Network Architecture of Smart Metering basing on Zigbee Sensors Network

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***Abstract*—Intelligence in electrical network refers to the capacity to watch and to control diverse industrial devices in order to supply the optimal power production. The control and the acquisition of the data resulting from various sensors are made from SCADA via communication infrastructures throughout the power supply railing.**

The smart grid will require a supple and effective frame to assure a precise information collect from diverse places within the electrical network at the appropriate time in order to supply a continuous and reliable network functioning. This functioning rely on the communication, which will play an important role in the future of the intelligent network.

In this paper we will present a new architecture of data collection from domicil meters based on a network of Zigbee sensors in the aim to connect the meters in various buildings.

***Keywords*—— Smart grid; intelligent sensors; Zigbee sensors network**

I. INTRODUCTION

The progress of Science and the Technology contributed to an economy that depends more than ever on electrical energy. Consequently, the evolution of the information technology result on a parallel development of the intelligent network. Hence, the improvement of the traditional electrical network in order to answer various requirements in particular the possibility of integrating the renewable energies by allowing the electricity to circulate in both directions.

The concept of SG aims to create a sophisticated system by integrating the information technology and the infrastructure of communication into the electrical existing system in order to exploit effectively the means of energy production and maximize the integration of renewable resources. To do so, a global and in real-time acquisition of all the measures on the electric railing. It is in this context that is situated the smart metering system.

The key element of smart grid evolution rests on the intelligent meters that allow the immediate exploitation of the measures supplied to an exploitation gateway for a reliable and real interaction between the customers and the energy supplier, including collections, storage and analysis of the measures. [1, 2]

II. SMART GRID

A traditional electrical network allows essentially the production, the transmission, the distribution and the control of electricity. However, an intelligent electrical network is used to improve the efficiency, the durability, the flexibility, the reliability and the safety of the electrical system by allowing the supervision, the control and the automaticity of the network. Besides, an intelligent electrical network opens to new applications such as the capacity to integrate, in complete safety, more decentralized renewable energy sources, electric vehicles and generators distributed throughout the network. It's allows the consumers to have a better control over their consumption of electricity and to participate actively in the electricity market. [3, 4]

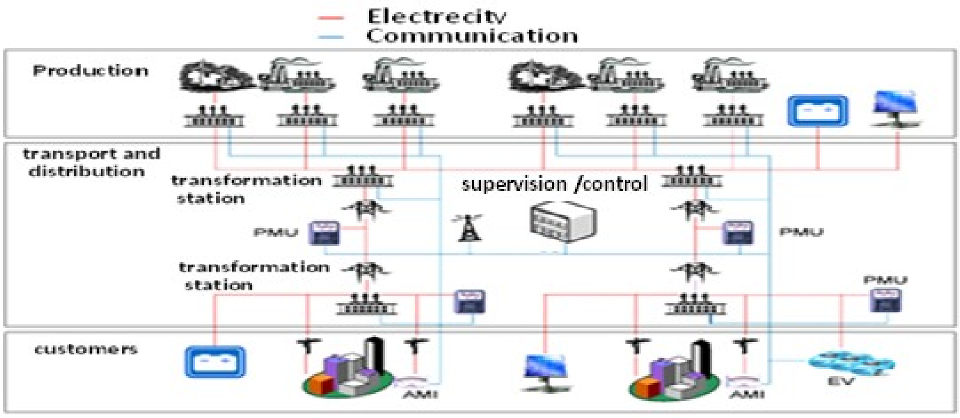

Fig I. Architecture of the electrical network and the communication network in a SG

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III. Smart Meters

The intelligent counting is the most important mechanism used in the SG to obtain information from the end users' devices. The smart meter is generally an electricity meter which registers the consumption in intervals of one hour or less and sends this information at least every day to the public service for follow-ups and of invoicing.

A smart meter has the capacity to disconnect and reconnect at distance and to control user devices to manage future requests of the "smart-home". Also, it allows the analysis of the energy consumption and the program of decision, to guide the users toward rational use of electricity and to reach information, the interaction and the capacity of the intelligent meters bases on the bidirectional communication of data by allowing to collect information concerning reinjected electricity in the electrical network of customers premises. [5, 6, 7, 8]

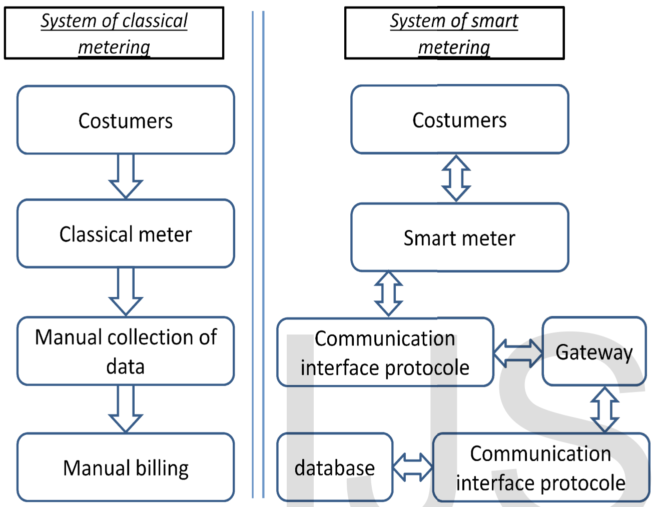

Fig II. The difference between the system of classic counting and the smart metering communication

IV. Communication

The construction of the information collection system of the energy consumption involves many equipment and technology, including intelligent meters, communication tools.

An intelligent counting communication system consists of the following elements:

- Smart Meters: which are devices of bidirectional communication, which measures energy consumption of electrical devices.
- Data transport network: which transports the measured data towards controls centers such as optical fiber , the interface of wireless private network, GPRS/CDMA Zigbee interfaces
- The gateway: the device, which collects or measures information of customers' energy use.

Meters have to be able of sending information to the central control system of the railing in order to allow for the necessary adjustments for the system to take place. There are four main challenges with the communication layer of an intelligent network:

- The architecture of the network: several communication architectures can be set up for intelligent network
- The bandwidth: the bandwidth can disable the bidirectional communication, necessary for the intelligent network. This problem can be solved by increasing the bandwidth.
- The interoperability: in a smart grid, all the communicating components must be able of communicating correctly and effectively.
- The growth of the quantity of data exchanged between the intelligent devices. [9, 10, 11, 12, 13]

TABLE I. Comparison between wireless communication medium in a SG

Comparison between wireless communication medium in a SG Standard/protocol	Rate of data	Range
Z-Wave	40 kbps	Until 30 m
Bluetooth 802.15.1	721 kbps	Until 100 m
Zigbee	250 kbps	Until 100 m
Zigbee pro	250 kbps	Until 1600 m
WiFI 802.11x	2-600 Mbps	Until 100
WiMax 802.16	75 Mbps	Until 50 km
2G	14.4 kbps	Until 50 km
2.5G	144 kbps	-
3G	2 Mbps	-
3.5G	14 Mbps	-
4G	100 Mbps	-
Internet satellitaire	1 Mbps	100-6000 km
IEEE 802.22 WRAN	18 Mbps	30-100 km

V. Sensors Network

Sensors network can be defined as a network of small devices, called sensors' nodes, they are devices equipped with a processor, a radio interface, an analog-to-digital converter, sensors, memory and power supply. The sensors are distributed within the network to communicate information collected on a ground watched by wireless connections. The data collected by the various nodes are sent to a receiver which uses the data locally or is connected with other networks

The routing of data in an intelligent network will depend on different technologies such as PLC, communication with optical fibers, wireless fibers cellular, Zigbee technologies of the communication, WIFI, and WiMAX. The WSN technology offers numerous advantages in comparison with the classic networks, such as low cost, continuous evolution, reliability, precision, flexibility and the ease of deployment which allow their use in a wide range of diverse applications.

The sensors technology becomes more intelligent, smaller and cheaper, billions of wireless sensors are spread in numerous applications. Some of the potential application fields are military, environment, health and safety. [8, 10, 14, 15]

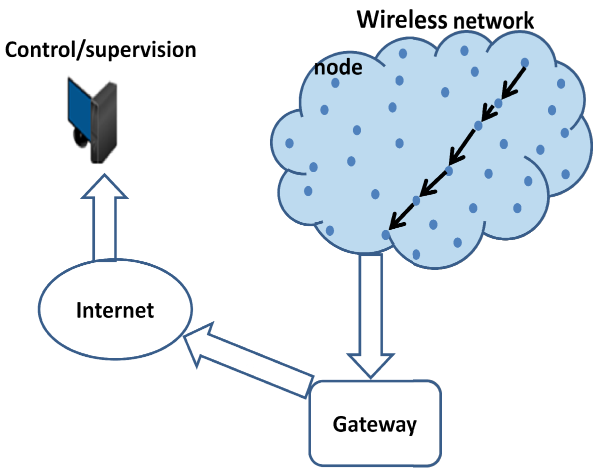

Figure III. Wireless network Zigbee

VI. ZIGBEE

Zigbee is a high-level protocol allowing the communication of small radios based on the standard IEEE802.15.4 of the IEEE family of standards for physical layers and connections, the standard is conceived for applications with requirements including low data flow, low power, short-range of transmission and low-cost

The application profile of Zigbee includes the home automation, the supervision of the industrial installations, the commercial smart building, the smart metering, the business of telecommunications, the networks of wireless sensors, the personal networks and region of origin.

Three types of frequencies are possible for the Zigbee signal:

- 868-868.6 MHz (Europe)
- 902-928 MHz (North America)
- 2400-2483.5 MHz (International)

The physical layer 2.4GHz uses the modulation Q-QPSK, while 780/868 / 915MHz uses BPSK. The nominal radio debits of data on these three frequency bands are 20kbps, 40kbps, and 250kbps. [6, 8, 16]

VII. ARCHITECTURE OF THE PROPOSED NETWORK

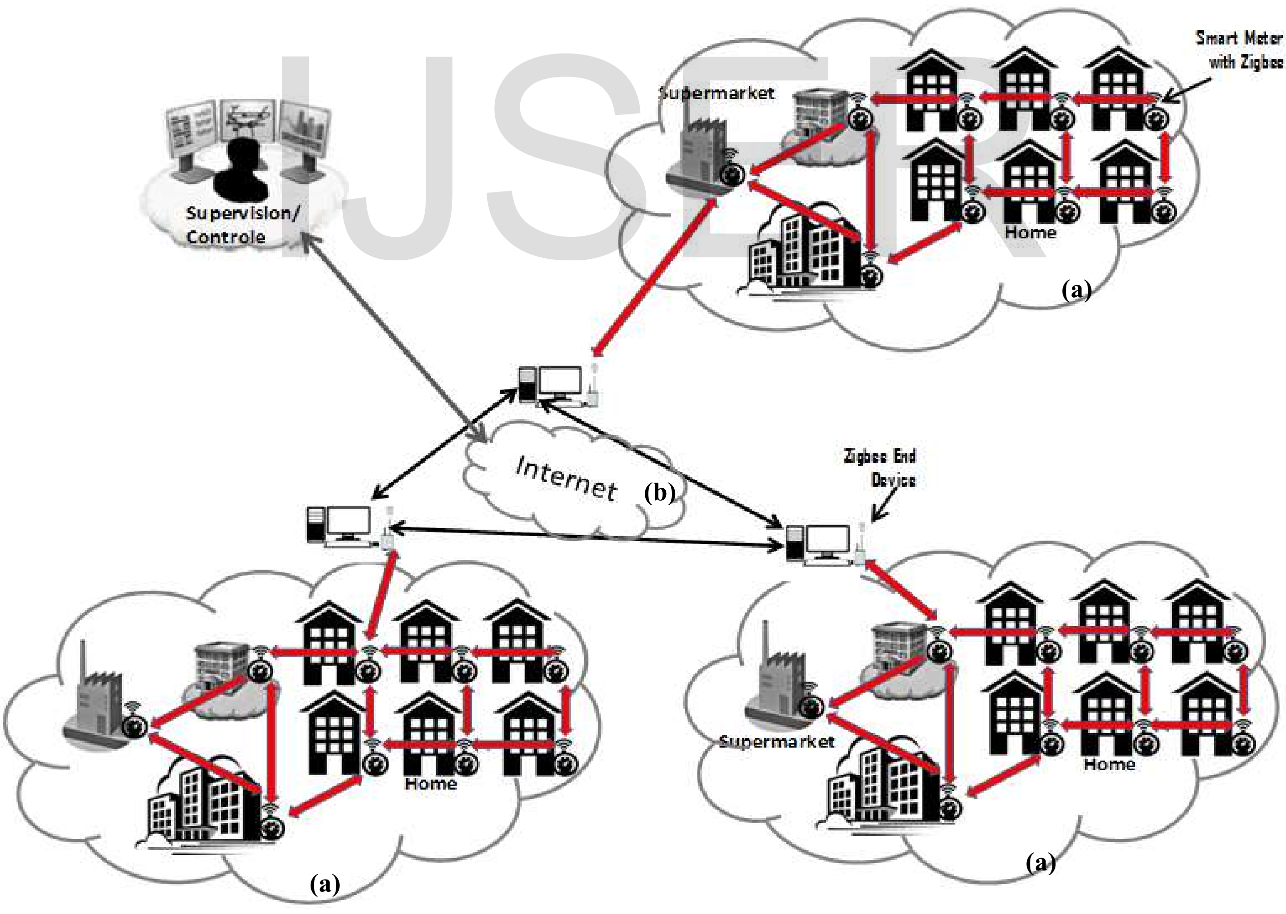

Figure IV. Proposed architecture for smart metering basing on Zigbee

In this work, we propose a new network architecture of the intelligent meters the objective of which is to conceive non-specialized architecture allowing to connect smart meters in various buildings by forming a data transfer cloud via Zigbee radio cards.

The formed network consists of a set of nodes (meters), every node has the capacity to transmit the data to the end-node (Sink) by passing in transit the data transferred by intermediary nodes. The end-node (Sink), connected to internet network, will forward the data to the supervision and control center.

Our architecture consists of three main entities represented on Fig 4:

- The cloud (a) which represents the network between the intelligent meters.
- The cloud (b) represents the internet network and its link with the cloud via the end-node (SINK).
- In the third entity, the data transmitted from different meters are collected and then exploited for the supervision and control of the network devices.

I. Conclusion

In this paper, we approached the technology of the intelligent meters and its positioning on smart grid. We approached at the same time sensor's network in the smart grid, and more exactly its strong employability in the intelligent counting.

In the work which follows we are going to validate the feasibility of the proposed architecture and test the conditions of use of the network architecture which will be formed by hundreds of knots which present systematically electricity meters customers.

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