FEDERAL UNIVERSITY OF RIO GRANDE DO NORTE
Metrópole Digital Institute

Monitoring system of distribution transformers

Natal / RN - 2018

Introduction

electric power low-voltage distribution transformers are among the most critical elements in a electrical grid, the occurrence of failures in these devices can lead to big losses for companies that provides electricity and for their customers.

Another very relevant issue for the company is the undue power consumption, "The damage to non-technical losses (irregular consumption) of electricity reached the level of R $ 8.1 billion per year, considering 61 of the 63 distribution companies that They passed by the 2nd tariff review cycle from 2007 to 2010. "

Our proposal is to develop a system capable of obtaining system, real-time, relevant information on the operation of the transformers, which allow fault forecast, as well as detection, large-scale, energy illicit consumption and monitor the quality the power supplied by the utility to their customers.

Team

The development team is composed of Israel Medeiros Fontes, student of the Bachelor of Information Technology at the Federal University of Rio Grande do Norte (UFRN) that already has some experience in embedded systems microcontroller acquired in projects for automation and Smart City technical school and university.

Lailson Silva dos Santos, who is also a student of the course Information Technology, Federal University of Rio Grande do Norte (UFRN), and has experience in developing web systems with Java at the scholarship Metrópole Digital Institute - UFRN.

System Description

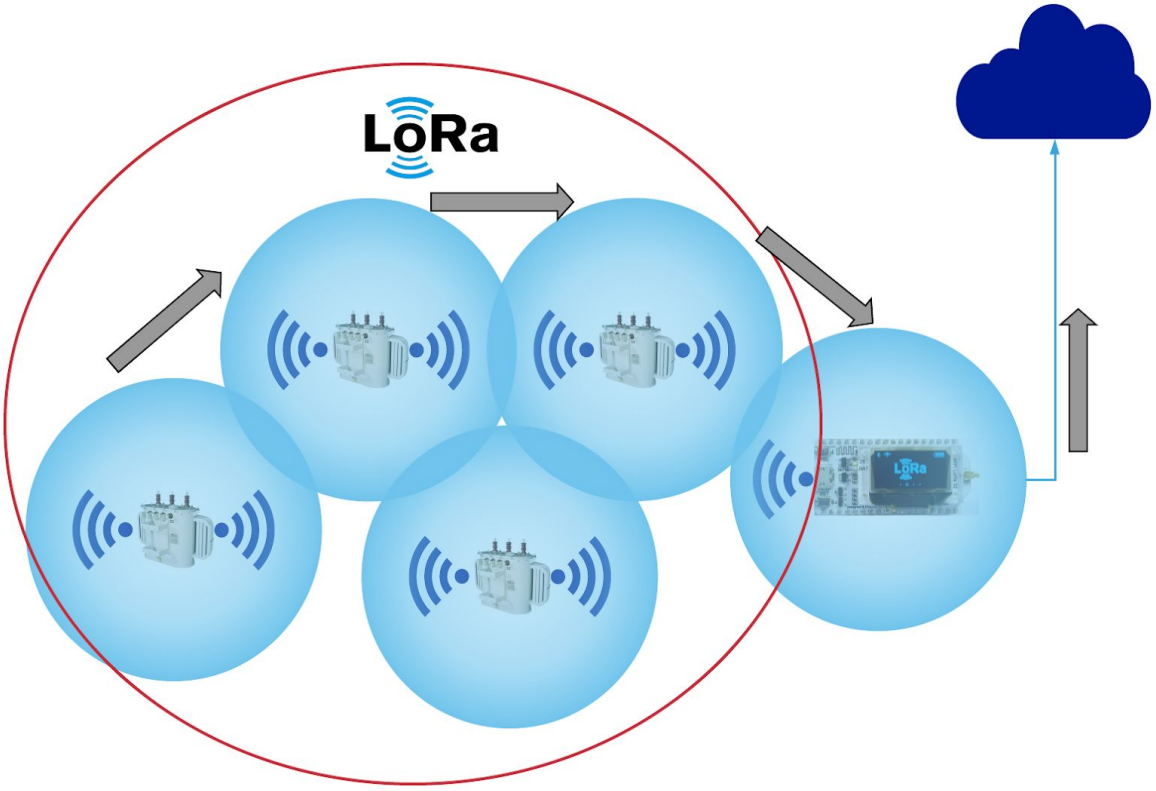
The system developed consists of several monitoring stations coupled to the distribution transformers. The stations make measurements of the parameters needed to assess the electrical grid and the transformer state. We decided sensorizar the transformer secondary voltage and current, or the network that is available to customers a certain low voltage region, and also sensorizar the operating temperature of the transformer.

With these parameters obtained, we can make some calculations that give us critical information for the proper functioning of the power grid and even detect energy theft and network failures, and to prevent potential problems. We managed to get the energy consumed by all clients connected to a transformer, unwanted variations of voltage, current and temperature, consumption patterns and even the network power factor. Finally, we send the data obtained from stations to a gateway that is responsible for forwarding the information to an application on the Internet that interprets the data available to the electric utilities so that they can act as best as possible, preventing problems and avoiding losses.

In our implementation we use a mesh wireless communication network using a plate offered by Heltec joining the ESP32 microcontroller with the SX1272 Lora chip that provides us with a great processing power and many wireless possibilities.

The choice of Lora technology was paramount to the development of this project, it gave us power of communication far superior to other existing technologies for communication in embedded systems. We kilometric range communication without the need for operators and communication restrictions. With it we can devise a mesh network that allows us to transmit information at much greater distances than any other network Iot.

The image shows the general structure of the system

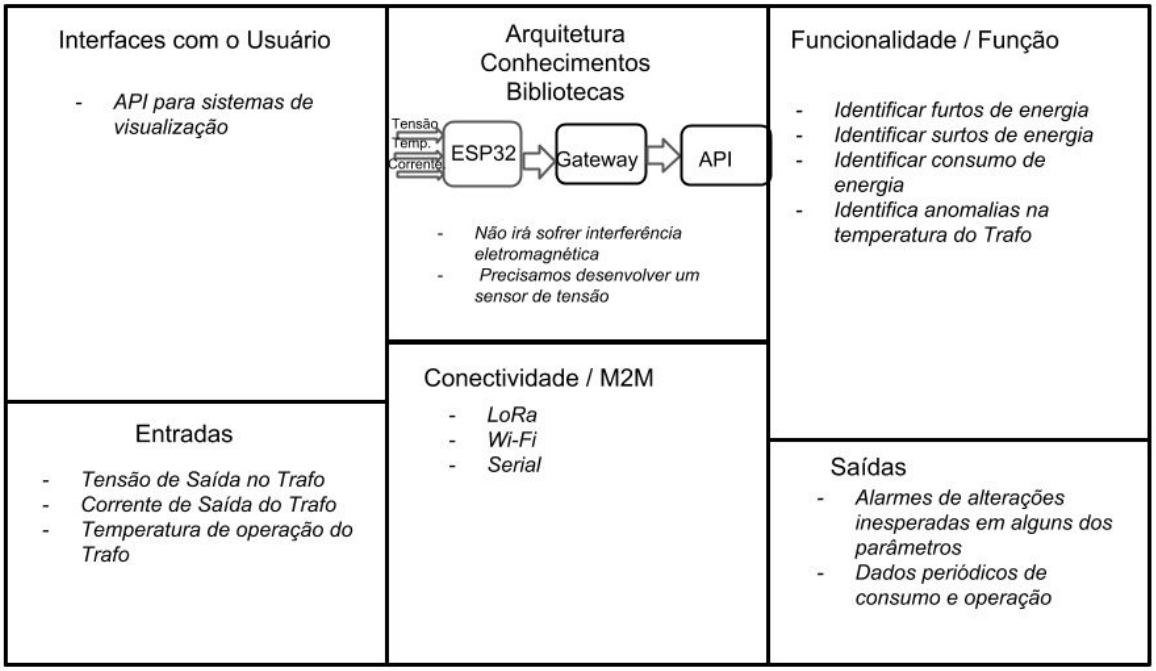


Mainly competitors

There are already some solutions on the market, but the main one is the solution VTInova company. They do something very similar to this project proposal, but use GSM communication which does not allow the freedom of the network and is more expensive for utilities.

we also focus on low cost of implementing this solution and easy deployment.

canvas

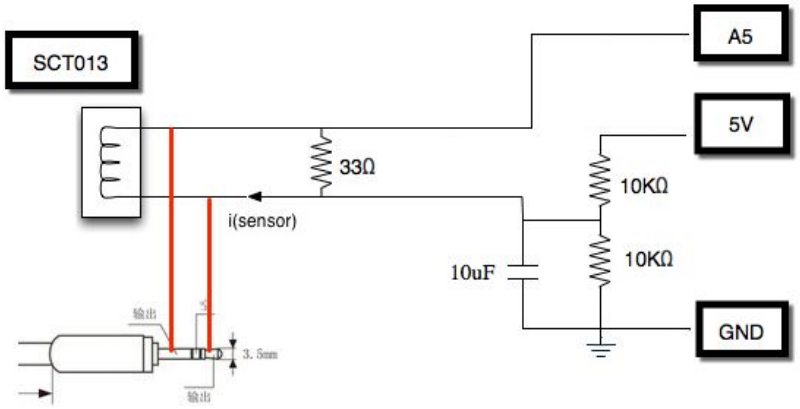


Methodology

The monitoring stations used as a central module one ESP32 with Lora chip. We use current sensors, voltage and temperature that are coupled to the processor. The ESP32 makes the sensing and routing information for the Gateway.

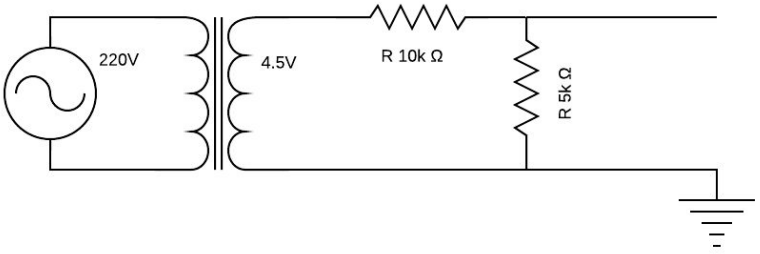
- Current sensor:
  To carry out the acquisition of the current value, use the SCT013 sensor, as the image below. It reduces the current through-values by a driver to a lower level and using a resistor scheme managed to turn these current values into voltage signals so that the microcontroller can interpret.

Wiring diagram:



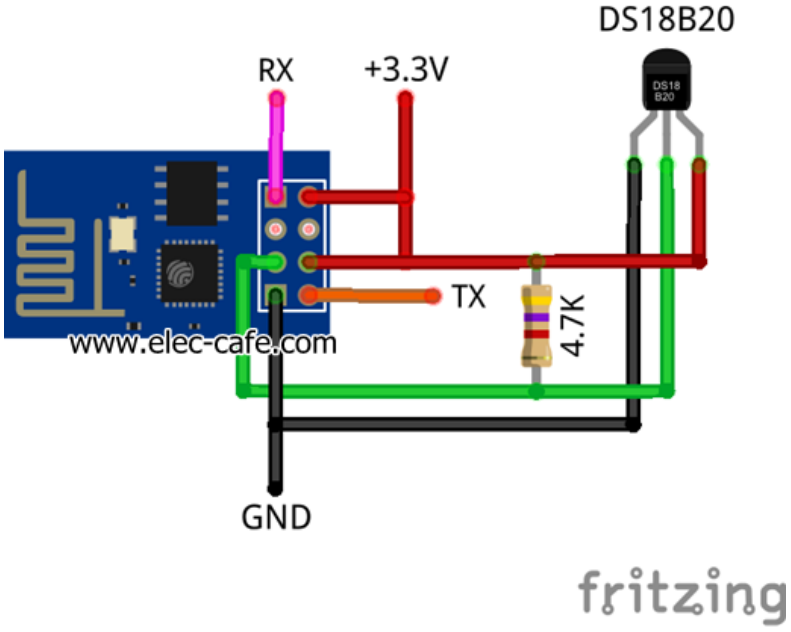
- Voltage sensor:
  The voltage sensor consists of a small transformer that converts the voltage of 220V network the transformer output to 4.5V. To keep the value of this obtained voltage sensor always positive, a through offset voltage of the microcontroller as reference for the secondary of the transformer was added. This is necessary because the ESP can not receive negative values as input.

  The circuit model of such a sensor is shown in the picture below.



- Temperature sensor:

We used the DS18B20 temperature sensor, a sensor widely used in industrial applications. It supports high temperatures with good accuracy.



Study on the acquisition of energy consumption:

When performing some studies, we concluded that for the power consumption in a transformer, we will use the parameters obtained by the current and voltage sensors, for in them we can get the power value at a given time. Thus, for power consumption, just implement the numerical integration of this power value in time.

Study on the acquisition of power factor:

For the power factor of the grid, we calculate the gap between the time that the voltage passes through zero value and the current goes through the same value. We managed to carry out a three basic rule with a power factor value and find out the current.

Lora Communication:

Communication via Lora is in the form of mesh network, however, as we had to implement the communication protocol, it is not yet fully scalable.

Each season awaits the arrival of a package that has a counter, if this package has passed through that station, the packet is discarded, otherwise it is sent back to the network. If the station has to send a given, it creates the shipping package, break the reception status and send.

The packages have a standard:

address / voltage / current / temperature / consumption / fatorPotencia / alarm / counter

they come out of the stations, arriving at the gateway and then is sent to the application or accumulator.

Next steps

- To develop a technique for stabilizing the voltage sensor.
- Studying numerical integration methods for obtaining energy consumption.
- Develop a basic protocol Lora communication.
- Implement a simple application.

Plans for the future

- Develop a robust application with basic functionality for system monitoring.
- Develop a protocol that allows automatic configuration of network-connected devices.
- Develop an API to allow third parties to develop applications with new features to the structure of our network.

  Note: The API should allow authentication between the developed application and the network that is being monitored by it, providing the security of company data that are using our system.