Energy Management in the nodes of telecommunications network systems

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Abstract: - Currently there is a significant increase in energy consumption, due to the use of electronic devices, at the same time the use of renewable energy has grown to reduce the impact of greenhouse gases. Therefore, the importance of implementing energy management in telecommunications networks to reduce costs and negative environmental impacts. So in this article we propose the implementation of an intelligent EMS architecture for telecommunications networks with the use of ZigBee and communication and data transfer elements. In addition, it has a server that collects and calculates energy generation and consumption data to establish usage and purchase patterns and creates useful information for statistical analysis. Finally, it is expected that this scheme will optimize the energy of the telecommunications network and result in energy savings

Key-Words: elecommunications, renewable energy, management, energy, energy efficiency, reduction of costs

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1 Introduction

The normalization of the use of ICT has implied a significant increase in the energy footprint [1]. According to Van Heddeghem et. al (2007), energy suppliers record a growth in electricity consumption from 160 TWh/year in 2007 to 259 TWH/year in 2012. Likewise, Gelenbe and Caseau (2015) point out that consumption related to ICT , represents 4.7% worldwide, despite the fact that more efficient ICT technologies are developed every year, considering energy savings, but it is not considered sufficient to reverse the trend of growth in the energy footprint, causing ICTs are responsible for 23% of global greenhouse gas emissions in 2030 [4].

Likewise according to Ejaz et. al (2017), the use of internet devices increases exponentially and consequently the demand for energy. So, energy efficiency and the useful life of the devices are important factors to reduce the environmental impact [6]. Kim et. to the (2014), states that the energy management design is directly related to the energy collection capacity, whether solar, wind, vibrational, thermal or produced by radio waves.

Ulukus et. al (2015), establishes that the energy harvesting capability directly involves the network protocol design, leading to harvesting-aware solutions to problems such as: topology control [9], routing [10], control access [11], transmission policies [12], management control based on programming [13], data cycles [14] and admission control [15].

Tan et al. (2015) describes that the formation of links between nodes depends on the available resources and energy, because long distance links require greater energy transmission. On the other hand, Hieu et al. (2016) points out that adequate energy management must consider residual energy, produced energy and link quality. Despite the importance of energy management, in relation to the use of ICT and its negative impact on the environment, it is a topic that has been very little researched, limiting the information for making policies and/ or strategies to improve energy management, especially in telecommunications networks. So, we propose to evaluate energy management in nodes for intelligent telecommunications networks. For which a scheme is developed that considers energy consumption, based on a ZigBee and a solar energy Gateway. Applying an energy management system (EMS) architecture, developed by Han et al. (2014), which considers both energy consumption and generation.

According to [26-27], distributed generation will be a factor that facilitates the gradual migration from a conventional generation system to a renewable energy scheme, so Fig. 1 shows the areas for energy intervention. Zou et al. (2016), considers solar energy production for the future, for which it proposes routing and grouping algorithms of nodes, with the aim of making data transmission more efficient and optimal. Likewise, Saleem et al. (2016), states that energy prediction allows the use of an energy management scheme to maximize its performance. According to Qureshi et al. (2017), having an adequate scheme for energy prediction makes it possible to improve the energy management of available resources and gives rise to establishing improved protocols to have an efficient energy supply system. This article is an extension of energy management in telecommunications networks, for which the document is divided into sections to describe the problem, the results and conclusions of the article.

2 Problem Formulation

2.1 System architecture

Over the years, technology has been developed to produce correct the grid energy-efficient devices or equipment [20-21]. On the other hand, currently renewable energies are more used for energy self-sufficiency considering a medium and long-term investment [22], although there are also non-renewable sources with a minimum percentage of pollution compared to conventional generation such as cogeneration. with natural gas [23-24]. At the same time, tools such as distributed generation are also used to improve efficiency and guarantee the reliability and resilience of the network [25].

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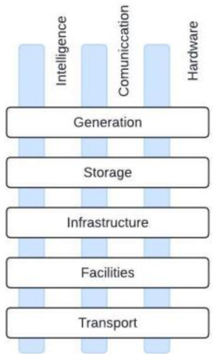

Fig. 1 Areas of intervention in management energy.

So, a new architecture is used for the energy-efficient telecommunications network, considering that the network at the energy level is composed of consumption and generation. Regarding energy generation, we have two schemes: 1. Electric energy and 2. renewable energy such as solar. Therefore, considering that the network consumes and generates energy, a control and monitoring device is required to verify and minimize the energy cost. Fig. 2 shows the architecture of the EMS system, which considers all the equipment and devices for the operation of correct the grid energy-consuming telecommunications and solar energy resources.

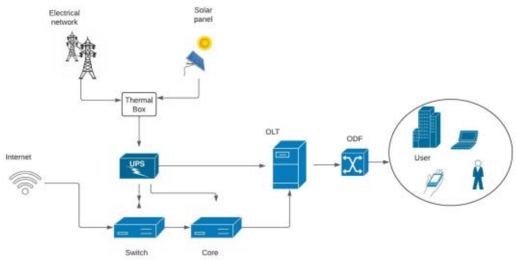

Fig. 2 Scheme of the EMS architecture of the network.

Energy consumption is monitored through an energy measurement and communication unit (EMCU), which has been installed in the outlet of each device, in order to measure energy and consumption, this information is received by the ZigBee server.

On the other hand, the generation of the solar system, which consists of solar panels, eight batteries, a solar inverter, and the REG, which guarantees the generation of energy, energy monitoring and its accumulation. This network architecture guarantees that the REG collects data and these are transferred via Ethernet to the server, to analyze energy generation and consumption data.

The EMS depends heavily on the server for the analysis of energy consumption and generation information, so that energy use and generation profiles can be established, estimating the amount of renewable energy generated, considering the weather forecasts calculated on the Internet.

So, the generation of energy with solar panels has several correlations with the climate. Therefore, once the correlations are identified, the server estimates the future generation of renewable energy. From there, the server performs the cost- benefit comparison with the energy prices of public service companies, so that it can manage and control the energy use of the network. Therefore, this allows strategies to be taken to optimize the use of solar energy, allows us to have updated information in real time and to be able to carry out adequate energy management, always relating generation and use.

The server is responsible for managing the EMCUs installed through the ZigBee app. The server through a node control block monitors and controls the EMCUs. In such a way that, with the help of an energy manager and with the data obtained over time, information is created to determine energy use patterns throughout the telecommunications network.

For which, the energy manager, taking into account the relationship with solar radiation, analyzes the generation of renewable energy and establishes weather patterns, in order to estimate renewable energy based on meteorological predictions. Finally, the server, based on the energy generation data, modifies the programming of the devices to reduce the energy cost, that is, it will alternate the use of solar energy or electrical energy, considering the low generation of renewable energy and the energy prices of public companies, this will make according to the priority of the operation.

2.2 Energy Management and Communication Unit (EMCU)

The EMCU is the key part for measuring power, energy, power factor, through an integrated circuit (IC) for energy consumption [3]. The IC determines power and energy by measuring voltage and current at different sample periods. Power factor results from the difference between voltage and current. So the IC stores the accumulated energy data, so that the power and factor calculation is in real time, and also includes an energy control to supply energy to the devices.

On the other hand, the IC guarantees communication between the EMCU and the server, so that it adopts ZigBee and the network to transfer energy, power, power factor, voltage and current.

2.3 Renewable energy gateway

The generation of solar energy is monitored with a PLC modem, with TCP/IP communication, so that the performance is calculated through the data collected. The REG makes its communication through three interfaces: PLC with the solar panel, Ethernet for the server and an RS-485 for inverters [13].

2.4 Remote Energy Management Server (REMS)

The REMS stores energy usage information for equipment and power generation. Once with the data, the REMS calculates the energy consumption of the network, with which it determines the standard energy use.

3 Problem Solution

The REMS, EMCU, PLC modem, REG and server components were developed in the laboratory.

Fig. 3 shows the devices connected to the EMCUs and the solar system of the telecommunications network. The figure describes the consumption of equipment energy, where several patterns have been identified, also shows us the consumption and total cost of energy from the electrical network. From the app, the user can consult information on the energy generation and consumption characteristics of the equipment.

Fig. 3 Telecommunications network, implemented EMS.

The REMS interface allows you to view graphs regarding the electricity use rate, statistical information on the energy consumption of the network over the operating time.

In Fig. 4, the EMCU prototype is shown, which is connected to the alternating current power line, so that it measures and controls the electrical energy of each device or equipment, the same one that will carry out the data transfer to the server. through ZigBee communication EMS architecture.

Fig. 4 EMCU, connects online with the renewable energy grid storage.

The board developed for the operation of the PLC modem and the Renewable Energy Gateway performs current and voltage detection and communication. Likewise, the REG communicates with the solar inverter through RS-485, allowing the collection of information. So that the correct functioning of the hardware is guaranteed so that energy management can be measured, verified, controlled and executed in the telecommunications network.

4 Conclusion

Once the renewable energy network with solar panels is installed, the energy consumption for the operation of the network and telecommunications nodes allows savings in energy costs, so it is verified that it is important that energy consumption and generation are simultaneous, to guarantee optimal and efficient operation of the telecommunications network.

So the intelligent EMS architecture is a proposal that considers consumption and generation, through the EMCU they measure energy consumption with ZigBee coordination to transfer data. This structure allows determining energy consumption patterns in the telecommunications network.

Likewise, the REG collects energy generation and consumption data from solar panels, estimating energy generation by estimating the weather forecast. Finally, with the information obtained, energy use can be controlled to minimize energy costs, also allowing users to monitor the energy information of the network. This is expected to improve energy management in telecommunications networks, reducing greenhouse gases and energy costs.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.