined by regional market will affect more than one operator or category of operators and will lead the client to an active position to the market. More or less, the value chain of the industry is expected to change the way presented in figure 6. Parts of support services that already bring value to the client are the DR's facilitators and the HAN interfaces.

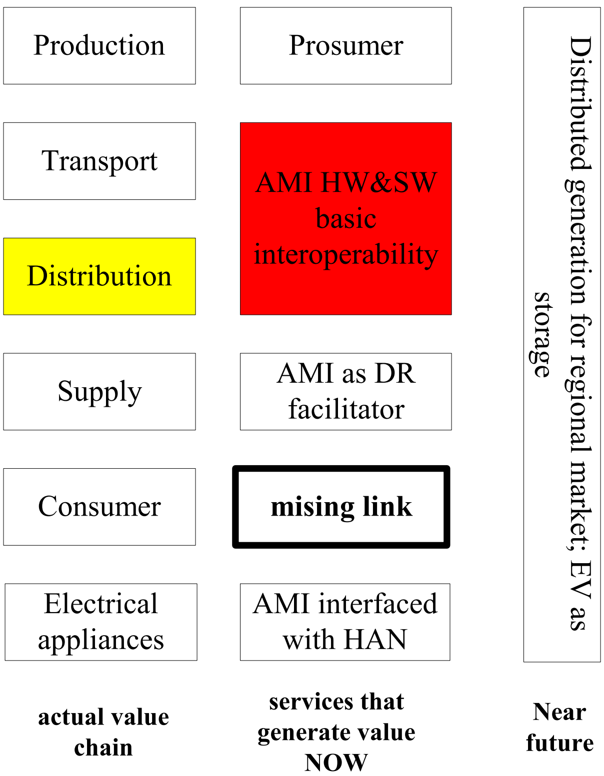

Figure 6 AMI interoperability in the context of value chain evolution

With architectures like the one in figure 4 is more or less difficult to make metering services part of value enablers for the customer. Some of the information that would be of use for the client like: reducing consumption or analysing outages could conflict DSO interest. Another argument to use a dedicated CDCO is that DSO is focused on data exchange, power wires and network stability since semantic interoperability is more than the ability of two or more computer systems to exchange data. Semantic interoperability needs to automatically interpret the information exchanged meaningfully and accurately in order to determine useful decisions as defined by the end users of both systems.

AMI IMPLEMENTATION THAT TAKE INTO ACOUNT SEMNATIC INTEROPERABILITY

Regarding utility meters AMR and AMI, one of the EU endeavours is to develop a standardised solution. The action started by adopting MID [10] and then asking from member states of 441 Mandate [11]. As a result the OPEN Meter project took place. Documents resulted from the investigation [12] were published and standardization requirements for the meters, the protocols and the communication channels were passed to CEN, CENELEC and ETSI. Since AMI systems that are currently fully covering the market like the ones in Italy, Sweden and Nederland's are in place, there is a risk of post-facto interoperability. This may evolve in market dominance of a particular product in contravention of any applicable standards. The main cause of this is that no effective standards were present at the time of that product's introduction. The vendor of the solution (meter +AMI) can then choose to ignore any forthcoming standards and not co-operate in any standardisation process at all.

Achieving interoperability with such a product is critical for any common energy market development. The good thing about actual AMI experiences is that it proved CDCO necessity. The bad thing is that the application in place is not really opened as interoperable at client level.
One real life approach close to CDCO architecture is the one of DECC [13]. Steps to follow from ground to promote such a service are:

- preparing consumer – update regulation, develop consumer engagement, learning what works best in the interest of the active client;
- developing smart metering system – technical specification, implementation, testing and trial of end to end interoperability
- data and communications – specification, licensing and procurement, testing and trial
- maintaining momentum – developing regulatory framework, complete installation, commercial interoperability measures, smart rental of meters.

When it comes to CDCO as licensed operator it's clear that a number of stages must be fulfilled:

- DSO's license discharge of license obligations
- Develop and maintain CDCO services
- Promote effective competition for CDCO
- Protect consumer interest through SLA
- Protect the security and privacy of data

- Provide services non-discriminatory

DECC approach avoids data access on discretionary basis and solves the problem of subtly altering or changing the product.

CONCLUSION

Developing AMI reaches sooner or later a stage that drives problems at market level. In order to correctly solve these problems with limited budget at acceptable quality level it is necessary to develop a national operator. The main task of such an operator is to deal with communication and data transmission from the meters to the interested parties. It is more or less clear that a unique operator could reduce at least the costs coming from interfaces development and of course since the system architecture is less complex improvements in reliability are expected.

CDCO Interoperability is achieved through five interrelated ways:

- Product testing with regard of a common standard
- Product engineering from the start
- Industry/community partnership
- Common technology and IP

The use of a common technology or IP may speed up and reduce complexity of interoperability by reducing variability between components from different sets of separately developed software products and thus allowing them to intercommunicate more readily.

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