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Towards a smart grid Communication

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Abstract

Smart grids are one of the technological answers to the '3 x 20' objective of the 2020 climate and energy package of the European Union: 20% renewable energies, saving energy and reducing emissions green house gas. The effective insertion of the production of renewables of intermittent nature (wind and) photovoltaic) and new uses of electricity (heat pumps, electric vehicles...) in the electric system requires the design of equipment "smart', thanks to the new technologies of information and communication. [1, 2, 5)].

A major challenge is to be able to use five key technology area :Integrated Communications, sensing and measuring ,advanced components, advanced control methods, improved Interfaces and decision support in an industrial context demanding in terms of quality, safety, security and cost.

This paves the way for researchers to propose relevant and sustainable solutions.

This paper tries to focuss on the importance of Information and Communication Technology (ICT), which ensures a two way communications with a collection of secure and reliable data from sensors and meters located throughout the grid and transmitted directly to the grid operator's control room.

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Keywords: Smart Grid, ICT, WAN, NAN, HAN, AMR, communication Protocols

I. Introduction :

Many definitions and several viewpoints are given to explain what is a smart grid . One may define a

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smart grid as an electricity network that can intelligently integrate the actions of all users connected to it generators, consumers and those that do both , in order to efficiently deliver sustainable, economic and secure electricity supplies. This defintion is extended to include the means to trasform the electric production from a centralized producer- controlled network to a more consumer interactive one. [4,6]
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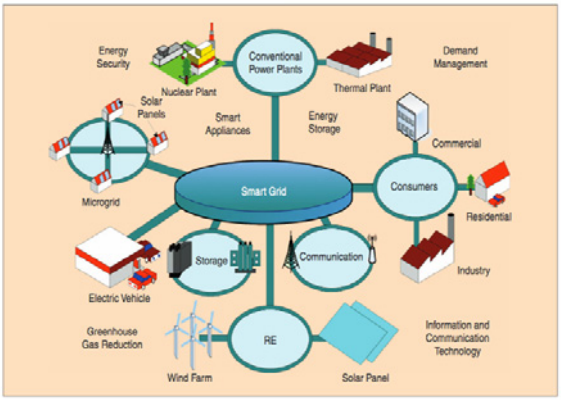

Figure 1 : The future electrical grid

II.ICT For Smart Grid

II.1 Conceptual model of Smart grid

Various efforts have been made regarding the standardization of smart grid communication. A number of organizations that are working on this : IEEE, International Electrotechnical Commission (IEC), and the National Institute of Standards and Technology (NIST). NIST has published standards include NIST 1108 (describes, among others, smart grid inter-operability and requirement of communication networks); and NIST 7628 (describes smart grid information securityissues). NIST has also proposed the Smart Grid conceptual Model which gives the characteristics, uses,behavior, interfaces requirements standards of the SG. [3]

This concept of smart energy encompasses a wide range of research issues : Distributed control , fault detection , prediction, grid stabilty and stability, data and communication, demand response.

Thus Smart Grid is a multidisciplinary area showing many chalenges. The next section is dedicated of one of these challenges : the communication infrastructure.

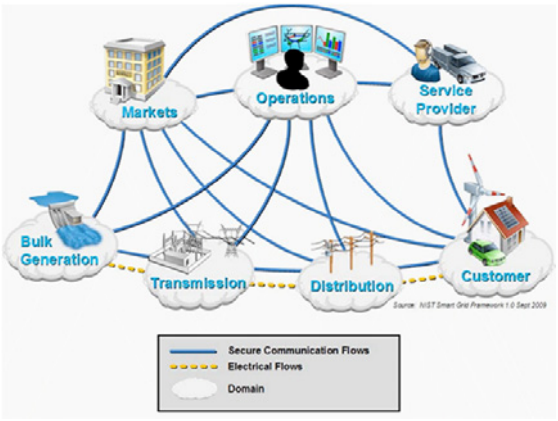

Figure 2 : Conceptual model of Smart Grid (source IEC)

II.2 Communications Structure for Smart Grids

Applying ICT to the grid is not obvious because it must deal with constraints that did not exist in automating the telecommunications network. Unlike the communications network, which routes packets of information, the electric grid routes power flows that have many constraints.

A Smart Grid communications infrastructure enables utilities to interact with devices on their electric grid as well as with users , distributed power generation and storage facilities. In order to satisfy the full concept of the Smart Grid, the communications structure has to be designed as a multilayer architecture that extends across the whole SG.It has also to cover a large geographical areas, consequently, the communications infrastructure of the SG should connect a large set of nodes of the entire region and utilities need to use and accept several networks:

- Wide Area Network (WAN) for automation, distribution and for covering long-haul distances by providing communication links between the NANs and the utility systems to transfer information
- Neighborhood Area Network (NAN) for connecting multiple HANs to local access points,
- Home area network (HAN) extends communication to end points within the end-user home or business.

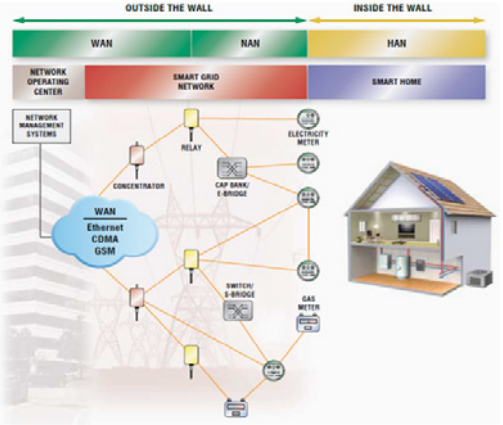

Figure 3 : The smart grid communications architecture

Each of the three networks is interconnected through a node or gateway: a concentrator between the WAN and NAN and an e-meter between the NAN and HAN. Each node communicates through the network with adjacent nodes.

Different communications technologies and protocols could be used depending on amount of data to be transmitted and of the transmission environments. In addition to the structure choice between wireless and powerline communications (PLC), there are a variety of wireless and PLC protocols , as it is shown in the following in three main regions.

Region	WAN	NAN	HAN
Europe	Cellular	G3-PLC,IEEE P 1901 ITU-T G.hnem, PRIME,WIFI	G3-PLC, HomePlug, ITU-T G tn, WIFI, Wirless M bus, ZigBee
North america	Cellular Wi MAX	G3-PLC, homePlug, IEEE 802.15.4g, IEEE P1901, ITU-T G.hnem, WIFI, proprietary wireles	G3-PLC, HOME PLUG, ITU-T G hn, WIFI, ZigBee, Z-Wave
China	Cellular Band Translated Wi MAX	G3-PLC, RS 485 Wirless to be determined	G3-PLC, RS 485 Wirless to be determined

Table 1: Smart grid communications protocols

- The WAN is the communications path between the grid operator and the concentrator. The WAN can be implemented over fiber or wireless media using Ethernet or cellular protocols, respectively. Cellular or WiMAX is most commonly used between the grid operator and theconcentrator.
- The NAN is the path between the concentrator and the meter. It uses either wireless or

PLC. Typically, the concentrator communicates with anywhere from a few to hundreds of meters, depending on the grid topology and the communications protocol used. NAN is mainly used for advanced metering appliations (AMI) and for consumer energy efficiency by managing all information between the WAN and the home area network using medium-voltage lines.

Today, there is no standard for this portion of the network, so most implementations use proprietary wireless or PLC technologies. Several standards bodies are currently working with utilities and technology providers to define Standards for wireless and PLC protocols. The IEEE 802.15.4g standard targets wireless; The IEEE P1901, OPEN meter, and ITU-T G.hnem standards are being developed for PLC.

- The HAN is used by utilities to extend the reach of their communication path to devices inside the house. This network can support functions such as cycling air conditioners, sharing consumption data with in-home displays. The HAN protocol is playing a key role with the arrival of electric/plug-in hybrid eletrical vehicles by using PLC protocols for communicating with vehicle charging systems. A HAN may also include peer to peer (P2P) communications between devices inside the house.

- RF communications Wireless communications is used in some areas for automated meter reading(AMR). Several proprietary and standardized wireless protocols are available today. Frequency bands of interest range from 200MHz to 3.9GHz.

- Powerline communications uses AC power lines as the transmission medium. Some systems, work over DC and cold wires as well. There are several powerline protocols in the market today. These protocols break down into one of two basic modulation schemes: frequency-shift keying (FSK) and Orthogonal Frequency-Division Multiplexing (OFDM).

- G3-PLC technology employs OFDM to optimize bandwidth utilization. Since OFDM uses multiple carriers to transmit data, interference at a specific frequency or frequency-selective attenuation can now effectively be eliminated. In addition to increased reliability, this capability allows Considerably more data to be sent.

- RS-485 bus architecture is used in harsh and noisy environments, such as industrial settings. This bus can be used to implement a low-cost, yet robust communication network. For instance, RS-485 can be used in an apartment building to transmit data from meters in each apartment to a central Unit that aggregates the data from the individual meters, which can then be read through a wireless or PLC link.

The following figure gives an example of a smart energy solution .

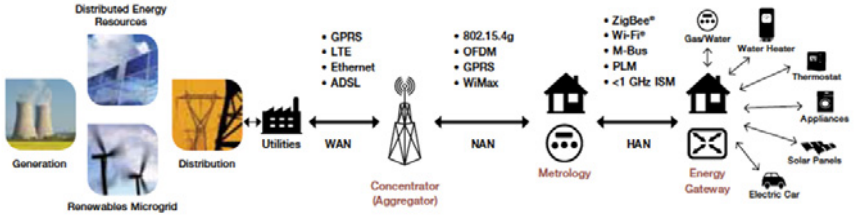

Figure 4 : A smart energy solution example

II.3 Smart Grid Communication challenges.

Sophisticated communication networks are added to the powerGrid to form a hybrid grid in which

power and communication have to work together. As it is shown in the following figure this hybrid grid requires a management and support system to guarantee reliability, safety and security. The main issue and challenge is that industry must learn quickly how to manage these networks effectively,. with the presence of millions of smart meters , network nodes and embedded communication devices added to existing systems. The result is a multilayer, multiprotocol communications network that incorporates various technologies such as wireless, fiber optics, Ethernet and ip. This means that the reliability, safety, security and costs of the power grid are becoming linked to how well the new communication networks are managed.

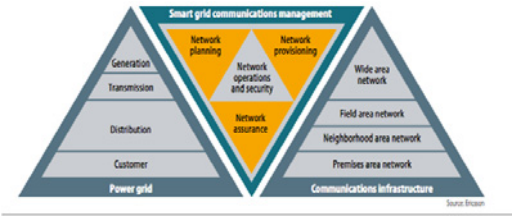

Figure 5 : SG communication management between power & communications parts

The solution to effectively managing this hybrid grid is to take profit of the telecom industry, by using the existing tools and exploiting the network knowledge. The telecom industry has developed a set of management systems that could be advantageously tused by the utilities. It is obvious that there is no one network structure that fits all solutions, that ensures, performance, low cost, security, so multi-technology communications networks are needed, and a proper network management software solutions are critical.

Conclusions

The short review about the main functions and components in the smart grid has clearly pointed out the need for reliable, secure and timely communication and data exchange. This aspect poses great challenges in evolving from the current control and protection systems deployed in energy grids to new communication frameworks tailored to the requirements of smart grids.

Despite the large number of studies concerning the identification of such requirements and the inventory of available standards and technologies, there is currently no definitive agreement about common reference architecture and standards.

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