International Center for
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Gateway Docking Station V1.0

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1. Summary

Any network has a boundary or a limit, so all communication placed within that network is conducted using the devices attached to it, including switches and routers. If a network node wants to communicate with a node/network that resides outsides of that network or autonomous system, the network will require the services of a gateway, which is familiar with the routing path of other remote networks.
The gateway (or default gateway) is implemented at the boundary of a network to manage all the data communication that is routed internally or externally from that network. Besides routing packets, gateways also possess information about the host network's internal paths and the learned path of different remote networks. If a network node wants to communicate with a foreign network, it will pass the data packet to the gateway, which then routes it to the destination using the best possible path.
The designed gateway docking station is implemented for easy installation process and provides voltage protection.

2. Problem definition and background

With the emergence of smart cities, smart communities and smart homes, the wireless technology has been greatly developed and applied for every research processes. Nowadays, the wireless methods are commonly used, such as GSM, GPRS, WIFI, ZigBee, etc.. LoRa (Long Range) is a spread spectrum modulation technique derived from chrip spread spectrum(CSS) technology and is the first low-cost implementation of chirp spread spectrum for commercial usage. It was developed by Cycleo of Grenoble, France and acquired by Semtech in 2012, a founding member of the LoRa Alliance. Semtech's LoRa devices and wireless radio frequency technology (LoRa Technology) is a long range, low power wireless chipset that is used in a lot of Internet of Things (IoT) networks worldwide.
LoRaWAN is a protocol designed for creating large-scale public networks; the technology allows for sensors to talk to the internet without 3G or WiFi. Community crowdsourced projects, such as The Things Network, aim to provide access to this technology by deploying gateways globally that others can freely connect to.
We propose a mechanical water metering system through which we gather the readings by the help of reed switch on Low Power Mode and , thus consuming less power . This provides the device to work for years. The purpose is to provide a guide for people to create their own outdoor LoRaWAN Gateway using off-the-shelf components, rather than purchasing a commercial offering. Many of the components used in this design can be substituted for cheaper alternatives.

2.1 Literature review

The major issue based on previous versions of the gateways are

- Most of the gateways that are based on IoT does not provide any voltage protection method.
- Second the power is provided externally.
- Third there is no proper plug in design provided.

So by taking all the above mentioned issues we designed a board that works fine with any voltage issues and that can be used in any residential and commercial purpose. This is commonly

effective for large scale developments due to the extreme use of communication nowadays. This can provide the clear usage of data communication that can be accessed within a certain kilometers and could be used for many research purposes and equipments.

2.2 Reference solution

The main scope of the design is that the module can be retrofitted to an enclosure. The proposed system also works in Low Power which provides a better method for energy consumption. The main objectives are:

- The proposed design provides with a crowbar circuit ie mainly used for voltage protection.
- The other challenge was to provide power without any external power plugins directly so by the use of POE (Power Over Ethernet) the board get sufficient power and also a buck boost is provided.
- The board design provides with easy plugin connection for modules.

3. Design

The design of the project is basically the main task. Usually what's a gateway?. A gateway is a data communication device that provides a remote network with connectivity to a host network. A gateway device provides communication to a remote network or an autonomous system that is out of bounds for the host network nodes. Gateways serve as the entry and exit point of a network; all data routed inward or outward must first pass through and communicate with the gateway in order to use routing paths. Generally, a router is configured to work as a gateway device in computer networks.
The device should be retrofitted to the enclosure designed. For the basic needs the design was developed that can be easily plugged in.

3.1 Schematic Design

The schematic diagram represents the basic gateway design for Gateway Docking Station.

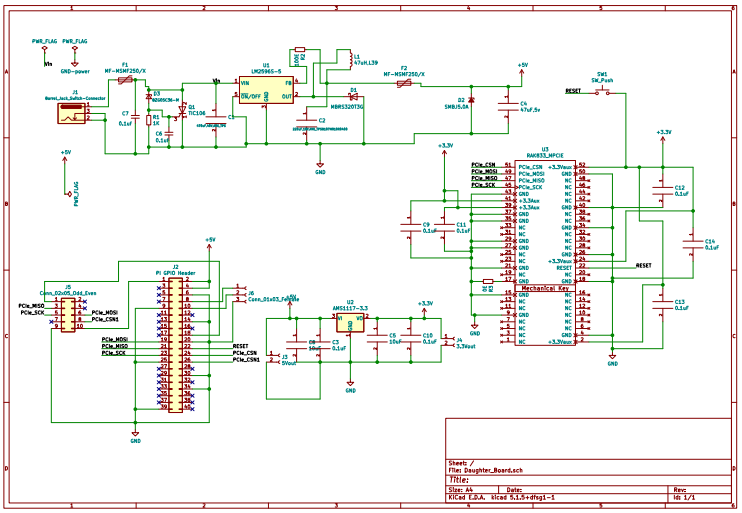

Figure 3.1: Schematic Diagram

3.2 Layout Design

The layout design of the Gateway Docking Station.

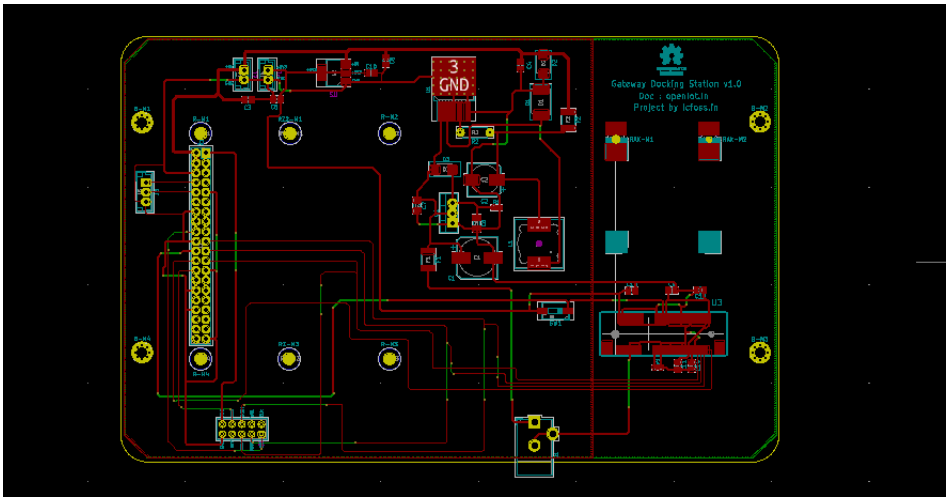

Figure 3.2: Layout Design without fill zone

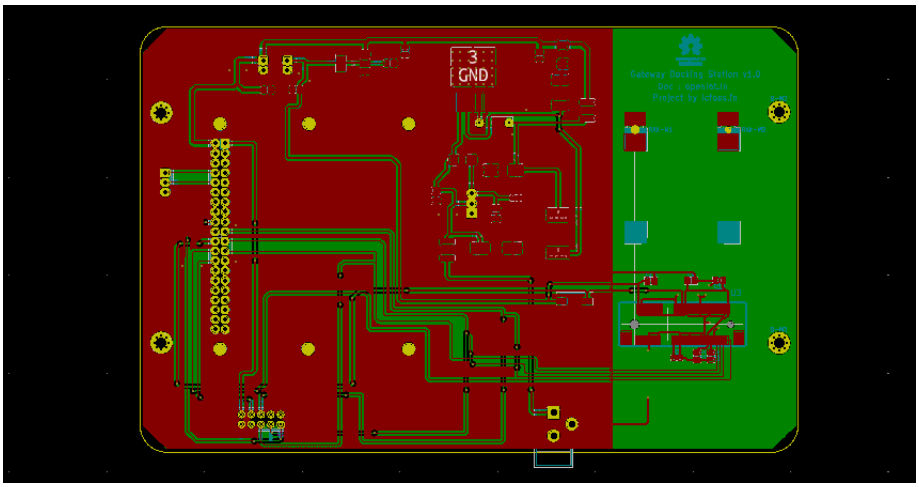

Figure 3.3: Layout Design with fill zone

4. Implementation

The proposed board is designed using a kicad an open software used for designing. The design consist of crowbar circuit from voltage protection with a buck boost which is essential for providind enough power for Raspberry pi and RaK 833. For the implementation of the gateway docking station the necessary circuits were developed. Tested each circuit seperately and all the necessary solutions were found out. Designed the schematic diagram and all the errors were cross checked and the layout was prepared. After several adjustments a board was developed and printed. All the components were assembled and checked.

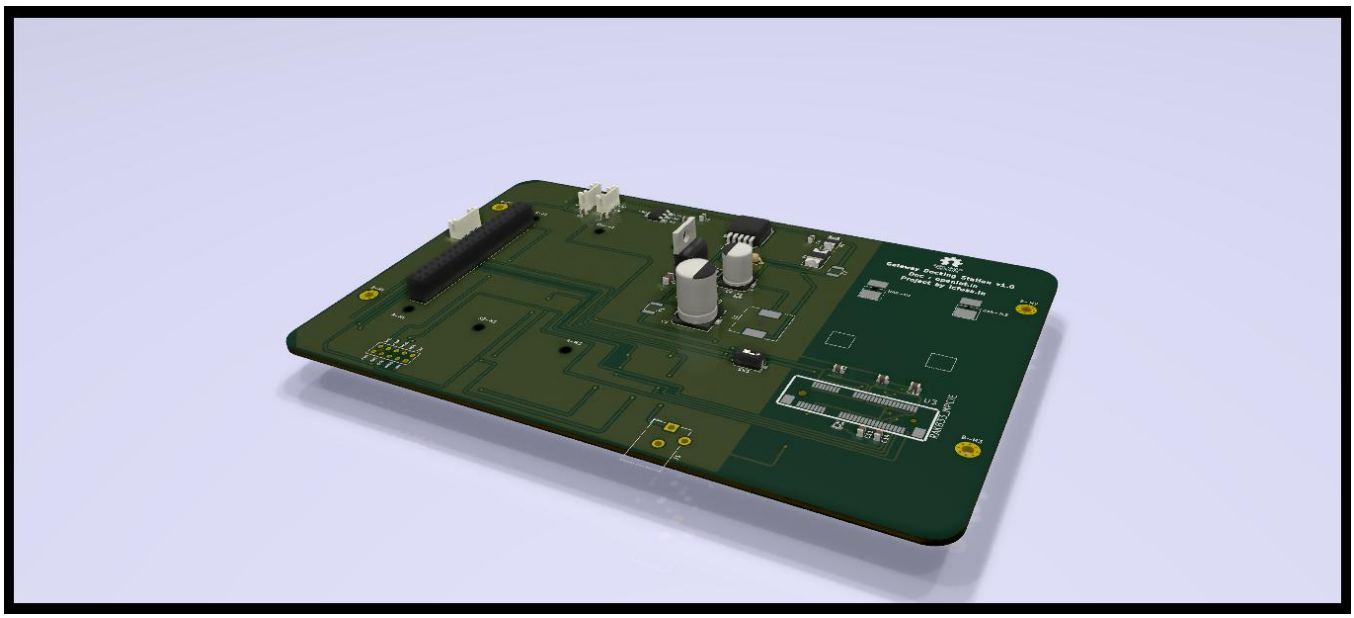

Figure 4.1: 3D Design of Gateway Docking Station

4.1 Hardware

The components that are used in the project are mentioned below.

1. **Raspberry Pi 3b+**

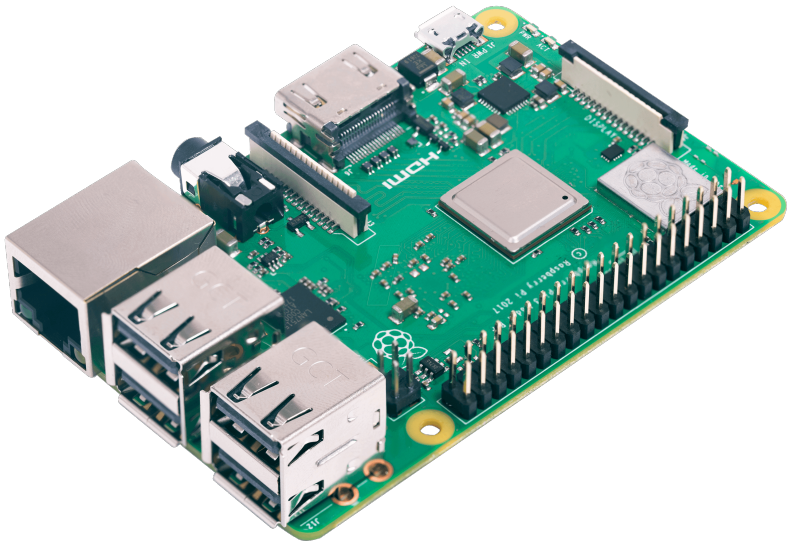

Figure 4.2: Raspberry Pi 3 Model B+

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4 GHz, dual-band 2.4 GHz and 5 GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HATThe dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market.

2. **RAK 833**

RAK833 is a fully-fledged LoRaWAN® concentrator module. It is very similar in function to the larger RAK831 module.The RAK wireless RAK83-SPI is a complete and cost effective LoRa gateway solution offering up to 10 programmable parallel demodulation paths. It's perfect for smart metering fixed networks and IoT applications with up to 500 nodes per Km2 in moderately interfered environments.

Figure 4.3: RAK 833

3. **LM2596S-5**

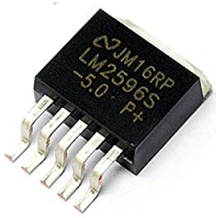

Figure 4.4: LM2596S-5

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

4.2 How it Works

The Gateway Docking Station consist of a crowbar circuit, a buck boost and all the necessary plug in module headers and mini PCLE slot. The board is powered using an injector and basically works for Raspberry pi zero and Raspberry Pi 3 Model B+. A crowbar circuit is an electrical circuit used for preventing an overvoltage condition of a power supply unit from damaging the circuits attached to the power supply. It operates by putting a short circuit or low resistance path across the voltage output (Vo), quite like were one to drop a crowbar across the output terminals of the power supply.
The buck–boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude.The buck boost is used to provide essential power for the Raspberry pi. An AMS117 IC is used convert the 5V to 3.3V which is used to work the RAK 833. The RAK 833 is a concentrator module which is a complete and cost effective LoRa gateway.

4.3 Testing

The main and the conclusive part of the project is testing. Initially, all the components are tested and verified that they are working properly and identified the current consumption. After all the individual tests the components are integrated and checked that all the connections are proper.
The second phase is testing the circuit using a dot board. Next, testing the device performance under the lab condition and continuously monitor the output of the device and check if the device outputs are valid to our need.
The last phase is to deploy the device for the field test, whether the device is performing under certain weather conditions. All the outputs are noted and compared with other similar devices. Finally, deploy the device for the implementation.

5. Results

For the testing of the device, several procedures are taken for accurate results. The product is designed for creating large-scale public networks, the technology allows for sensors to connect with the internet.

5.1 Test 1

From the initial state, the crowbar circuit is developed and tested. For the testing purpose several fuse were tested. Therfore 2A fuse is needed for the proper working of the circuit. Then next procedure was to find out the total input current taken by the board. Therefore each modules input current is tested individually and also the efficiency is calculated.
Total absolute input current = 2000+(2000*3) = 2600 mA
So it is approximately 2.6A. Therefore trace width is calculated using PCB calculator. All the necessary net classes width are gathered. After routing and all the procedures are completed a DRC check is done, whether there are errors or not. Then the board is cross checked and gerber files, pdf files are generated.
Finally, we test the device inside the lab condition and checked the performance. The test found to be successful, there is no problem regarding the device and also works fine using POE injector. After the lab test, the node is deployed for the field test and again checked the performance. In both of the scenarios, the device performance was accurate without any problem and its output is compared with the commercial device and note the error percentage.

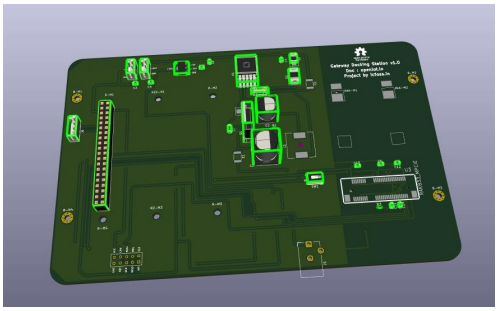

Figure 5.1: Gateway Docking Station V1.0

6. Conclusions

In this design, an IoT gateway for communicating different kinds of sensors was designed, consisting in a Raspberry Pi acting as a controller node, and RAK 833 concentrator and a web platform for monitor and control the network. The developed system so far, accomplishes the proposal features and purpose, giving the user the ability to access the environmental datas remotely. Nevertheless more tests to the system in multiple situations can be done in order to prove the efficiency of the developed architecture.
In the future, we are planning to compare multiple communications protocols for each point of communication, or even offer a solution supporting multiple communication schemes. Furthermore, additional functionalities will be considered for the system, such as the possibility to create sets of rules directly from the platform and add Artificial Intelligence or Machine Learning. At last, the focus will be towards a more secure system, with the implementation of encrypted communications and an SSL protocol and certificate on the webserver side.

7. Bibliography

- Kicad EDA
- www.youtube.com
- Several datasheets of the compponents and modules.

Appendix A: Resources

Report the config files of the software used (i.e. SU2 [**?**] and the mesher). Also attach to this report an archive with the mesh files, solutions and the reference solution data (e.g. data points of a Cp plot ...)

Mesh configuration files

SU2 configuration files