VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DESIGN AND IMPLEMENTATION OF A PROTOTYPE FOR MONITORING AND TECHNICAL ASSISTANCE IN REMOTE VSAT STATIONS

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ABSTRACT

The field of action of the company Interedes are departments that are characterized by areas with difficult access by geographical conditions and public order such as Amazonas, Vaupés, Putumayo, Arauca and Sumapaz; Transmitting technologies such as radio links, to these areas is unlikely and highly costly. The satellite link becomes the best option and ultimately the most used; Although its implementation is somewhat expensive, VSAT stations have made the economic factor not an influential factor; Is ideal for breaking the limitations of distance and hostile geography; is very susceptible to falls of the link between the station and satellite due to climatic aspects, overheating of the satellite modem and even by a low quality of the electrical service that supports the system; The best solution for the most frequent and stated problems is to make a reset to the satellite modem, suspend the electric fluid and after a few minutes reestablish the fluid, this restart cools the equipment, allows to establish a new connection to the satellite on a channel less Deteriorated, channel that would have better characteristics like better capacity of reception and transmission. When evidencing from the monitoring center the many occasions in which the technicians on site of the company have to leave their work and go to execute this restart, a prototype is implemented, which allows to automate this process, allowing short technical assistance times And greater time in the availability of the service, thus causing a positive impact on the customers. The prototype is focused on VSAT stations, but can be applied to different communication nodes and extends to preventive restarts on the second equipment according to the network topology, after the satellite modem, to correct locks on this device or blocking in the Ethernet ports on the same or on the satellite modem ports; The characteristics of the prototype are extended by providing temperature and humidity monitoring at three different points of the node or station and its average is printed on one of the three web pages with which the prototype counts.

Keywords: transmission technologies, VSAT stations, link, connecting channel, connection levels, technician on site, communication nodes, topology, ethernet ports.

INTRODUCTION

The internet has become an increasingly important tool, helping to improve the quality of education, quality of work, quality of life among other advantages; Having access to information and communication technologies and access to the internet for a society can mean more progress and more development can help optimize your public and private processes.

Interedes S.A.S. Is a Huilense telecommunications company, "Born in the USCO", more than 90% of its staff is from the USCO, in most of the electronic engineering program, for more than 5 years venturing into departments such as Amazonas, Vaupés, Putumayo and Sumapaz; Helping its inhabitants to have access to the internet service, bringing, together with the ICT ministry, technological tools to schools, mayors and governorates.

In satellite transmission an unguided transmission medium such as air is used; the transmission medium is a microwave beam, unidirectional at frequencies between 100 MHz and 10 GHz, sensitive to interference losses and loss of the link due to attenuations caused by the weather. (Tuxcom)

The satellites rotate around the earth at an average height of 35700 km. The orbits of the satellites can take only one of the three paths shown in figure 1. (Hernandez, 2005)

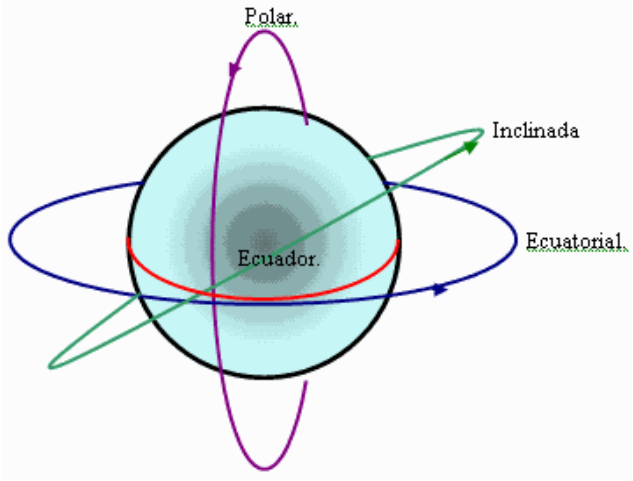


Figure-1. Paths of satellite orbits. **Source:** (Hernandez, 2005)

The implementation of a satellite system, breaks the limitations of the distance and offers high transmission speeds, but its implementation has a high cost; Is part of the economy of scale to make the implementation of a satellite station is more economical, so are born with stations with small diameter antennas (plates of 1.20 Mts in diameter) called VSAT stations by its acronym in English.

Each satellite has multiple transponders, each transponder covers a certain frequency band, each beam can be extensive or thin, in a thin beam, the power is higher and small diameter antennas can be used to capture the signal. (Alejos)

The multiplexing technique is used to transmit data at a high speed, two types of traffic are transmitted, control traffic better known as bus, which supports the operations of traffic information known as payload. (Alejos)

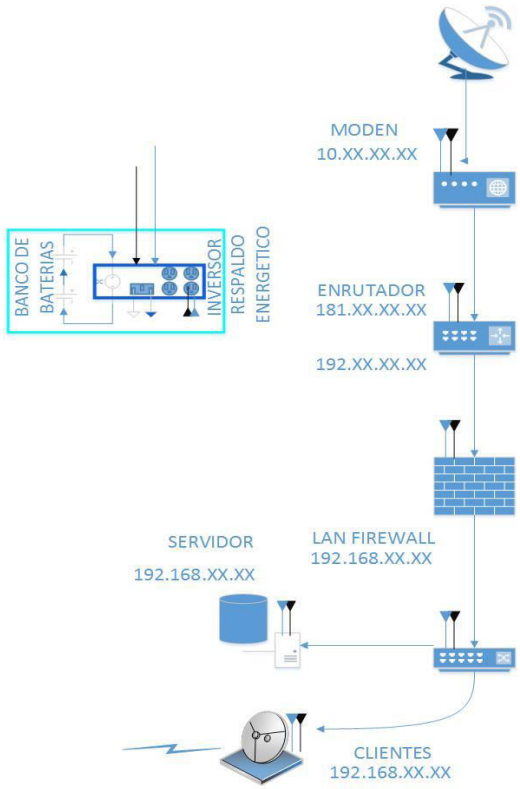


Figure-2. VSAT station generally mounted by Interedes S.A.S. **Source:** Author

The VSAT stations offer reliability, flexibility and economy is considered the solution to communication problems in isolated areas, it is easy and quick to put into operation and incorporate new terminals; A critical point is the satellite, if the satellite falls the whole network falls with it; Could be a problem not very serious because if a single transponder drops, a simple restart of the satellite modem, will cause a change of channel, moving to another frequency band in Figure-3. (Erazo, 2011)

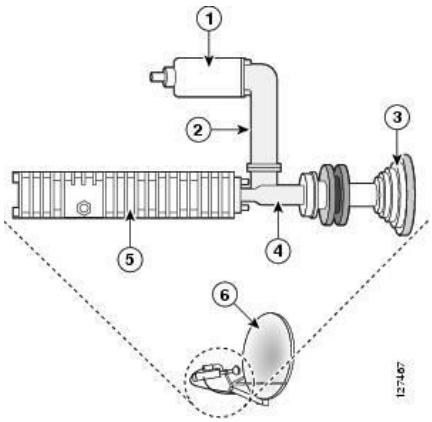


Figure-3. Elements of the ODU. **Source:** (Educational Institution "José María Arguedas", 2013)

Table-1. Part the ODU.

	ODU Components	Function
1	Low noise block converter (LNB)	Amplifies and converts high frequency satellite signals into low frequency signals.
2	Transmit reject filter	It filters signals transmitted by the satellite to the LNB.
3	Feed horn	It captures the signals and transmits energy to the reflector.
4	Orth mode transducer (OMT)	Separates and transmits signals, depending on polarization and frequency.
5	Solid state block converter and power amplifier (SSPA)	It amplifies and converts low frequency signals from the IDU to high frequency signals for transmission to the satellite.
6	Reflector	Surface of the concave dish, 1.20 Mt for VSAT stations, where the energy received from the satellite is centered on the hom feed and transfers the energy transmitted by the hom feed to the satellite.
7	DU	Satellite Modem, encodes the data and regulates the speed of transmission and reception.

If SQF levels are low, there will be no reception or transmission, impeding navigation; Are due to weather conditions (rain or cloudiness), saturation, or heating of the modem; The solution, given by the channel provider and owner of the station's IDU and ODU elements, is to electronically reboot the satellite modem, suspend the power for a few minutes, and then turn the modem back on, in order to turn the modem on Modem Can be re-hooked the station with the satellite, for a new channel

with better connection levels, Allowing to recover the service t to have a good navigation. Very rarely do problems arise with the coaxial cables connecting the modem and the antenna, or the misalignment of the polarization angle of the ODU, problems that take a little more time to detect them, and their solution requires personnel on site. (Educational Institution "José María Arguedas", 2013)

Every satellite station must have tools that allow the detection, diagnosis and follow-up of faults that cause loss of navigation (suspension of the internet service), and where possible, help to restore the service; Due to this, it is necessary that a remote station have:

A monitoring and supervision system which is analyzing and reporting the activities and events of the station, allowing them to be aware of any faults that may arise.

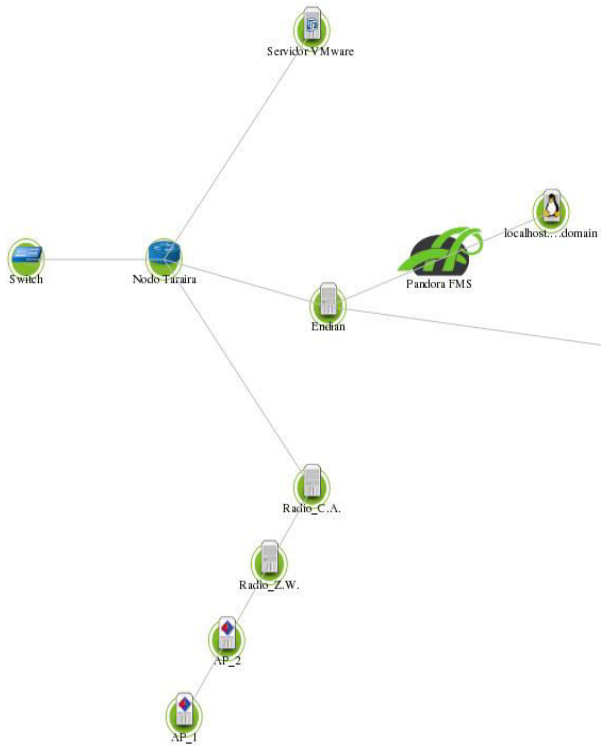


Figure-4. Pandora Fms 2nd software implemented by the monitoring center.

Interedes has a monitoring center, the creation of this was supported entirely by students of Electronic Engineering of the University Surcolombiana, at the request of the company, supervised by engineers of the Intic business group; Which has evolved with the accompaniment of students and graduates of the Usco, being today an important tool in the areas of design, operation and technical support of the company.

It is very helpful to have a Detection and Restoration Device, providing top-level technical assistance, helping to make downtimes less time consuming.

When an Internet service is contracted, some clauses are defined that define the tolerance to the unavailability of the service, this is measured in percentage and monthly, for most contracts where the company Interedes is the service provider must have no less of 98% of service availability, if this percentage is not met, without justified reasons, the client can take legal action, impose demands or even demand not to be charged the month of service; Interedes has on-site support technicians, people from the area who are linked to the company to develop tasks such as preventive maintenance, support to failures in clients, make site studies for new clients; When the lack of internet access is present, the technician must prioritize this failure, abandon all activity, go to the main node and try to recover the service; In these areas, clients and the secondary nodes are usually very far away, reaching the main node can take half an hour, two or three hours in the case of Sumapaz, or half a day in some areas of Vaupés and Amazonas, or From three to four days in other areas of the latter two departments, depending on the availability of flights between the zones; It becomes somewhat difficult to address the high priority failure in reasonable times because of the difficulty of displacement.

METHODOLOGY AND MATERIALS

Description of the process

It is designed a prototype to which it has been baptized in the company Interedes as "Hand Remote. Figure-5 shows that: 1 - the prototype detects the presence of energy from the commercial network, 2 - has AC connections to reset the satellite modem, 3 - has web pages for management and monitoring, 4 - has temperature and humidity sensors for the most sensitive equipment, 5 - connection to the cellular network with which alerts and event reports will be sent, 6 - server for database and where the pages are deposited, 7 - test the status Of the most critical customers.

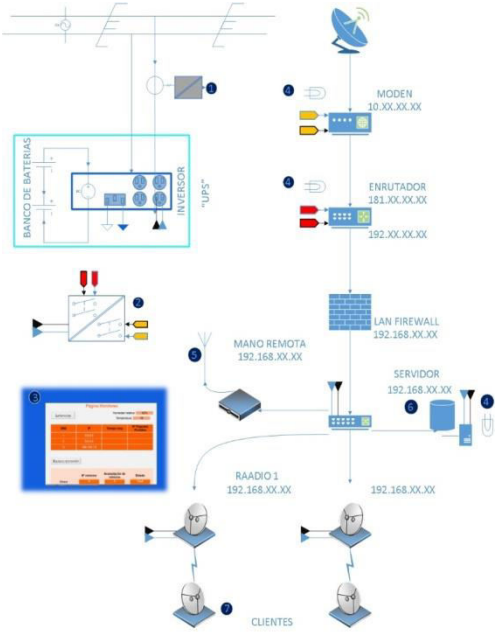


Figure-5. General diagram. **Source:** Author

Figure-6. Remote hand prototype and rear view
Source: Author

A. Latency test

Ping testing to detect the drop out of the Internet and to identify the type of problem that causes the service failure, this process together with the exercise of the switching stage are essential in the main objective of the prototype, the is the recovery of internet service.

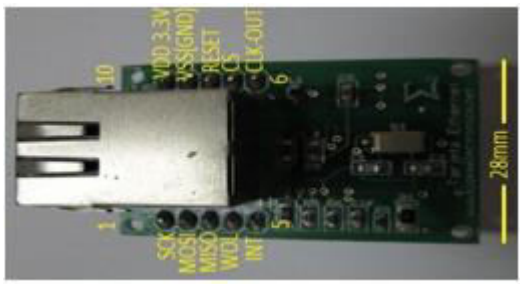


Figure-7. Ethernet module ENC28J60
Source: (Sigma Electronica, 2011)

For this prototype an Arduino Mega is used like processor and center of all the programming; An Ethernet module supports with the connection to the network, allowing to generate the constant ping and reports to the database of the dedicated virtual server only for the prototype, in the server besides the database are the different pages that allow the Monitoring and management of the most relevant prototype variables, the prototype server communication is constant and is of vital importance.

The prototype is programmed to do the tests according to the protocol that the technicians in place follow to determine the fault and to take evidences before exerting any action on the equipment, in other words it is automated the process of support of first level and recovery of the link.

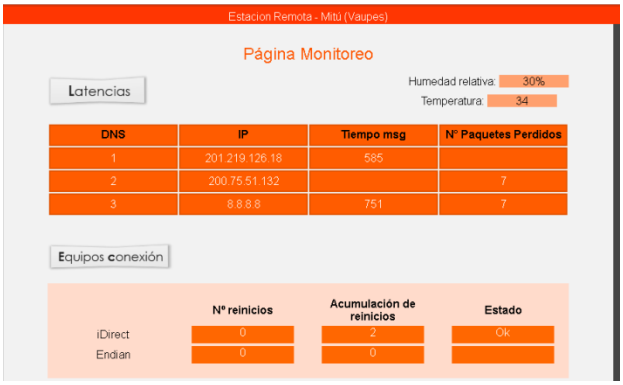


Figure-8. Visualization of the result of the tests and the state of the main equipment. **Source:** Author

Three public IPs are established in Internet, with which the connection tests are performed, the results are stored and exposed in the monitoring page of the device, if the tests to the three ip in Internet fail, the prototype verifies connections at the level of the LAN and it discriminates the root of the problem and does the restart of the equipment that agrees.

B. Switching

The prototype has two alternating current outputs where the satellite modem and the main network router must be connected, it allows to have an ON / OFF control on the equipment, thanks to this stage can be carried out the reset task of the satellite modem and of the router, also helping to solve the link loss due to channel deterioration or problems with the modem, as well as to solve problems such as blocking Ethernet interfaces or blocking the main router.

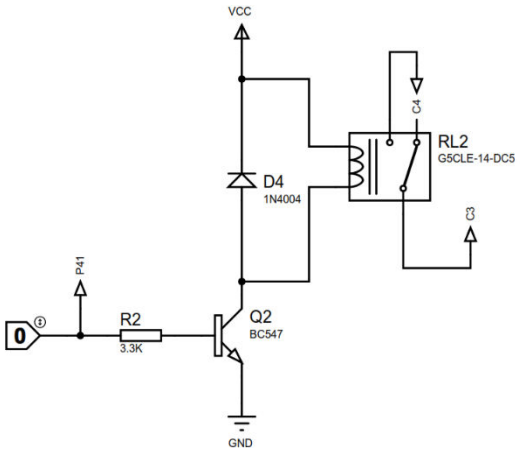


Figure-9. Switching circuit of a computer.
Source: Author

For the switching module, the following circuit was designed to control the AC output and offers a considerable level of insulation:

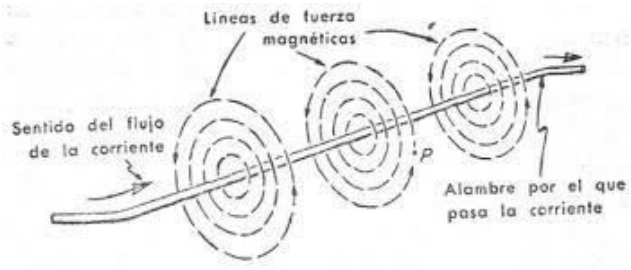


Figure-10. Board with two switching circuits. **Source:** Author

Each time the actuator (relay) is actuated in the chassis of the prototype, a blue LED illuminates, located in a bar of indicators properly labeled, this indicator represents the suspension of the energy to the device in question, then presents a flashing of the same led Indicating that it has been re-energized and waiting for the network equipment to start normally; If after carrying out the process of verification and recovery, the equipment does not respond to ping, a red led is triggered which is located in the same bar of indicators, warns that the problem with the equipment is of greater magnitude and leaves Of the scope of the prototype, cannot be solved with a first level assistance; A text message is sent to the technician on site stating the problem with the equipment and requiring the prompt technical assistance.

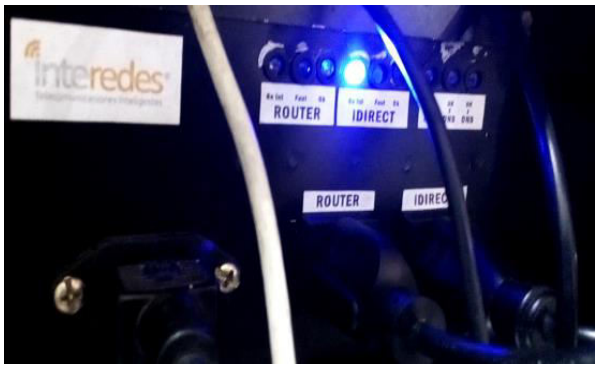


Figure 11. Restarting iDirect. **Source:** Author

C. Sensors

In the areas of operation of the company Interedes, the electric fluid is not of good quality, and there are many absences of the energy service, that is why the company implements energy protection and backup solutions. The prototype has a sensor that allows knowing the absence of the electric fluid and counts the time of autonomy given by the solution, according to the data that would be previously entered in the configuration page; you can observe the time of absence of energy in the monitoring page.

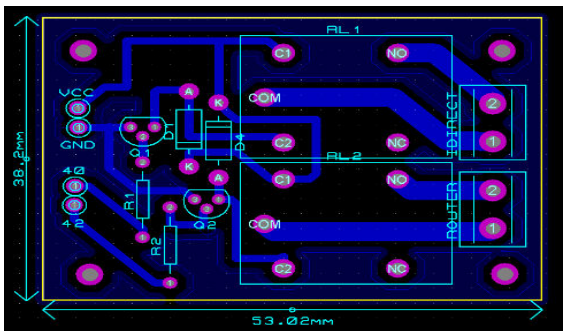


Figure-12. Magnetic field lines generated by the electrical fluid by a conductor. **Source:** (Donald G. Fink)

The principle of the non-invasive volt-amperometric tweezers is used, detecting the electric fluid thanks to the magnetic field generated by it, without having to intervene the transmission lines, the magnetic field induces a current at the output of the clamp and the circuit of Figure-16 conditions this.

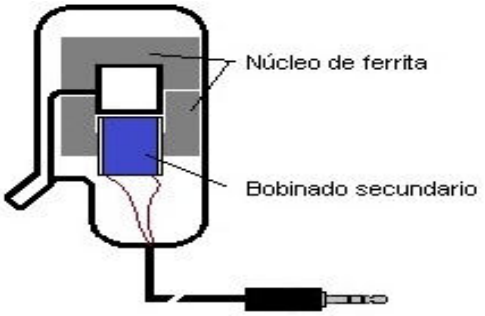


Figure-13. Pinza SCT-013. **Source:** (HD)

A gain selector is proposed in the conditioning circuit in order to sense current flows of high magnitudes.

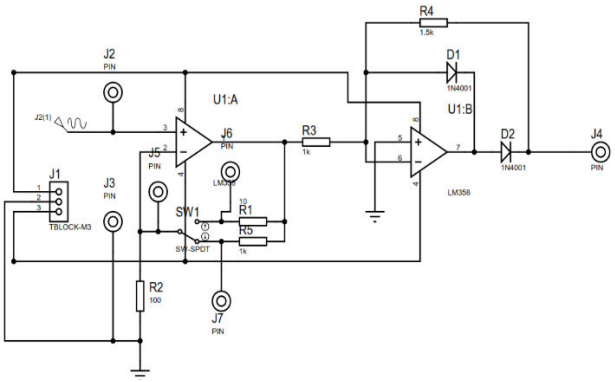


Figure-14. Signal conditioning of the SCT-013 **Source:** (D-Robotics UK, 2010)

The characteristics of the prototype are expanded, adding a stage of sensing of the physical variables temperature and humidity; some connecting devices are more sensitive to overheating and humidity can become a determining factor for the life of most equipment; The DTH11 sensor mounted as shown in Figure-14 is used. Pin 2 is the digital output; the output is set to a high digital

level with a pull-up resistor to achieve correct sensor performance.

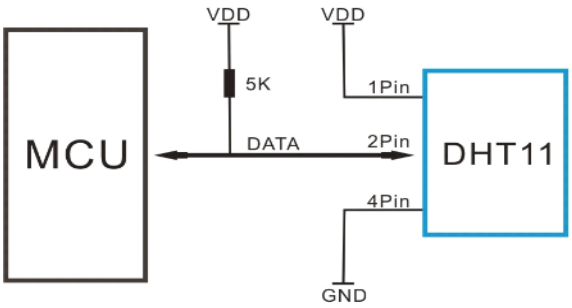


Figure-15. Sensor mounting DTH11.
Source: (D-Robotics UK, 2010)

Two plates were designed with the objective of being able to locate the sensors as far as possible from the main chassis of the prototype, 3 sensors are used to have an average value of the variables, USB inputs are used to be able to carry the signal sensed to the main processor of the prototype, Thus making the prototype modular, is fed with 3.3 Volt, the accuracy of the sensor used is +/- 5% in the measure of humidity and +/- 2 ° c in temperature.

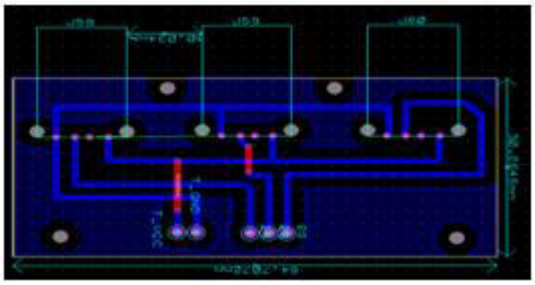


Figure-16. Board with USB inputs embedded in the main chassis. **Source:** Author

D. Indicators

Most of the prototype kept what had been raised in the beginning, but other characteristics were arriving as the same was developed, the prototype was going to be a black box with the necessary connectors for the input of the sensado signal, rescheduling And Ethernet; It was presented the need that the technician on site could discriminate in which part of the process was when seeing the device, or if he found a fault that he could not solve, that is why the circuit is assembled to have luminous indicators which would go on According to the results of the analysis of the system and the state of the equipment. The circuit that fulfills this function is the one shown in Figure-19.

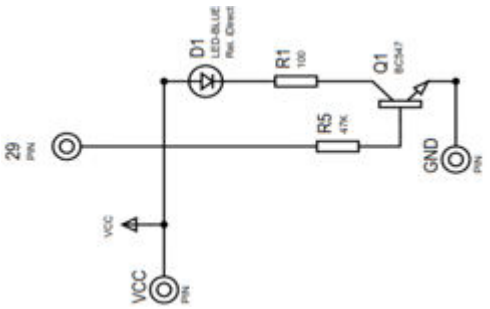


Figure-17. Circuit mounted by indicator.
Source: (D-Robotics UK, 2010)

Is calculated:

$$R_1 = \frac{(V_C - V_D)}{I_{LED}} = \frac{5-2,8}{20\ mA} \quad (1)$$

This calculation is for the case of the blue and green LEDs, for the red LED we have Vd = 1, 8 and Iled = 50 mA.

$$R_5 = \frac{(5-0,7)*200}{20\ mA} \quad (2)$$

Where 200 = β minimum of the transistor

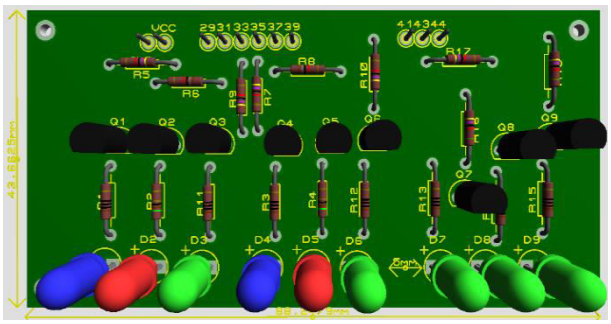


Figure-18. Indicator strip.
Source: Author

These alerts are activated: Green - when one of the DNS IPs responds, there is a led for each DNS tested (the 3 green LEDs in the lower right corner); Blue-when power is suspended to one of the equipment, which flashes when it is energized again and the equipment is starting; Red - when the test of some team failed, after executing restarts to this one; Green when testing a computer and responds normally.

E. Text messages

The GPS / GPRS / GSM V3.0 module allows the use of the cellular network in projects that require a remote communication with the implemented designs; with this module you can send text messages, make phone calls and establish communications based on GPRS

The GSM module V3.0 uses the 2G cellular network, works with normal SIM cards of any National operator and supports bands 850, 900, 1800 and 1900 MHz, is economical and effective, responds to commands

known as AT (Commands), these commands are used among other functions to program actions and order the execution of some tasks, the characters must be entered in capital letters; For the case of the communication between the different platforms and the GSM module you have to put the ASCII equivalent of the special characters that you want when entering the AT commands.

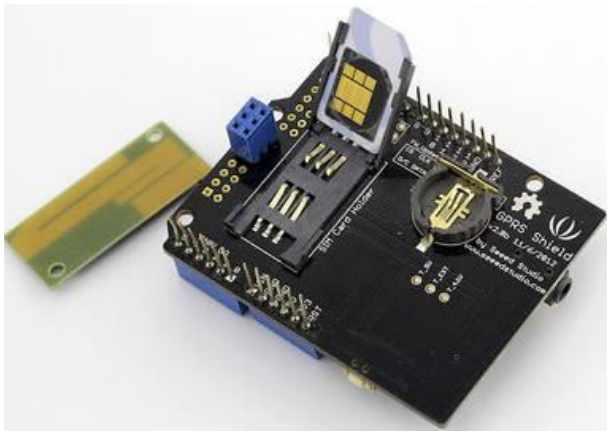


Figure-19. Circuit mounted by indicator.
Source: (Seeed Studio)

Here are some of the many commands:

ATA: allows us to answer a call, this can also be programmed to execute.
ATH: You can hang up the existing call.
AT + CGMI: This command requests information from the module manufacturer.
AT + CGMM: Allows requesting the model number of the module.
AT + CGMR: Provides module firmware information.
AT + CGSN: The IMEI number assigned to the module is requested.

With the combination of the AT commands in the correct way it is possible to execute the text message sending functionality with the GSM Module, as follows:

```
// enter the AT command that initializes the modem in the text message mode
  Serial1.println ("AT + CMGF = 1");
// enter the command that enables it to read the message that will be entered
  Serial1.println ("AT + CMGR =?");
// enter the command that takes it to the message sending mode, the structure since this command is executed is the following AT + CMGS = <number><CR><message><CTRL-Z>
  Serial1.print ("AT + CMGS =");
  // put quotation marks ", so that what you take identifies it as a stream
  Serial1.print ((char) 34);
  // we put a telephone number
  Serial1.print (cell number);
  // re-enter the character "to tell you that the stream ends
  Serial1.println ((char) 34);
```

At that precise moment, the logic of the prototype enters the message according to the verified and enters the ASCII equivalent for Ctrl-Z, which is (char) 26 giving the command to perform the sent.

F. WEB pages

Being a remote technical assistance device, it is essential to be able to manage this prototype from the internal network LAN, as well as from the company's operations center, which is why two WEB pages are planned one that has the function To load configuration data, it will only be controlled by the on-site technician or resident engineer who has all the knowledge about addressing and other variables on the installed equipment, the other page a monitoring page from where they will be viewed from Average Temperature and Humidity, Latency, loss of response to ping, until time of absence of the electric fluid, initiative is created a third page that would be the home page of the system to see the person who accesses the dedicated ip and in addition to make the presentation of the project, Allows you to move between configuration and monitoring pages.

The pages are hosted in the server that is in LAN with the prototype, in which besides being the software of Monitoring Pandora FMS, it performs functions of revolver of domain names, it houses digital contents among others, it is virtualized a new dedicated machine For the prototype pages and database, the communication between server and device is made through the HTTP Protocol.

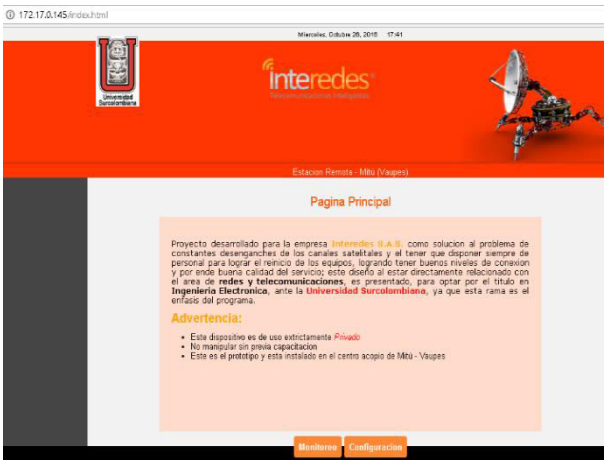


Figure-20. Main page.

In every communication system there must basically be 3 essential factors for the system to be effective, a means of transmission, a message to be transmitted and both the speaker and the receiver speak in the same language; Protocols are that language that standardize communication on the internet, are a set of rules that allow the teams involved to interpret the message correctly, there are many protocols, depending on the need and type of communication

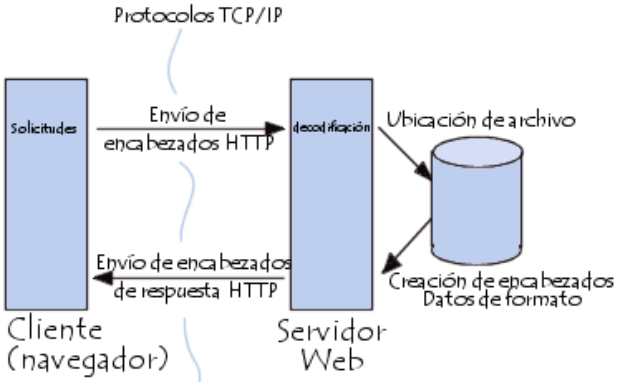
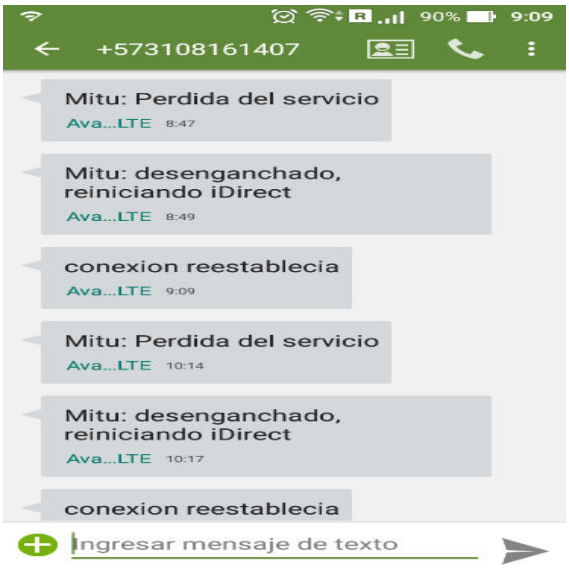


Figure-21. Prototype server communication
Source: (CCM)

Protocols identify source and destination, define which kind of communication will be established, whether it is required to be secure, high or low priority, the way data transmission, encapsulation class, message size, delivery options Message, among other features.

In encapsulation each protocol sends important information, the prototype uses http requests to send data to the local web server, this takes the values of the variables takes them to the local database; When entering the different pages of the prototype, will show the last values stored in the database, the prototype each time a verification process completes sends the update of the collected data.



RESULTS AND DISCUSSIONS

In execution of one of the projects of the Ministry of Telecommunications in the department of Vaupés, three VSAT stations were set up in the municipalities of Taraíra, Carurú and Mitú, after the implementation phase once the service period began, evidence was taken of The recurring problems in the Mitu VSAT station as it was the most critical point of the proposed solution and after requesting authorization from the Operations Coordinator of the company, the prototype is assembled giving him the opportunity to test his performance in the field.

Since the VSAT station is in government facilities and due to permit issues it becomes impossible to provide support on the part of the staff on non-work days, so when the equipment is blocked these days and need to be restarted it was expected to wait until the next business day, Which caused many problems with the users who were the community in general, when the prototype was installed, we not only had a technical assistance at times when we were denied entry, but we had knowledge of the exact moment in which it fell The service, through the received text messages, to follow up and be able to claim the company with which the satellite link was contracted with hard evidence.

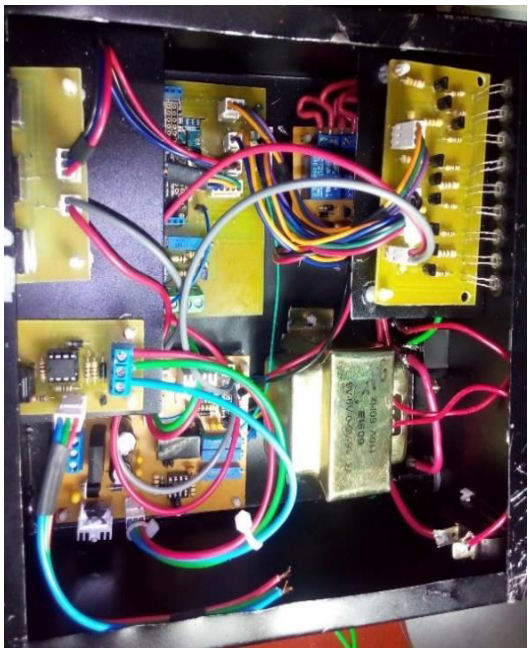


Figure-22. Fully assembled prototype

With the person who was currently supporting the monitoring center, from the company headquarters in the city of Neiva, the reports that were being displayed on the monitoring website were tracked, of restarts by falls of the channel as by prevention of blockades and in order to migrate a channel less deteriorated.

Figure-23. Received messages, reporting channel drop and recovery. **Source:** Author

The performance of the prototype was the best, it was possible to show the company and the supervisor of the project in the site, on the part of the client, the interest to improve, to provide the best service and the committed ones that was with the work, made known the And the change in the availability of the service acquired from the moment of the installation of "La Mano Remota", by means of a report to both parties where the graph of traffic generated by the Firewall.

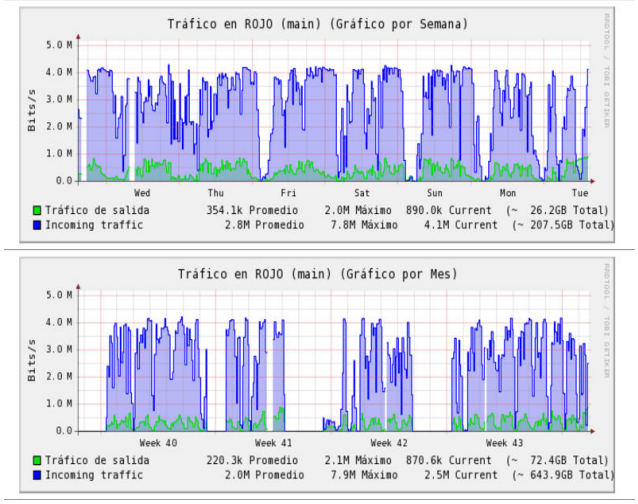


Figure-24. Traffic graph.

In the middle of the week 43 of 2016, it is decided to install La Mano Remota, in Figure-34 we see in the graph superior the traffic from the day of the installation a constant navigation is observed in the total capacity of the channel 4Mbps with momentary falls And recovery of service without the intervention of technicians on site, in the lower graph shows the relationship of the week that until then carried in field test the prototype with the previous weeks, clear evidence is obtained of the improvement in the availability of the Service and the use by the customer, the community, the final result that was obtained is a change of days of unavailability for only 20 minutes that takes the prototype to make the diagnosis, corroborate the failure and execute the control action.

CONCLUSIONS

After carrying out the fieldwork, as we call it in the field of telecommunications, with the prototype to 100% of its performance and applied to its referent station VSAT, the different consensuses and some recommendations on the development of this class of Prototypes.

Being the satellite connections very favorable to break the limitations of the distance, VSAT stations an economically viable alternative and the users of the internet service every day more demanding; The disadvantages as the slow propagation by the degradation of the link, become more notorious, being increasingly a major problem; With the help of engineering, it is possible to debug processes and even find better techniques to perform them, processes that can help disadvantages such as loss of the outbound link to the Internet are a factor less influential in the opinion of the client and giving an added value even greater To industry.

It is important to identify needs, necessary variables of control as well as the means and factors that are in favor in order to be able to propose the best way to give a solution to problems of high influence or to minimize the impact that it has on the quality of the service offered by our Companies, as engineers we are called to not see constraints, not see problems, if we do not find reasons to do our work better and better.

The development of prototypes in the industry besides optimizing the processes, allows identifying better ways of doing the same, helping the companies to have a positive impact in front of the clients and the benefited organizations.

The GSM / GPRS module is a very important tool, it has great features and from it, you can find a very wide advantage the invitation is to propose models, projects, prototypes that can exploit all its functionality and its wide range of tools.

Arduino is an important tool in these prototype processes, it allows to debug, to extend and even to compact the logical structure of the solution to pose, to make tests of performance even before making a total dedication to the development of the hardware and investment in the assembly.

Thinking about an energy backup system for this kind of devices would allow a time of autonomy for a last and of high importance warning about the fall of the complete system or the suspension of the service that would directly affect the activities of the clients.

The support of the private sector is as important as the public on issues that encourage the creativity and application of knowledge of future graduates, helping to generate high degrees of belonging to engineering; Testing the way to plant solutions, tackle projects and achieve goals.

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