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Water Management System (WMS) Beta v2.0

**15th July 2021**

**Scope:**

This brief serves as an update to the original proposal document and details the design and operation considerations of WMS Beta version 2.0.

**OVERVIEW**

This document serves as an update on the milestones proposed in the original document as well as a detailed walkthrough of the design and operation of Beta v1.2 of the prototype. This document also covers the “Instruction manual for adding of nodes to system” milestone of the proposed requirements.

**CHANGELOG**

1. The router chosen to provide LoRaWAN network coverage and connection to “The Things Speak Network” was changed from the LG01 to the LG02.
   1. The WMS software was written for use with LG02 gateways of firmware version LG02\_LG08-5.3.1580178039 or later as MQTT communication in previous versions of the software will not work with our node scripts.
2. Arduino IDE version was changed to Arduino IDE v1.8.15 for software development as it was found to keep system behaviour responsive and consistent.
3. Compatibility for the LoRa Mini Dev added
4. Sleep mode added to LoRa Mini Dev

**MILESTONES**

The original design milestones that have been met with this prototype version are as follows:

* Gateway communicates with one Node
* Gateway communicates with two Nodes
* ThingsSpeak website and MQTT database launched
* ThingsSpeak integrated with Gateway and Control loop
* Website communicates with mobile device/Laptop
* Instruction manual for adding of nodes to system
* OFF mode – allow 6 kl a month through the control loop then fully stop thereafter
* ON mode – track water usage, update logs using Tx line from node to gateway twice a day minimise current drawn from power bank by node

The remaining milestones are as follows:

* Control loop measures and controls water consumption
* Low battery signal received at LoRa Gateway and updates website
* First verification and acceptance test passed
  + Verification Pass condition determined by Consulting Engineer
  + Acceptance Pass condition determined by User/Client.

**SYSTEM OVERVIEW**

The LG02 router serves as the gateway through which the Arduino Uno node and TTN communicates. Upload to update TTN uses MQTT machine-to-machine communication between the node and gateway where the gateway uses an internet access point to send updates to TTN. Download to update the node status uses the TalkBack API webapp to send commands from TTN to the gateway which is then broadcasted to all nodes subscribed to the router via MQTT. Uploaded data consists of water usage readings and device statuses whereas downloaded data consists of commands sent by a system administrator. TTN collects and records the data uploaded and the node MCU collects data and actuates on command.

**List of components:**

1. **LoRa LG02**

To be used as network gateway

1. **Arduino UNO + LoRa Shield**

To be used as node MCU processing unit

1. **2000mAh power bank**

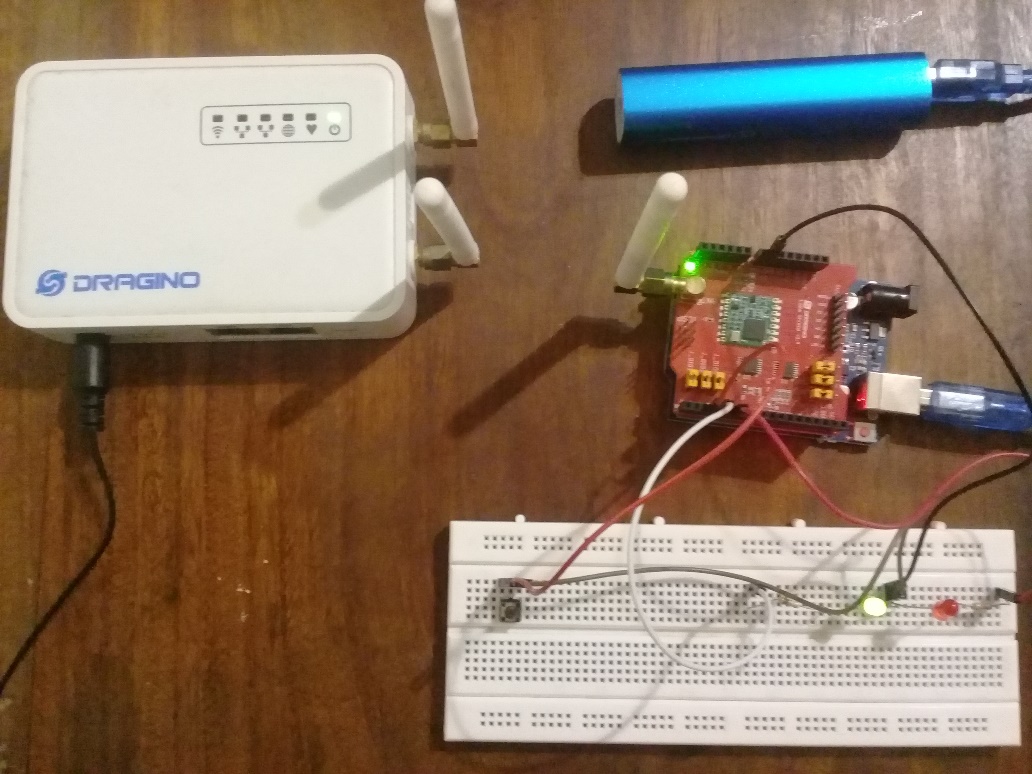
To be used as Power Supply for the Node

1. **2 x 100Ohm resistor and 2 x LED**

To simulate the valve open and close operation

1. **4-pin Switch**

To simulate the hydrometer measurement operation



RED – LG02 Gateway

YELLOW – Power Bank

GREEN – Arduino Uno + LoRa Shield

BLUE – Switch

PURPLE – LEDs

**SYSTEM SETUP AND INITIALISATION**

1. **LG02 gateway**

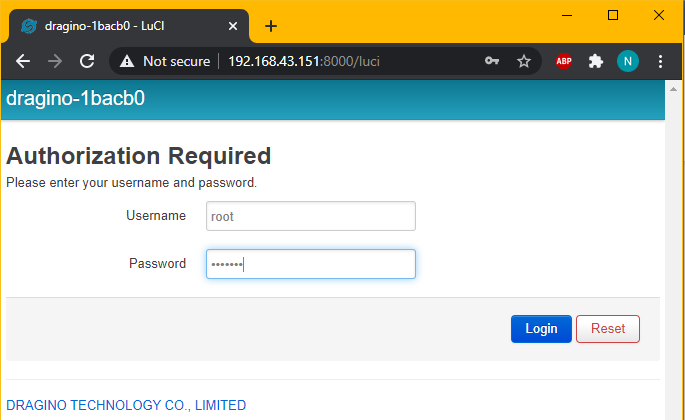
**Access the LG02 gateway device**

Connect to the gateway via LAN cable and enter **10.130.1.1** into your browser to access the gateway settings.

Alternatively, one can also access the gateway remotely by ensuring the PC and gateway are clients on the same Wi-Fi network and entering the assigned gateway IP address into the browser using port 8000 to connect:

**FORMAT: “<IP address of gateway>:8000”**

This will be shown later in this section.

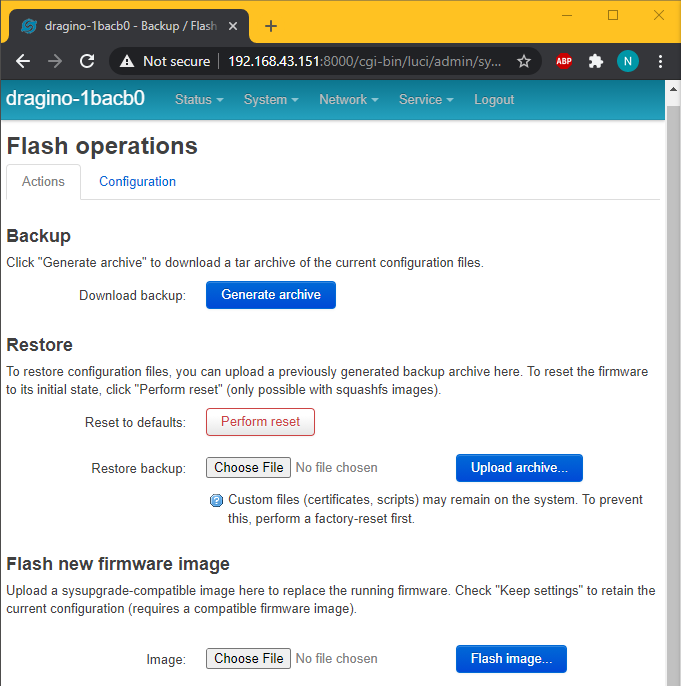


**USERNAME: root**

**PASSWORD: dragino**

**Update the firmware to version LG08-5.3.1580178039 or later**

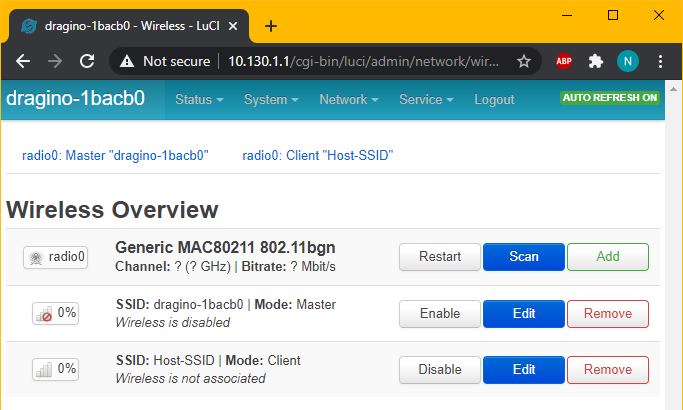
Navigate to the “**System**” tab and access the “Backup/Flash Firmware” option.



Click on “**Choose** **file**” and select the update image from your computer’s local directory. Then click on “**Flash** **image**…”. Wait for the system to update and restart then proceed with the following steps.

**Connect to a Wi-Fi network**

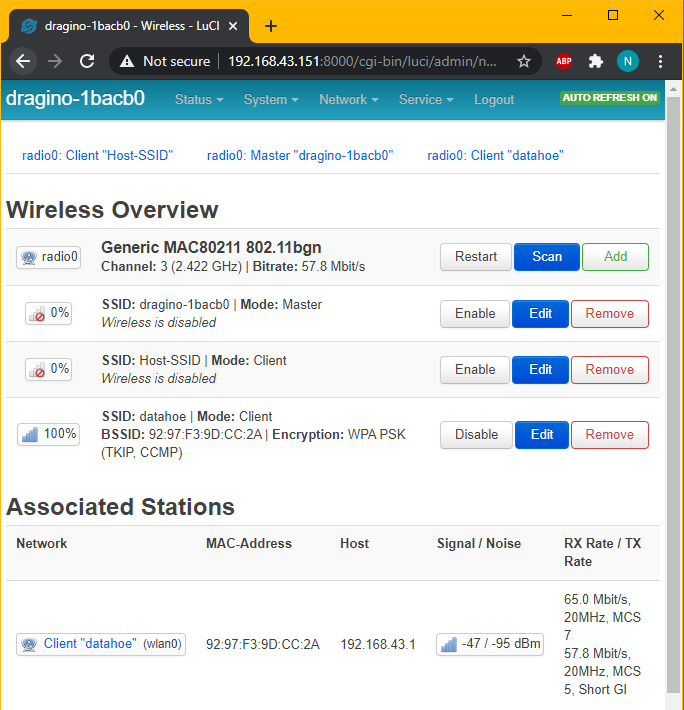
Navigate to the “**Network**” tab and select the “**Wireless**” option.



Select the “**Scan**” option to search for available Wi-Fi networks then select “**Join** **Network**” on your Wi-fi Network and enter the passphrase associated with your network.

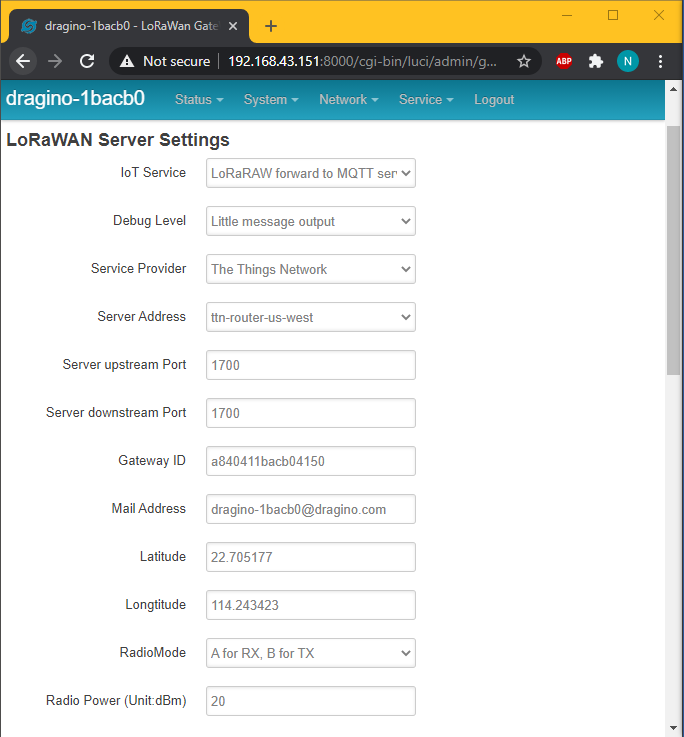
Once you have Saved and Applied your settings, navigate back to the “**Wireless** **Overview**” page and disable “**Host-SSID**” to allow your gateway to become a client on the new Wi-Fi network.

\*Once you have determined the IP address of the gateway, the gateway can now be accessed wirelessly after this step

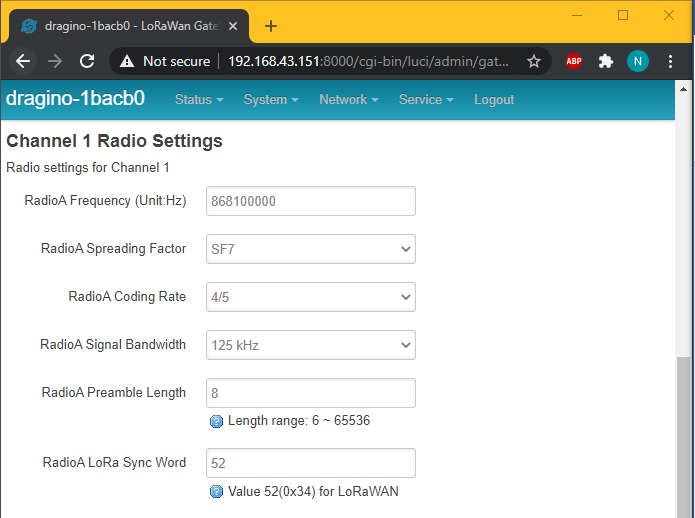


**Change gateway settings to support MQTT format communication**

Navigate to the “**Service**” tab and select the “**LoRaWan** **Gateway**” option. Then change the “**Iot** **Service**” option to “**LoRaRAW** **forward** **to** **MQTT** **server**”, change the “**Service** **Provider**” to “**The** **Things** **Network**” and the “**Server** **Address**” to “**ttn-router-us-west**”

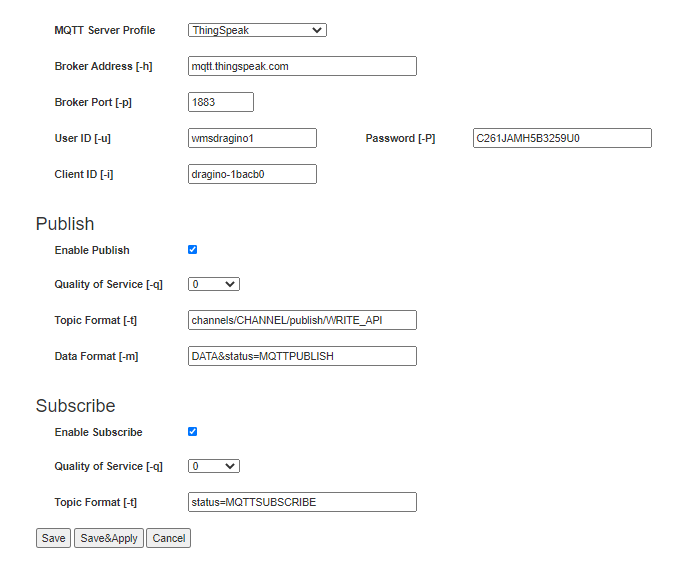


On the same page, ensure that both Channel Radio Settings have the following settings:



Navigate to the “**Service**” tab and select the “**MQTT** **Menu**” option. On the MQTT Configuration page, ensure that the gateway has the following settings:

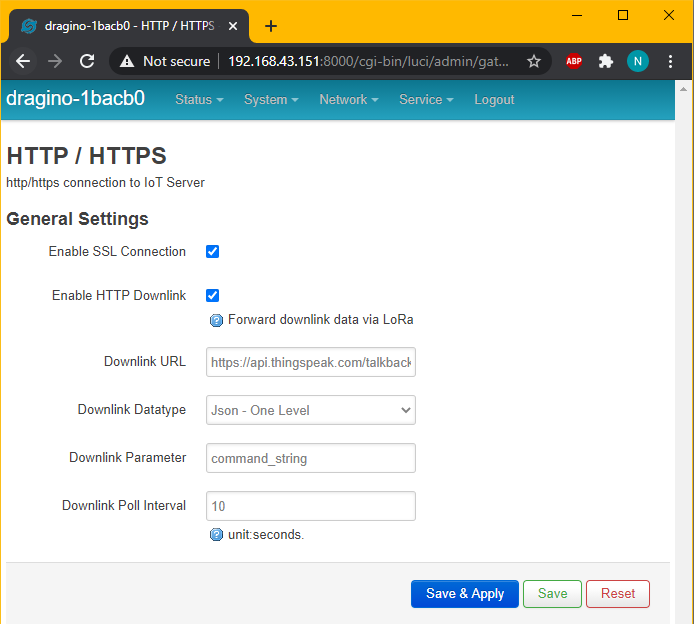
\*The “**Client** **ID** **[-u]**” has to be changed to the unique ID of the gateway



Navigate to the “**Service**” tab and select the “**HTTP**/**HTTPS**” option. Enter the following link into the “**Downlink** **URL**”:

<https://api.thingspeak.com/talkbacks/41716/commands/execute.json?api_key=X4JDJ1DYNPLI2F1Q>

Also ensure that the General Settings are as follows:



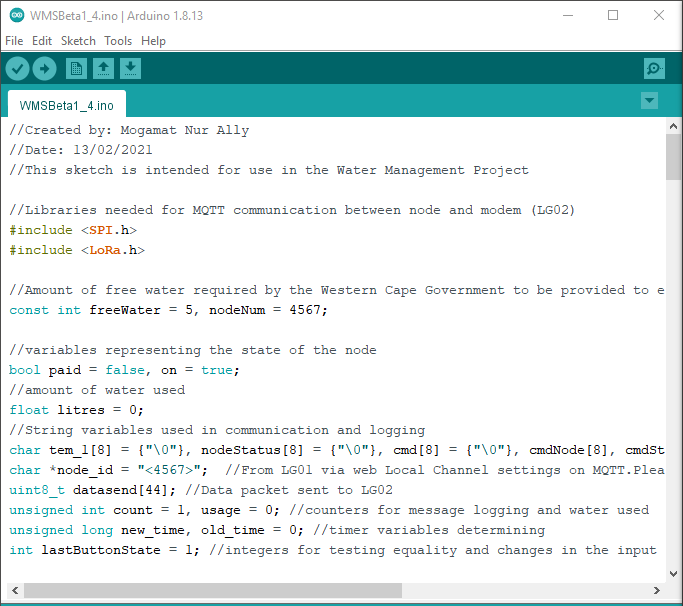
1. **Arduino Uno + Lora Shield node**

**Connect to and Name the Node**

Connect to the serial port of the node via USB. Open the **WMSBeta1\_4.ino** sketch in Arduino.

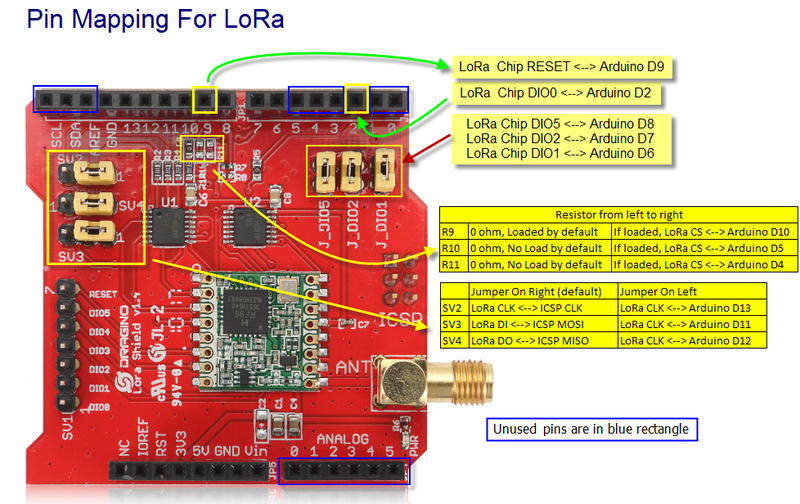
Assign a number to the “**nodeNum**” and “**\*node\_id**” variables, these numbers must be identical and will become the name of the node.

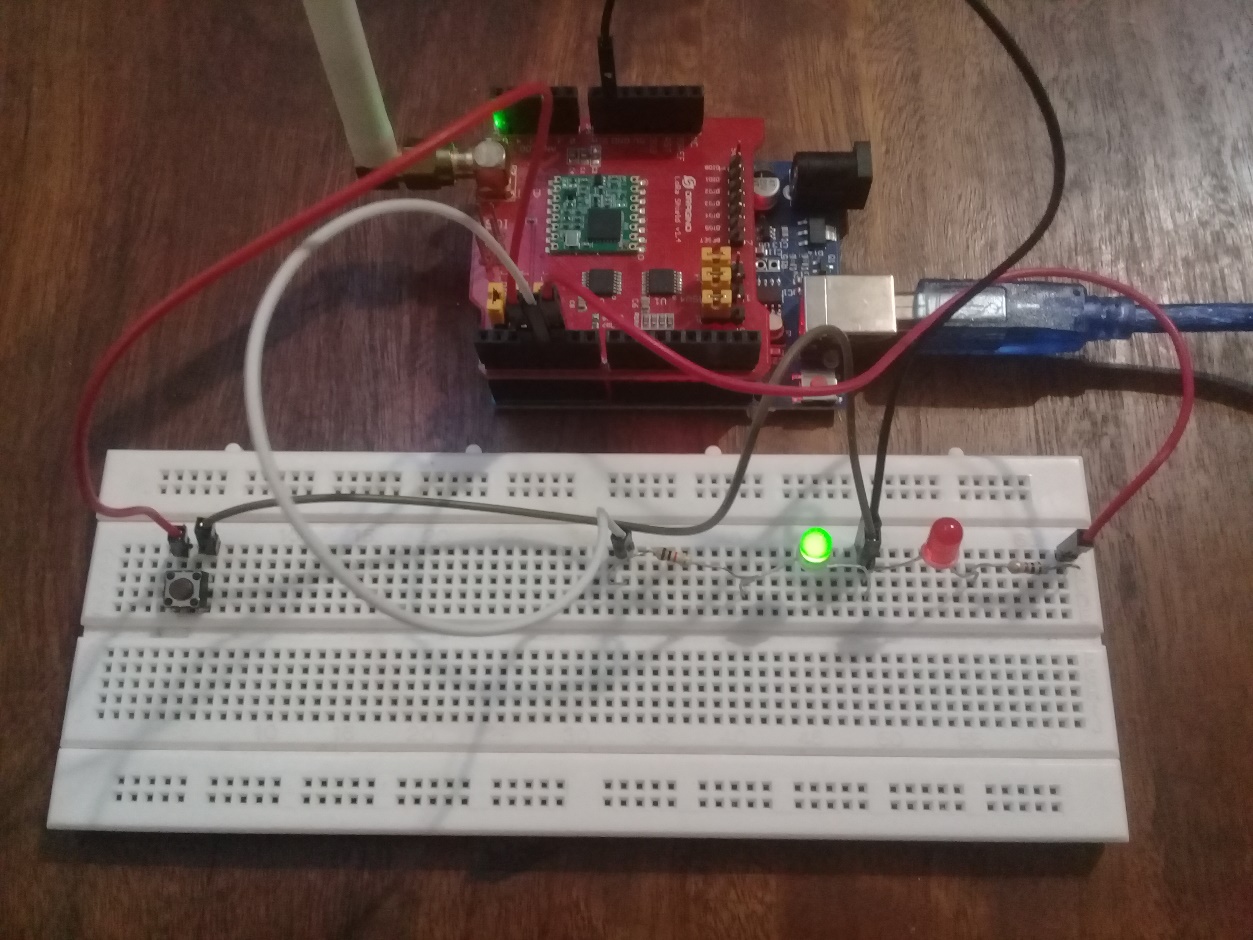
Then Upload the sketch to the Arduino Uno + LoRa Shield (ensuring that the COM# of the Arduino IDE is correctly matched to the USB port, this setting can be changed and checked under the “**Tools**” tab)



**Connect the switch and LEDs**

Using the diagrams below as a guide, connect the positive end of the switch to **Digital pin 3** and the negative end to the on-board **GND** pin. Connect the positive end of the series resistor + Green LED combination to **Digital pin 4** and the negative end to the other available on-board **GND** pin. Connect the positive end of the series resistor + Red LED combination to **Digital pin 5** and the negative end to the other available on-board **GND** pin.



**Node Setup**

1. **Adding a new node to The Things Network**

**Create a new channel to collect and display the node data**

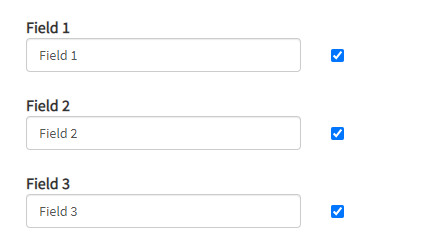
Open your browser and navigate to thingspeak.com and log in using the following details:

**EMAIL:** [**wmsproject001@gmail.com**](mailto:wmsproject001@gmail.com)

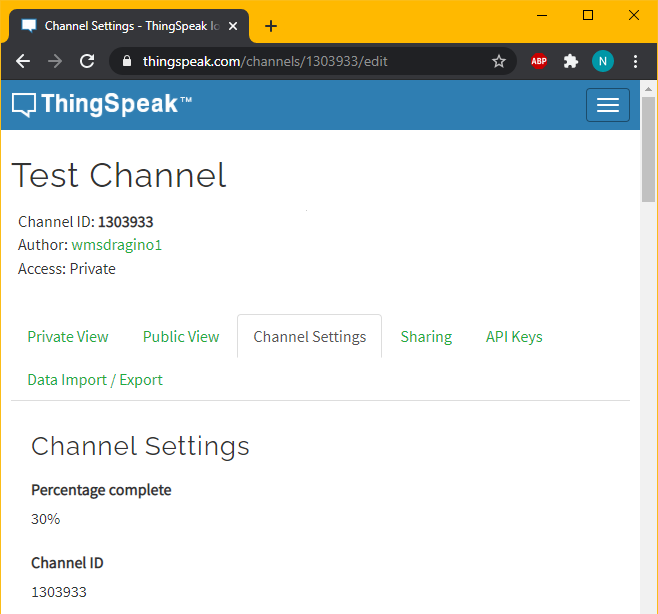
**PASSWORD: Wmsp0786**

Navigate to the “**Channels**” and select the “**My** **Channels**” option. Select “**New** **Channel**” option.

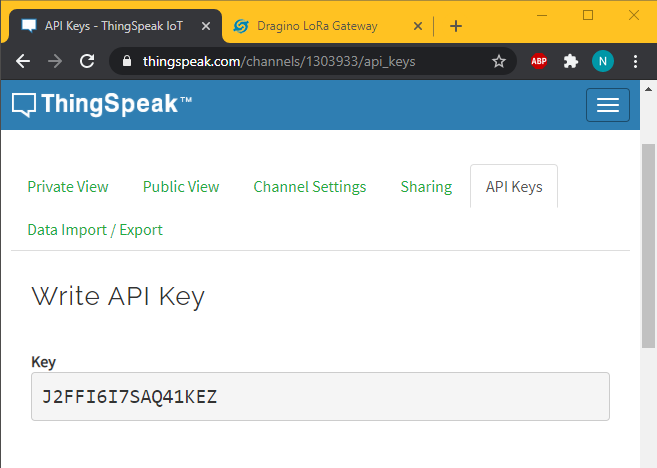
Enter the node number under “**Name**” and activate the first 3 fields using the following naming convention:



Navigate to “**My** **Channels**” and open your channel. Go to “**Channel** **Settings**” and note the “**Channel** **ID**” number.



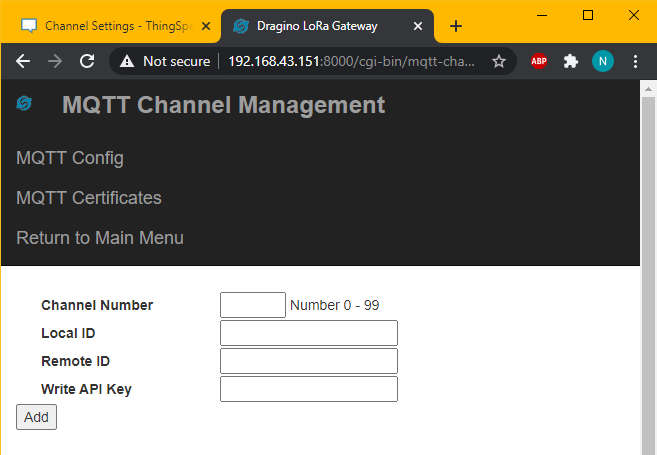
Then navigate to the “**API** **Keys**” tab of your channel and note the “**Write** **API** **Key**”.



**Create MQTT communication link in gateway**

Access the LG02 gateway via LAN or Wi-Fi and log in. Go to the “**Services**” tab and select the “**MQTT**” menu. Once you are in the MQTT menu, navigate to the “**MQTT** **Channels**” tab.

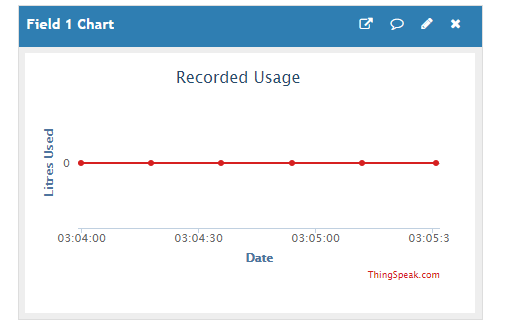
Insert any available number in the “**Channel** **Number**” field, insert the node number/ name of the node into the “**Local** **ID**” field, enter the Channel ID into the “**Remote** **ID**” field and enter the Write API Key of your channel into the “**Write** **API** **Key**” field. Click “**Add**”.



**SYSTEM OPERATION**

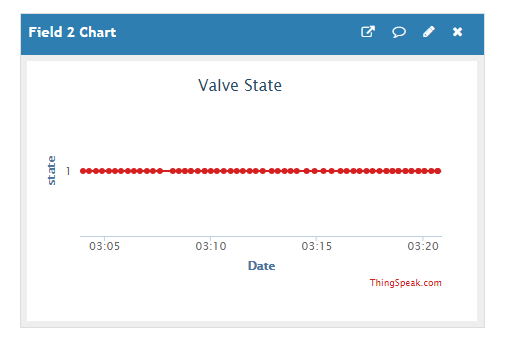
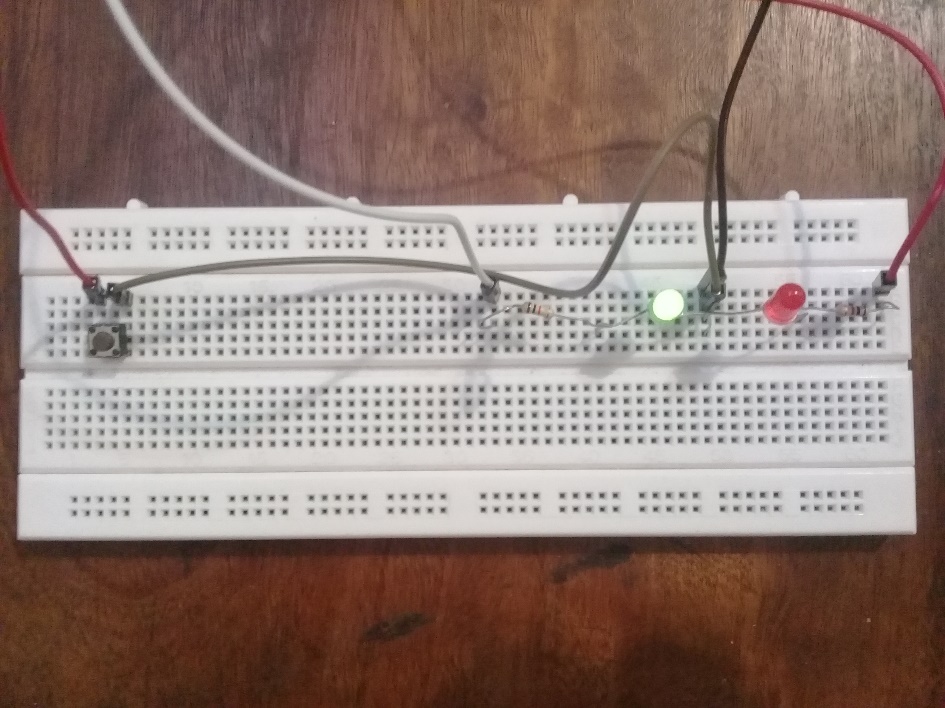
1. **Hydrometer operation**

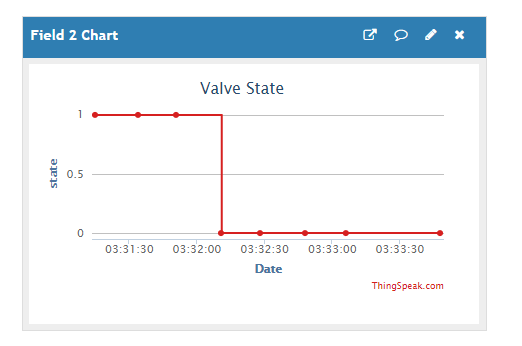
To simulate the pulse signal produced by the Sensys220C hydrometer, a switch is used. When the switch is pressed and released, a rising-edge signal is sent to the node. The node registers this as a 500ml consumption. The node then logs the node number as well as the total usage recorded to the serial port as well as sends the data to the gateway, this “Update” operation takes place every 12 hours. When the gateway receives the data packet, it forwards the data to TTN and updates the channel to which the node is linked.

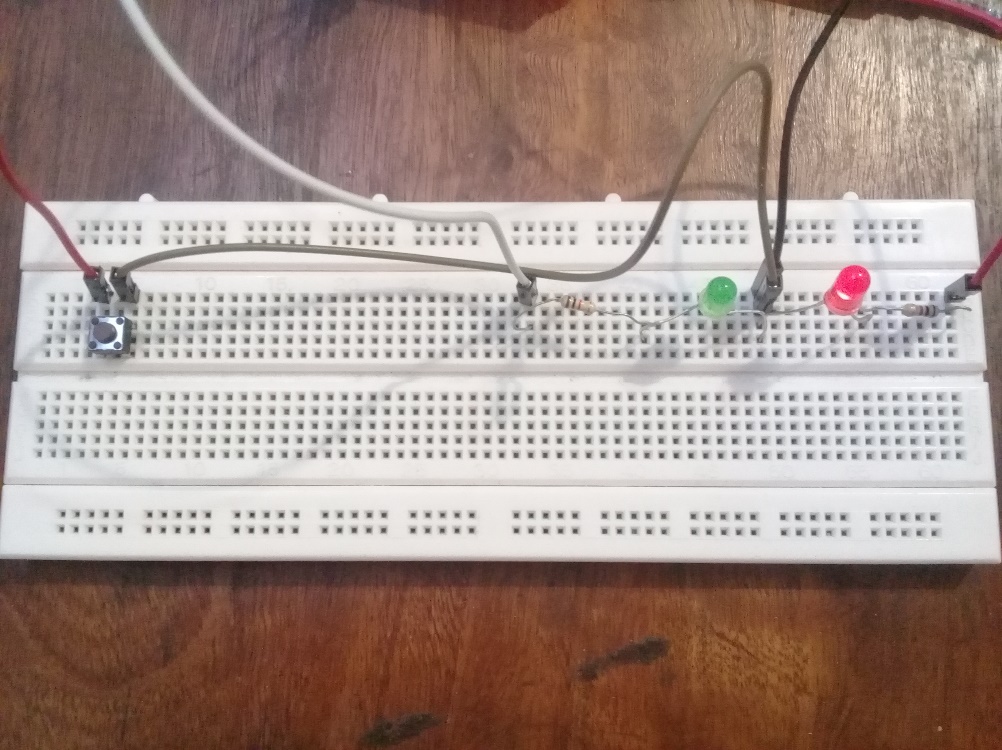


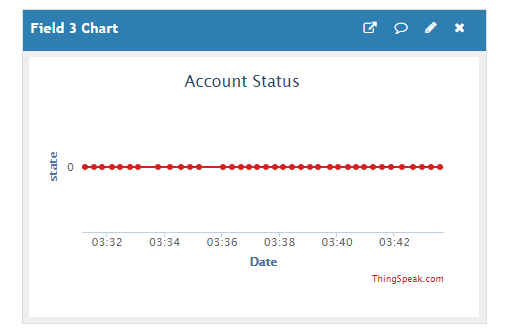
1. **Valve operation**

To simulate the state of the valve, two LEDS are used. When the valve is in the open position, the green LED will be lit and when the valve is closed, the red LED will be lit. This is to indicate the polarity of the voltage provided to the valve motor. When the “Update” operation takes place, TTN is updated with the status of the valve. On TTN a recorded value of “1” means that the valve is open and a “0” means the valve is closed.

The figures below show the system in the open valve state.

The figures below show the system state after the valve has been put in the close position.

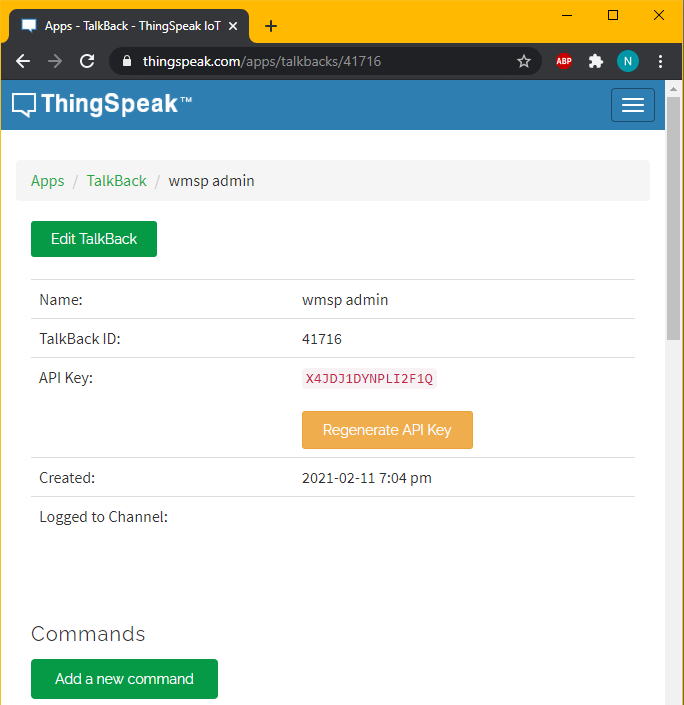


The valve is also set to close automatically at a certain recorded usage depending on the status of the “paid” variable. Thich indicates that the consumer has used their free basic water amount and have not paid for further water consumption. The status of the “paid” variable linked to the node is also sent to TTN and displayed on the channel when the “Update” function takes place.

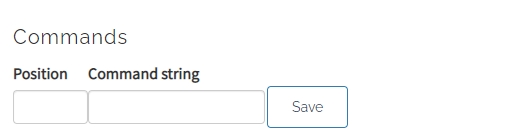
The system is currently set up to provide 6000 litres of water while the “paid” variable is set to false, thereafter if more water is recorded being used, the system will close the valve until the status of the account is change by the administrator using the “**TalkBack** **API**”

1. **Node control operation**

On the thingspeak.com website, if the system admin navigates to the “**APPS**” tab and select the “**TalkBack** **API**” option, the system admin can broadcast commands to all nodes across the LoRaWan network.



Select the “**Add** **a new command**” option to open the interface that allows broadcasting to the LoRaWan network.



The format of the command string broadcasted is as follows:

**<node number>\_<command>**

Only the nodes which match the <node number> will carry out the command.

The list of commands are as follows:

**OV: Open Valve**

**CV: Close Valve**

**CAS: Change Account Status (Paid to Unpaid or vice versa)**

**Eg: 4567\_CV**

**This command will close the valve of node number 4567 regardless of its status.**

**SYSTEM TROUBLESHOOTING**

Please follow the “**MQTT forward instruction**” manual to test the LG02 gateway and Arduino UNO + LoRa Shield components and identify any faults with these components. The software and manuals needed to set up the test environment should be attached along with this document.

A test version f the node software should also be provided to test the operation of the node in the system once the gateway has been set up for MQTT communication. The test version updates every 6 seconds and has a free water usage limit of 5 litres to make testing the system functions easier.