AMR/AMI – AUTOMATIC METER READING & ADVANCED METERING INFRASTRUCTURE

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ABSTRACT

This paper deals with new methods of measurement in an electrical grid. The aim of the paper is to explain the way of distant measuring and shows the hardware solutions. AMR & AMI are very important parts of the smart grid concept.

KEYWORDS

AMR, AMI, Smart Grid, Wireless, ZigBee

1. INTRODUCTION

Currently, there is a big challenge in energy power systems and it's called Smart Grid implementation. It will take decades to fully implement such a complicated system like the Smart Grid. This is a big challenge not just for a few scientists but for thousands of people all around the world. Still, it is possible to split the issues into many particular problems which could be solved independently.

One of the sub-problem is advanced measuring infrastructure (AMI) or automatic meter reading (AMR) also called. AMI & AMR represents the way to get "online" data or information from the customers to provide higher efficiency in the grid. The customers themselves could be households as well as big industrial companies. The idea of the remote or distant measuring system is to send online information from the customers to the energy distributors to be able to react and control the whole network and provide higher quality of the energy. This helps to build a more reliable network and implement new ways of charging and pricing based on real-time data.

AMR involves many devices and protocols in the tool-chain. The tool-chain or data processing will be described more precisely later in this paper but basically AMR could be divided into three main segments. The first segment is the measuring at customer place. The second one is information transfer and the last one is data mining and processing at the distributor facility.

AMI represents the information infrastructure and communication channels which can be used for data transfer.

2. THE PRINCIPLE OF THE AMR

The principle of the AMR is based on an electronic way of value reading instead of a mechanical way of reading. There are many approaches to its implementation in reality.

Figure 1 shows almost all of these approaches on the solution by TI (Texas Instrument). It is an example for one phase but the measuring of the other phases is almost the same. It is obvious that the meter is composed of three main parts - metrology, processor and communication interface. Every single part of the system can be a very sophisticated and complicated electronic circuit. The metrology part has to convert the analog value to the digital value which could be digitally processed in the next step. The second part is the computing unit and its task is to manage algorithms, and communication. The last but not least part of the system, a communication interface, is important for smart technology, and smart metering.

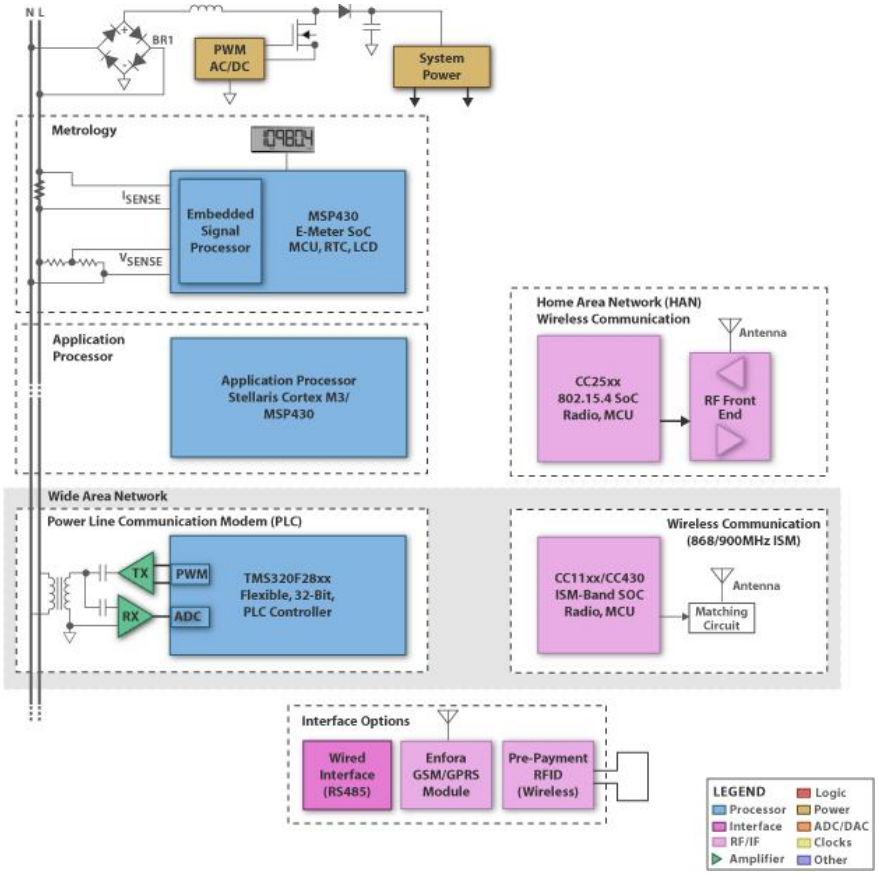

Figure 1 – AMR device principle (*source: Texas Instrument*)

Figure 1 also shows a lot of available communication interfaces such as RS485, GSM, RFID, Power Line or ZigBee. Currently, meters can be read manually. The drivers behind each choice are cost, existing infrastructure, and local regulations. In some cases the usage charge for a radio frequency band can be higher than the cost of manual reading, or the local grid may not support communication over the power line with complicated transformer bypass.

For AMR to become truly pervasive it needs to provide more than a reduction in meter reading costs. It must provide optimization for asset tracking, dynamic pricing, tamper notification, outage management, load profiling and network diagnostics. This drives the move from mechanical meters towards Static (electronic) meters for all major utilities (Electricity, Water, Gas, Heat).

3. AMI AND SYSTEM SYNERGY

When having AMR ready to use it is necessary to build information infrastructure which would be able to transfer the data to the utility company. This challenge is done via multiple approaches like GSM, Fiber Optic, and Wireless Network (ZigBee). Of course, many of these approaches are not suitable and sustainable.

3.1. IEEE 802.15.4 and ZigBee

Nowadays, a new technology is being tested in many countries all around the world. ZigBee and IEEE 802.15.4 standard seems to be very appropriate for AMI purpose. ZigBee has a self-healing ability and can be driven as a low power device. Moreover, ZigBee alliance defined a Smart Energy profile with many functions ready to use. This improves a lot the synergy of the systems.

ZigBee Smart Energy offers utilities and energy service providers secure, easy-to-use wireless home area networks (HAN) for managing energy. Smart Energy gives these groups and their

customers the power to directly communicate with thermostats and other smart appliances. New advanced metering and demand response programs can be implemented in homes easily and securely because of ZigBee wireless technology. Now utilities and energy service providers can easily implement energy management and efficiency programs to meet changing government requirements.

The ZigBee Alliance and the Home Plug Alliance have been working to define a wired and wireless version of Smart Energy. It includes insight to a variety of use cases including plug-in electric vehicle (PEV) charging, installation, configuration, firmware download for HAN devices, prepay services, user information and messaging, load control, demand response, and common information and application profile interfaces for wired and wireless HANs.

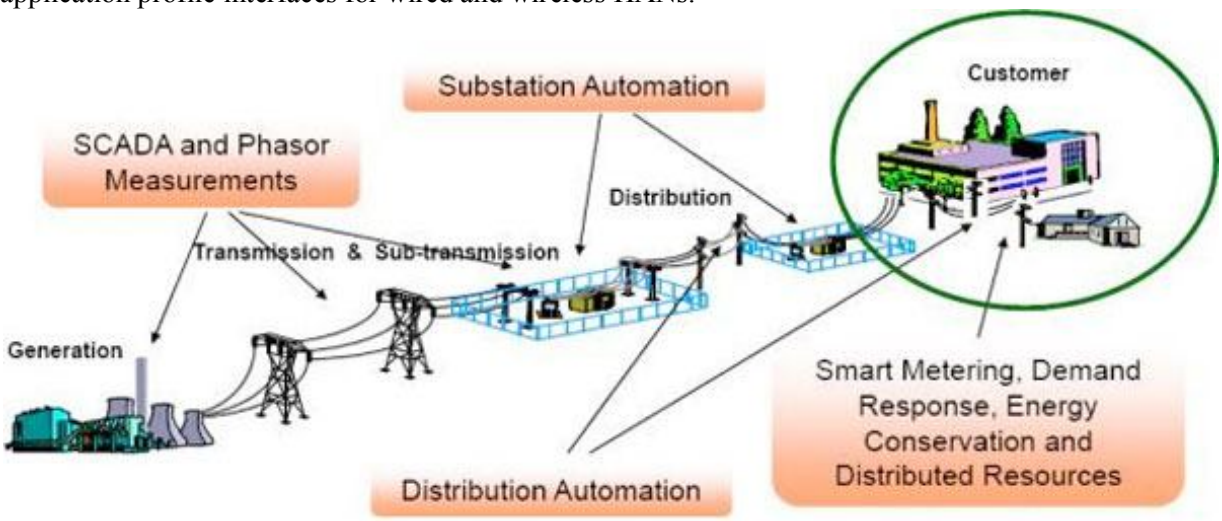

Figure 2 – Information flow (source: www.homeplug.org)

3.2. Development in Europe

North America has been a leader in technologies like ZigBee for a decade but now Europe has fully understood the importance of smart metering and especially wireless sensor networks. Due to this fact the European smart metering alliance (ESMA) was founded to coordinate different approaches. ESMA has been formed by a number of interested organizations with partial funding from the European Union's Intelligent Energy program. All companies or organizations with an interest in smart metering are invited to join the Alliance.

Another European group is called the European Smart Metering Industry Group (ESMIG) which recognises the fact that the relevant industries have a key role to play in Smart Metering technology. ESMIG gives advice and provides its expertise to key stakeholders and actors, such as the European Union institutions, EU Member States governments and authorities, regulators, consumers and utilities on all aspects related to Smart Metering.

3.3. Smart Utility Network (SUN)

IEEE is responsible for new standards releases. As IEEE 802.15.4 standard is a very new technology there are still many ideas and challenges how to get it better. In 2008 task group 4g was founded to start developing a new standard with the code name SUN. The role of IEEE 802.15 Smart Utility Networks (SUN) Task Group 4g is to create a PHY amendment to 802.15.4 to provide a global standard that facilitates very large scale process control applications such as the utility smart-grid network capable of supporting large, geographically diverse networks with minimal infrastructure, with potentially millions of fixed endpoints.

4. CONCLUSIONS

There has been huge progress in this technology during the last few years. The main issue is a complexity and the synergy of systems. The ZigBee technology seems to be very useful and robust enough for such application like the smart metering. Moreover, new studies and approaches show a big potential of wireless technology.

After a few of years of stagnation Europe is now getting ready to join the very last development and innovations in smart technologies. New groups and grants help to coordinate projects coordination and provide necessary information.

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