

# IoT System for Internet Connection Monitoring with Automatic Modem Reset

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## ABSTRACT

This article aims to show a solution for people and companies who constantly face issues with internet signal loss. Therefore, taking this approaching of internet connection failure as the case study and utilizing the NodeMCU, relay, libraries ESP8266Ping.h and Gsender.h, it was made a prototype so that the modem automatically stores the drop-down and the return time of connection. Thus with the fall and return times, these informations will be sent to an email to be used as control information.

## General Terms

Computing, Embedded systems, Online monitoring

## Keywords

Relay, ESP8266, Gsender, IoT

## 1. INTRODUCTION

The fast technological advancements of the last few years allowed computing to evolve, so that computing devices were reduced in size and at the same time optimized their processing capabilities. These technological advancements allow the development of more sophisticated and precise solutions to assist in a wide range of purposes, from equipment communication, organizational decision making, process automation, or even home automation [4].

Then, an area of technology has emerged that has the purpose of managing networked equipment. IoT (Internet of Things) equipment are devices with network access that can interconnect and communicate with each other [14].

This article aims to find an automatic solution for the constant falls of the Internet that happens in the homes of users or company's facilities who use wifi modem, storing the failure and return times for a better monitoring of the connection. In fact, it becomes a nuisance users having to get up and go to the location where is the modem to restart it. This article aims to create a prototype that stores idle network times and automatically reboots the modem.

## 2. THEORETICAL FOUNDATION

Microcontroller is a small computer (SoC - System On Chip) on a single integrated circuit which contains a processor core, memory and programmable input and output peripherals. The programming

memory can be RAM, NOR flash or PROM which is often included in the chip. Microcontrollers are designed for embedded applications, in contrast to microprocessors used in personal computers or other general purpose applications [10].

NodeMCU was created shortly after the release of ESP8266. On December 30, 2013, the company Espressif began producing the ESP8266. The production of NodeMCU began on October 13, 2014, when Hong posted the first nodemcu-firmware file on GitHub. Two months later, the project expanded to include an open hardware platform when developer Huang R. published the gerber file of an ESP8266 board, calling it devkit 1.0 [3].

NTP stands for Network Time Protocol. It is the protocol that allows the synchronization of the clocks of the devices of a network like servers, workstations, routers and other equipment from reliable references of time [18].

A flexible long-term real-time monitoring system for PV plants developed at the University of Huddersfield, UK, can be found in [6]. The system monitors a weather station and a PV system connected to the grid that produces 1.98 kWp. The system is made around wired / wireless devices and it uses IoT to integrate monitoring of photovoltaic and environmental data. Different programming platforms were used in development such as LabVIEW, Arduino and Weather Link. Two communication links to monitor all data locally and remotely were used. Radio frequency modules, Bluetooth chip and Ethernet protection based on a static IP address are used to offer different monitoring options.

A computational platform was developed for real-time power flow models with the integration of intelligent measurement, real-time monitoring and an information management system developed at the National University of Colombia, Bogotá Campus [16]. With a capacity of 15 kWp the communication used consists of a computer with a wireless network card that collects the meter data via WiFi. The meter is connected to the output of a GSM modem for data transmission via Ethernet and the computer is connected to the Internet to send data to the remote server. The real-time management system consists of three OSIsoft PI servers, two to collect and store a large volume of data and another to organize information in hierarchical structures for quick localization. Graphs of real-time behavior of voltage, current and power of the generated PV system are shown.

Table 1. Comparison of various types of monitoring.

Paper	Connection	Data transfer	System
[8]	Network	WI-FI and Ethernet	ADSL
[7]	Network	WI-FI and Ethernet	CDR
[2]	Network	WI-FI e Ethernet	NULL
[13]	Network	Serial and USB	WEB
[9]	Undefined	Wireless Sensors	A cloud
[1]	Network	Wi-Fi, email and SMS	WEB
[17]	Network	WI-FI	WEB with arduino
[16]	Network	Wi-Fi, ethernet e GSM	A cloud

Monitoring the quality of a given service has become essential for users to have control over the service being provided. It is possible to find numerous works that deal with this topic (Table 1).

Day-to-day systems use *Relays* as a tool for triggering devices.

The device of remote activation of electric gates via cellular using microcontroller, this project integrates the Arduino UNO board, whose microcontroller is ATmega328, a board with SIM900 GSM module and a board with relay modules in a single prototype, performing user registration, adding new ones or removing existing registers, via text message sent by a system administrator - the first user to send an SMS to the prototype [11].

The proposal of a system capable of automating the drive of household equipment through the internet, on a free hardware platform. With HTML interface controlling and supervising a house with four common rooms, each room will have a compact fluorescent lamp. Ideally, the customer can be aware of each[15].

### 3. METHODOLOGY

The ESP8266Ping.h library was used. With this library, an ESP8266 can test the connection of the device with a remote machine and thus know if it can be accessed. The storage is done in a Boolean type, that is, it will be true if it is reachable, false if it can not be accessed. The library supports the host name too, just pass a string instead of the IP address. In addition, the function accepts a second integer parameter *countque* that specifies how many connection tests were performed [5].

The modem is connected to the prototype where the modem's male connector is connected to the female connector of the device, and the male connector of the device is connected to the socket. With the system on, the device at sixty seconds intervals tests the connection by performing three reachability tests for the different sites that are running 24 hours a day. After the connection tests two situations can happen. First, all three tests may have been terminated and the variable will hold true, which will cause another sixty seconds of waiting without restarting the modem, and after that, it will re-run the connection tests, starting the steps again. Second possibility is that one of the tests fails and the variable stores false causing the modem to turn off for ten seconds, after that time the modem is turned on and it waits another thirty seconds for the signal to be reestablished and again the device performs the tests. If the connection is established the return schedule will be stored and sent back with drop-off time for a pre-established email.

The *textit Gsender.h* library is used to send an email when the connection is established [12]. The steps that the system performs from drop to restart can be checked in a more illustrative way following the flowchart (Figure 1).

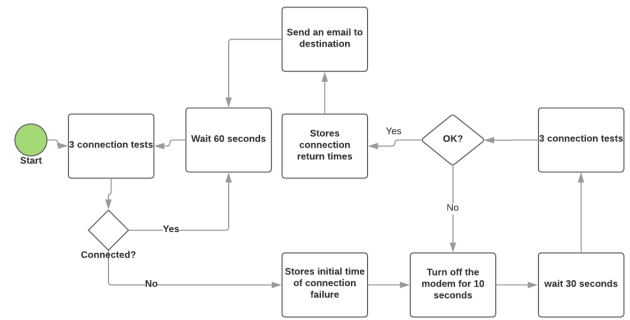


Fig. 1. Flow of system steps. [19]

In the first step, tests were done to detect the fall of the internet using only one LED that lit when it detected the fall. With only one GPIO pin (14) of the ESP8266 the circuit was prototyped along with the LED connected to the GPIO (14) that powered the LED when the internet dropped. Using the 3G internet routed from an ordinary cell phone, turning off and on the Wi-Fi access point mode. The circuit consists of making the LED connected to the NodeMCU emit constant light for a period of 10 seconds when it detects the absence of the network to which it is connected.

The experiment was conducted in a residence with internet access provided by a broadband provider. A *Wireless 300Mbps Router - LI-RW333* was used for testing the network. We selected a four weeks period for further analysis to find out what days there is more connection idleness.

The destination email has to be changed to receive from untrusted sources. So, go into app settings and enable "Allow less secure apps".

### 4. RESULTS

The construction step was performed using the NodeMCU, modem, relay and a power cable where one end has a female plug connected and the other has a male plug. This cable is designed so that the power cord of the modem is not cut off and does not damage the equipment. The relay was used to enable the activation of a 220V load through the GPIO14, using a voltage of 5V applied to the relay. Thus, the coil will generate an electromagnetic field attracting the NF (normally closed) contact which is connected or vcc to the (normally open) NO, thus closing the circuit, thus allowing the modem current to be interrupted and then switched on, restarting so the equipment. The circuit diagram is shown below Figure 2.

Figure 3 shows the NodeMCU (A), Relay module (B) of the assembled circuit on a circuit board.

Table 2 shows the time when the internet was idle for each day of the week in the selected period.

The initiative to create a prototype to monitor idle time proved to be quite effective in its results. The downtime from the moment the internet is disconnected and the return time of the connection were quite satisfactory. The time that the equipment is turned off is in accordance with the standard that is used by the vast majority of users (it is also the one recommended by the operators), that is, the time of ten seconds.

greater control. These records can serve as evidence to the user regarding the carrier that provides the internet.

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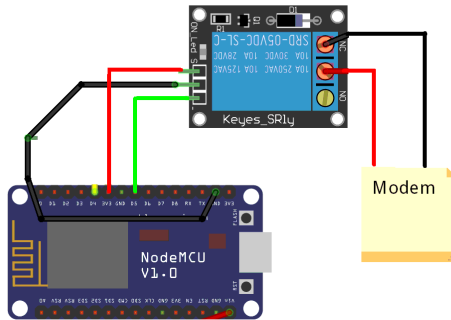


Fig. 2. Circuit diagram.

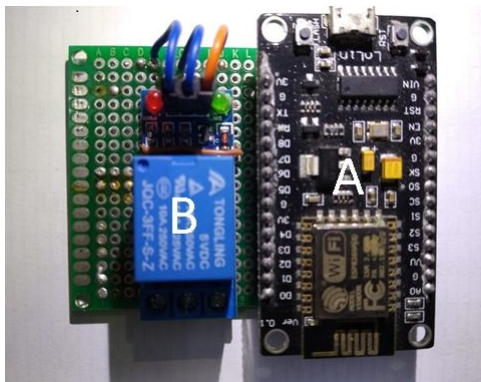


Fig. 3. Prototype Circuit

Table 2. Idle time per day.

Days	First week	Second week	Third week	Fourth week
Sunday	00:13:24	01:34:43	00:03:12	00:21:53
Monday	00:09:11	00:12:07	00:04:19	00:12:46
Tuesday	00:17:55	00:05:47	00:07:04	00:11:34
Wednesday	00:40:37	00:15:59	00:18:29	00:16:12
Thursday	00:18:03	00:17:21	00:09:13	00:40:35
Friday	00:26:40	00:23:44	00:14:22	00:15:01
Saturday	02:41:20	00:10:08	00:23:48	00:09:19

## 5. CONCLUSIONS AND FUTURE DIRECTIONS

Difficulties were found throughout the development of the prototype. When recording the code on the NodeMCU, the system detected only the first drop of the wifi, so the system did not loop. The solution found was quite simple, after the first drop the cable connected to the NodeMCU was disconnected and soon after connected, with this solution the system started to work perfectly.

Work can be evolved to a more effective solution. A log can be created to let the user know how many times the internet has fallen, which are the most common days without Internet access, the most common times of not having access to the Internet, thus generating

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