Single Channel LoRa IoT Kit v2 User Manual

Document Version: 1.0.7

Version	Description	Date
1.0.0	Release	2019-Jan-28
1.0.1	Modify limitation words	2019-May-10
1.0.2	Add description of MQTT publish format	2019-Jun-15
1.0.3	Add ThingSpeak downlink example, and Video Link	2019-Jun-19
1.0.4	Correct broken links.	2019-Jun-25
1.0.5	Add trouble shooting for Arduino 1.8.10, add CN470 support, Change Cayenne to Mydevices	2019-Oct-25
1.0.6	Add Password	2020-Nov-24
1.0.7	Instructions for changing TTNv2 to TTNv3	2021-Aug-04

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1 Overview

1.1 What is Dragino Single Channel LoRa IoT Kit v2?

Dragino Single Channel LoRa IoT Kit v2 is designed to facilitate beginners and developers to quickly learn LoRa and IoT technology. It helps users to turn the idea into a practical application and make the Internet of Things a reality. It is easy to program, create and connect your things everywhere. A number of telecom operators are currently rolling out networks, but because LoRa operates in the open spectrum you can also set up your own network.

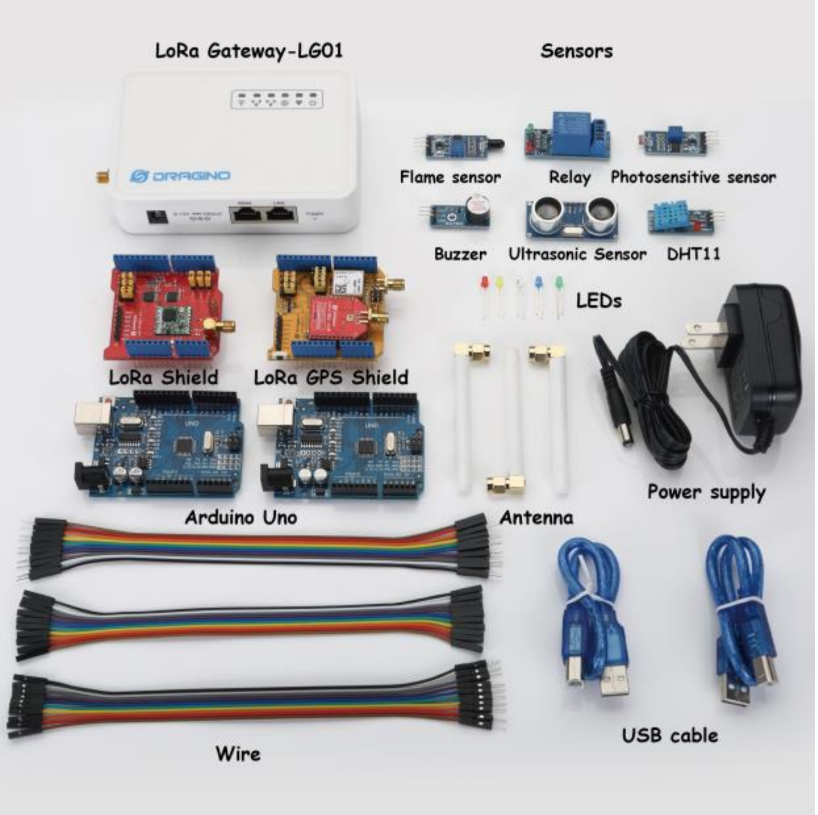
The LoRa IoT kit v2 shows how to build a LoRa network, and how to use the network to send data from a LoRa sensor node to the cloud server. Depends on the actually use environment, the LoRa gateway will connect your other LoRa nodes up to 500 ~ 5,000 meters.

1.2 What can you learn from the kit?

The goals through this LoRa IoT kit v2:

- ✓ Understand the structure of an Internet of Things network, and how does an IoT network works
- ✓ Learn coding method for Arduino micro controller
- ✓ Learn some common sensors.
- ✓ Learn some basic commands for Linux and
- ✓ Learn about LoRa and how to set up a LoRa network.
- ✓ Learn different way to connect LoRa network to IoT Server and compare their advantages / disadvantages.

1.3 What parts Dragino LoRa IoT v2 includes?



Single Channel LoRa IoT Kit Packing List.

- ✓ 1 x LG01-N single channel LoRa Gateway
- ✓ 1 x LoRa end node (LoRa Shield + Arduino UNO)
- ✓ 1 x LoRa end node (LoRa/GPS Shield + Arduino UNO)
- ✓ 1 x flame Sensor
- ✓ 1 x relay
- ✓ 1 x photosensitive sensor
- ✓ 1 x buzzer
- ✓ 1 x ultrasonic sensor
- ✓ 1 x DHT11 temperature and humidity sensor
- ✓ 20 x dupont cable (male to male)
- ✓ 20 x dupont cable (female to female)
- ✓ 20 x dupont cable (male to female)

2 Preparing

In the kit, there are two LoRa End Node, they are LoRa Shield + UNO and LoRa/GPS Shield + UNO. Both of them use Arduino UNO as MCU to control the LoRa transceiver.

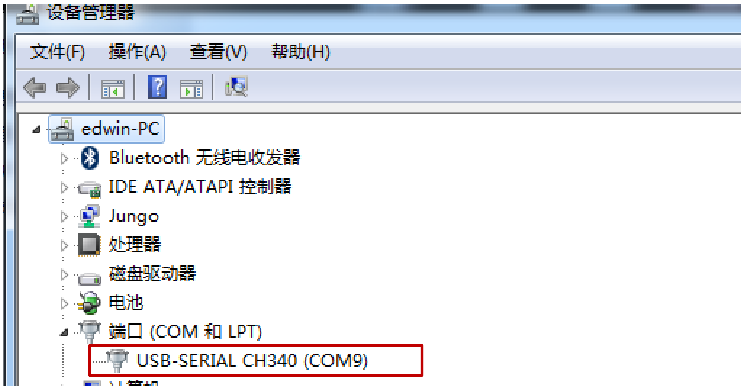
We need to program the Arduino UNO during our testing to support the required functions for end nodes. To finish this, we need to install some software and library first.

2.1 Software for End Node

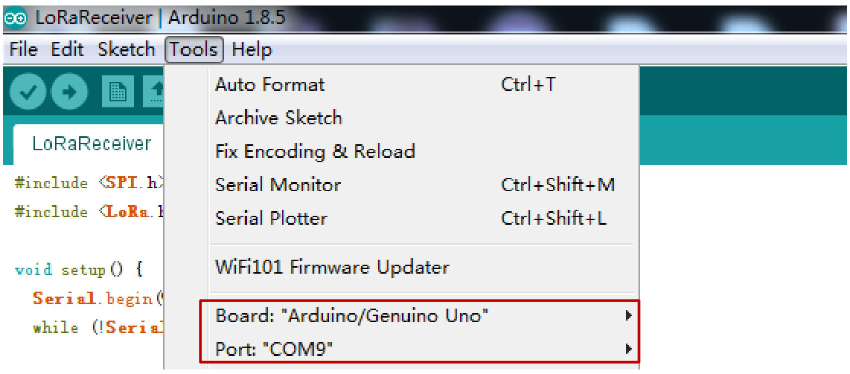
2.1.1 Install Arduino IDE and CH340 driver

First download and install Arduino IDE. This is the tool to program the Arduino UNO.

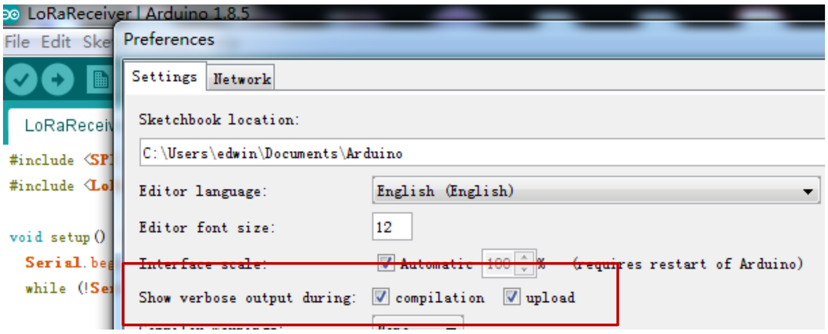
The Arduino UNO in the kit is clone version and is equipped with CH340 USB to UART chip. We need to install CH340 driver in the PC to let the Arduino IDE program it via USB. If we successful install the driver, a com port will show in the system device manager:



After install the driver, start Arduino and we will be able to use the board Arduino UNO and corresponding COM port to program UNO now.



We can enable compilation and upload in Arduino → File → Preference. This will help us in debug.



2.1.2 Install LoRa Library for Arduino

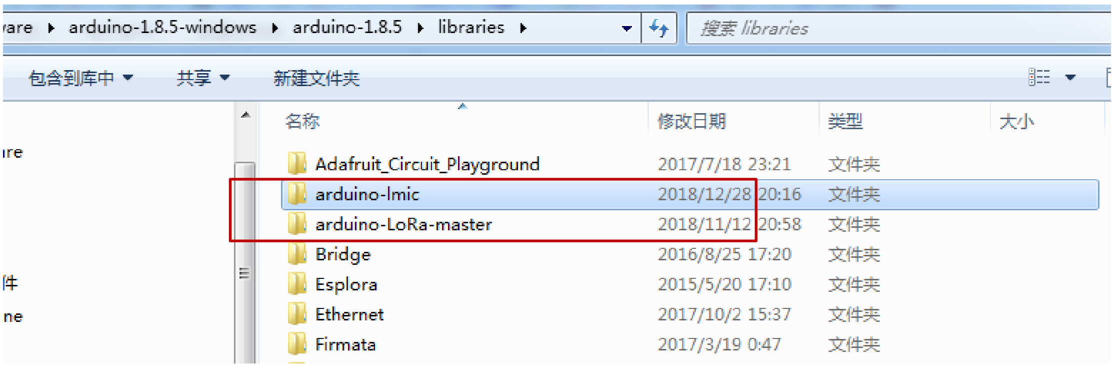
In our examples, we will use two different LoRa libraries for End Node to build different type of LoRa network. They are:

- Arduino-LMIC : LoRaWAN library to configure the End node as a standard LoRaWAN end node.
- LoRa-raw: This is a simple library for LoRa transmit & receive, all data transfer without ID control, encryption. If user wants to develop a LoRa network with private LoRa protocol, he can modify base on this Library.

We also need to install some libraries to connect to different sensors:

- DHTlib: This is the library to use DHT11 temperature & humidity sensor.
- TinyGPS: Library for LoRa GPS Shield to get the GPS data.

Download all above libraries and put them in the Arduino → Libraries directory



2.2 Prepare for LG01-N Gateway

In LoRa IoT Kit v2, we use LG01-N as LoRa Gateway. Unlike LG01-P in v1 kit, the LG01-N has its own LoRa utility and not need to program it via Arduino. Since we need to connect to Internet IoT Server, we need to configure the LG01-N to have internet access.

2.2.1 Configure LG01-N for internet connection.

Below steps show how to set up LG01-N to use WiFi for internet access.

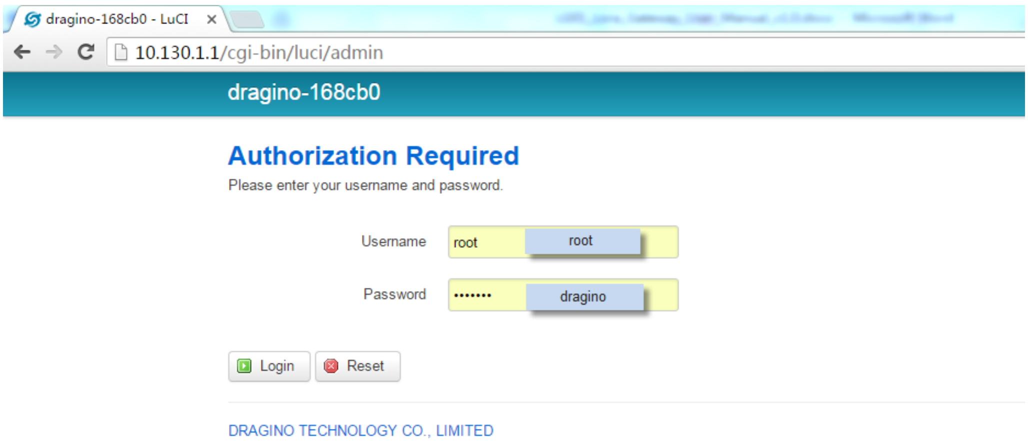
Step1:

Connect PC to LG01-N's LAN port via RJ45 cable and set up PC Ethernet port to DHCP.
PC will then get IP from LG01-N. The ip range is 10.130.1.xx
Use browser to access the LG01-N via IP 10.130.1.1. (Recommend use Chrome here)

User can also connect to the wifi AP network from LG01-N, the **wifi password** is **dragino+dragino**.

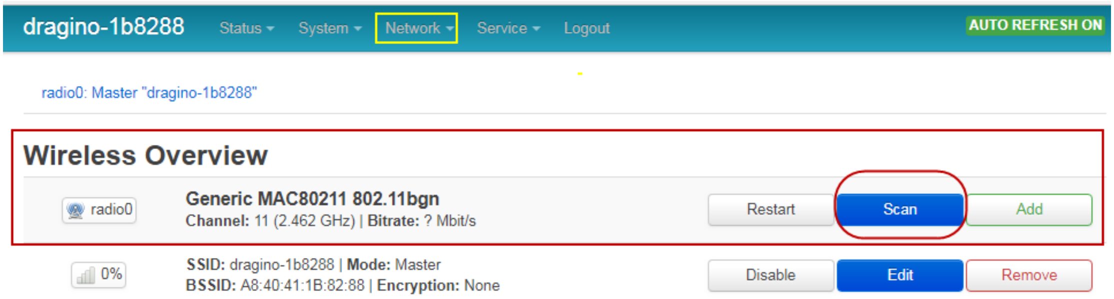
Step2:

Open a browser in the laptop and type
http://10.130.1.1/cgi-bin/luci/admin
User will see the login interface of LG01-N.
The account for Web Login is:
User Name: root
Password: dragino



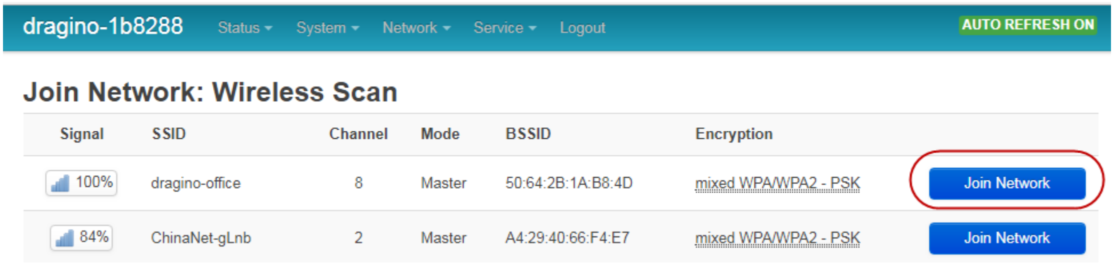
Step3:

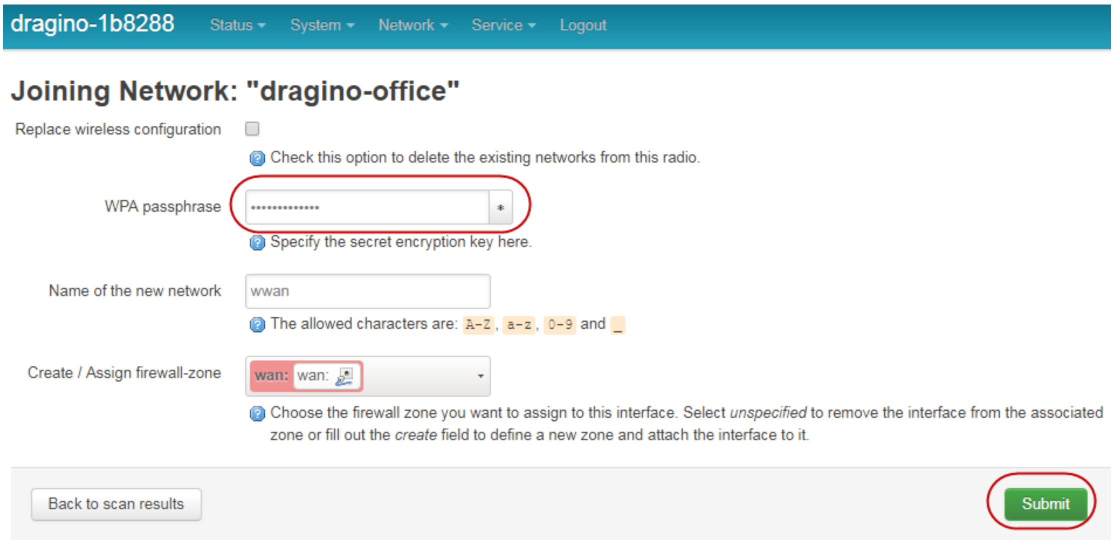
In network -> Wireless, select radio0 interface and scan.



Step4:

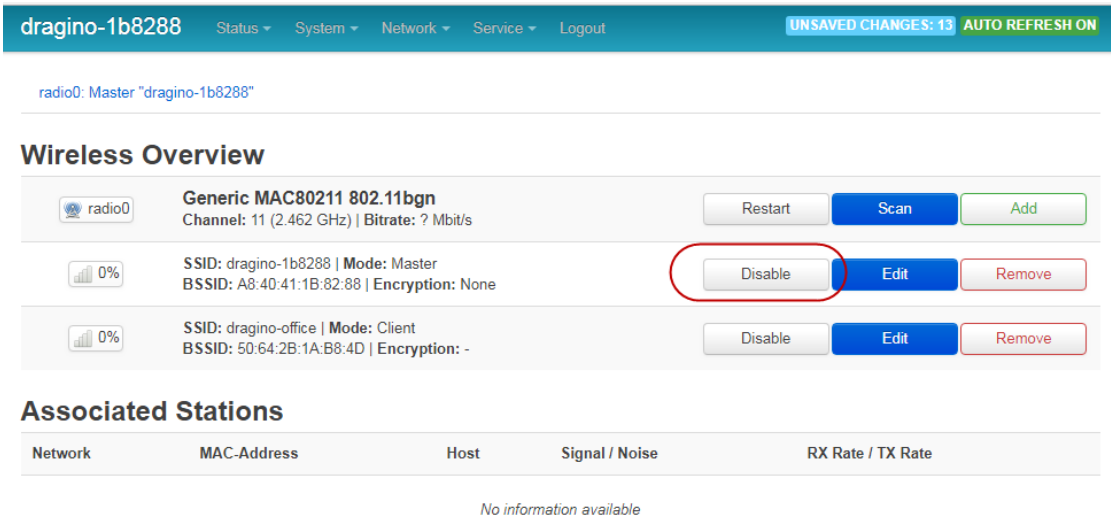
Select the wireless AP and join the wifi network:





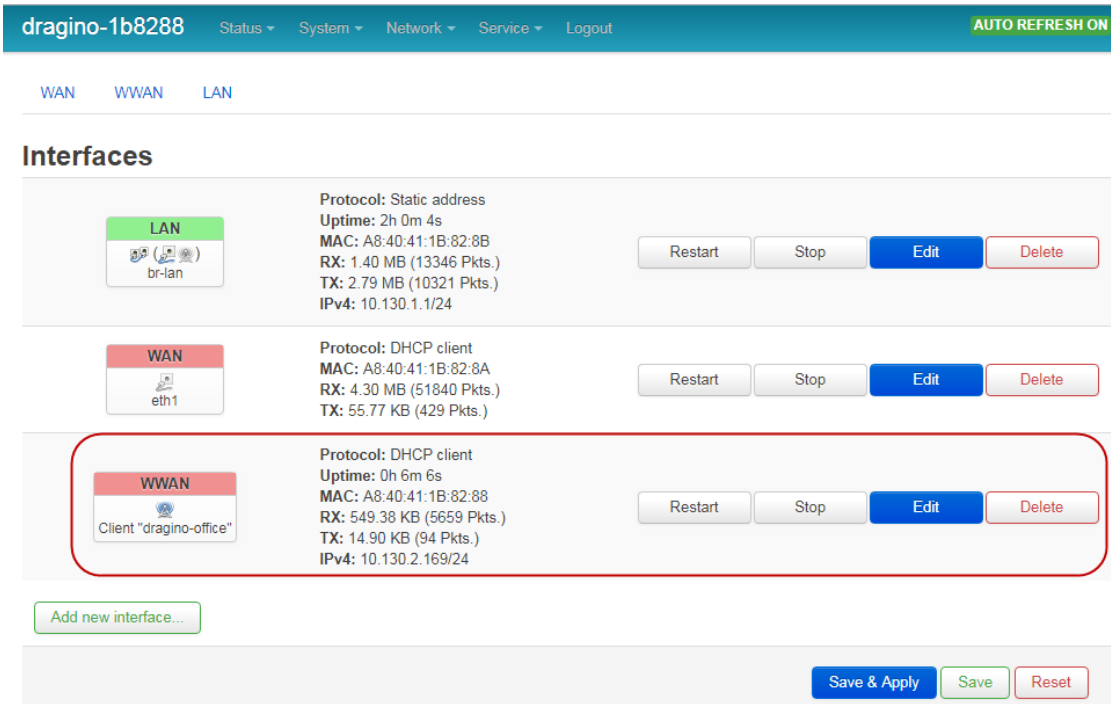
Step5:

In network->wireless page, disable WiFi AP network. Notice: After doing that, you will lose connection if your computer connects to the LG01-N via its WiFi network.



(Note: make sure click the Save & Apply after configure)

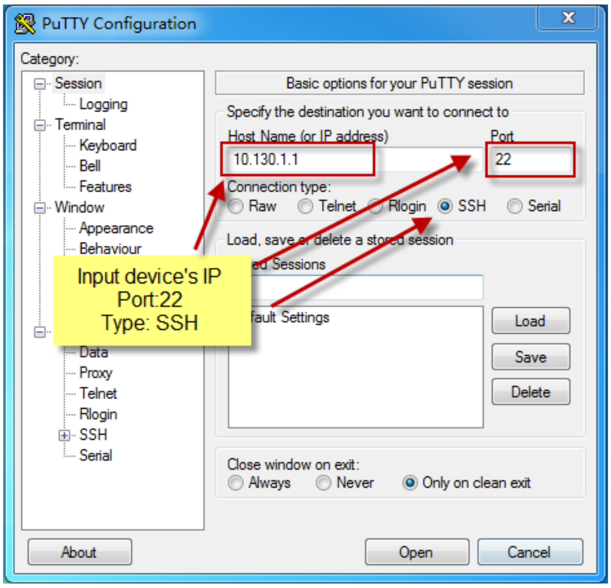
After successful associate, the WiFi network interface can be seen in the same page and see LG01-N get the ip from the uplink router.



2.2.2 Download putty tool to access LG01-N via SSH

It will be helpful to see the LG01-N inside Linux system to understand the data flow and debug.

User can access to the Linux console via SSH protocol. Make sure your PC and the LG01-N is in the same network, then use a SSH tool (such as putty) to access it. Below are screenshots:



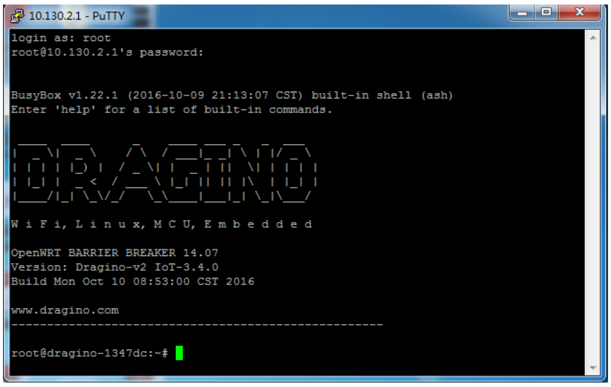
IP address: IP address of LG01-N

Port: 22

User Name: **root**

Password: **dragino** (default)

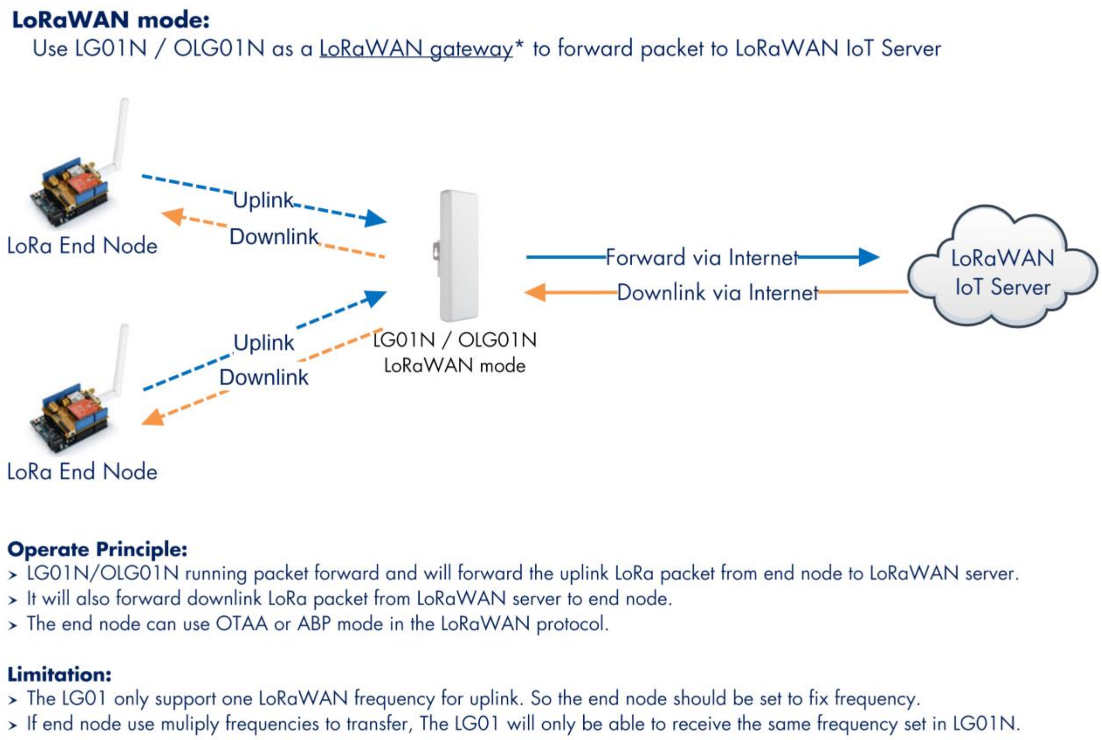
After log in, you will be in the Linux console and can input commands here.



So we have prepare what we need and let's go for the examples!

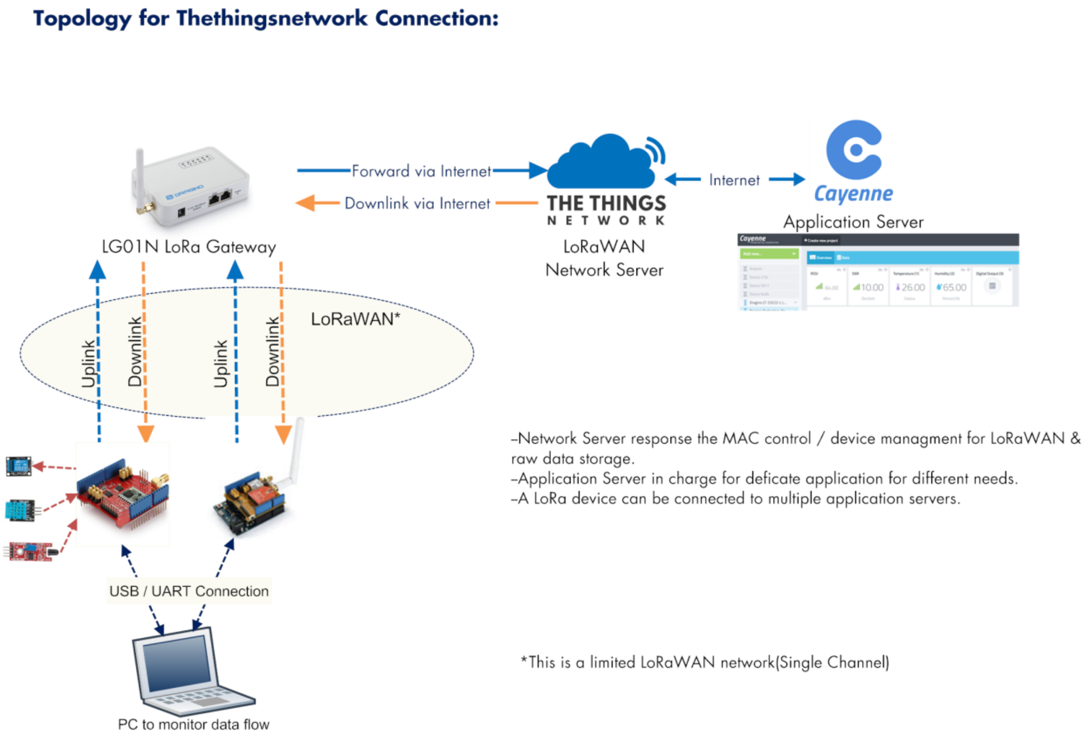
3 Example 1: Test a LoRaWAN network

This example describes how to use LG01-N, LoRa Shield & LoRa GPS Shield to set up a LoRaWAN network and connect it to TTNV3 LoRaWAN Server. It also shows how to use external application server to monitor / manage the LoRa Nodes.



3.1 Typology and Data Flow

The network topology and dataflow for the example is as below:

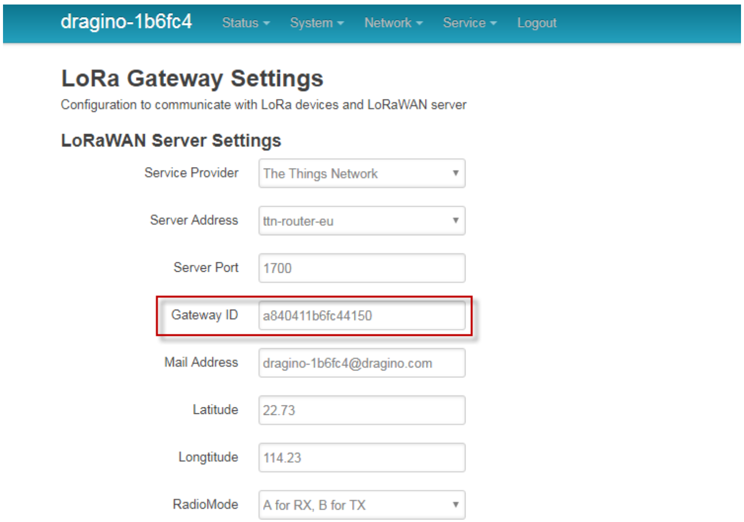


In next section we will start to configure for this example.

3.2 Create a gateway in TTNV3 Server

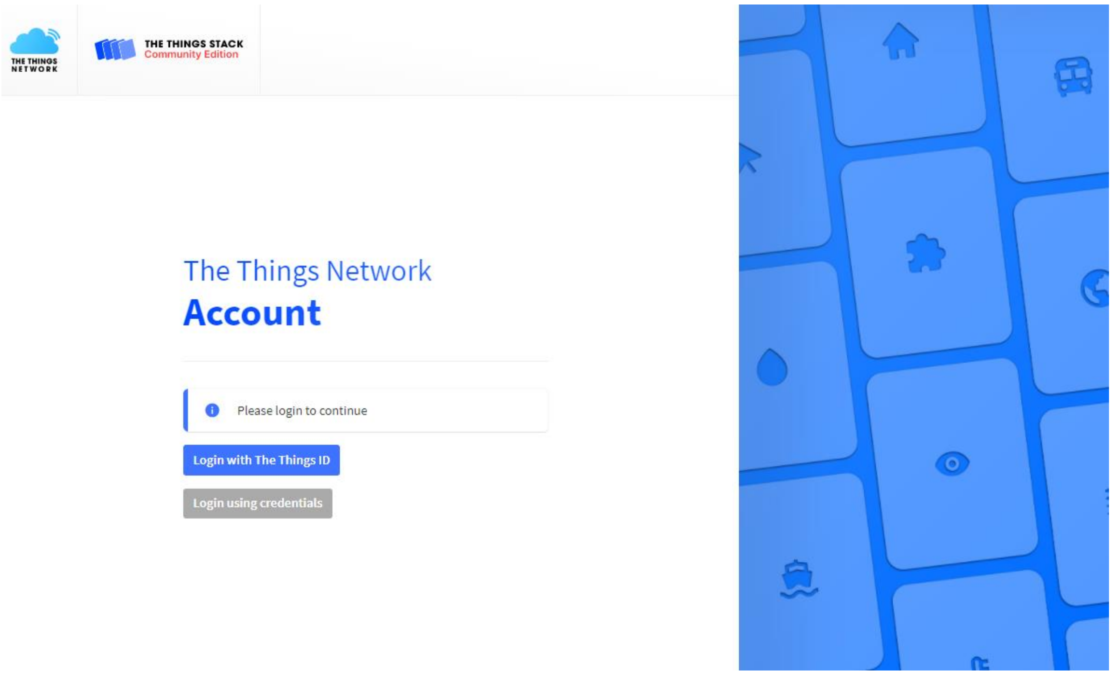
Step 1: Get a Unique gateway ID.

Every LG01-N has a unique gateway id. The id can be found at LoRaWAN page:

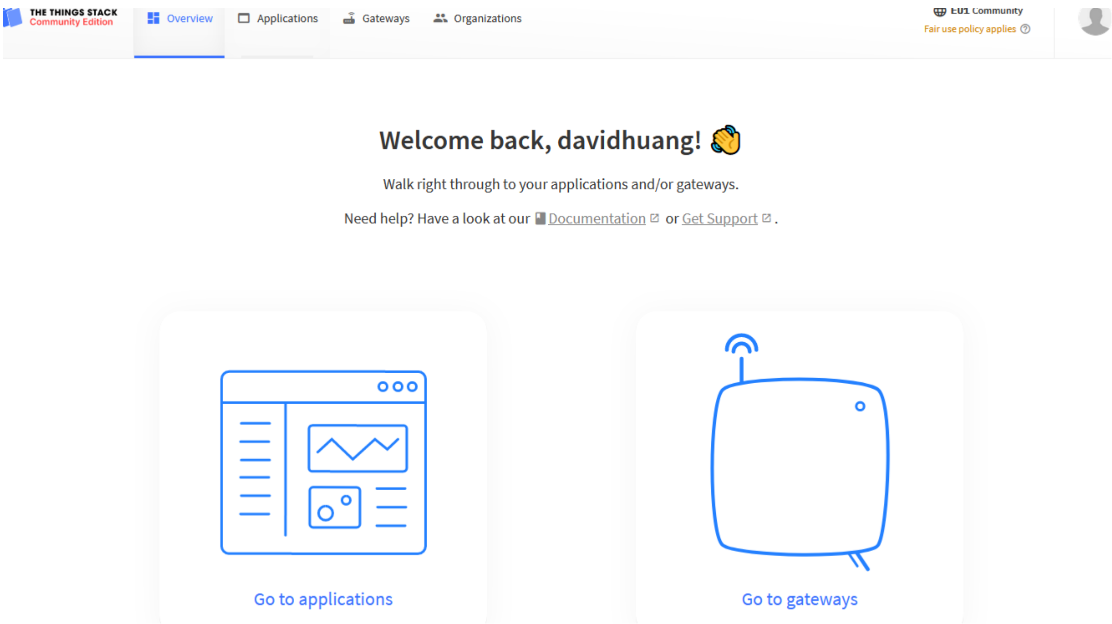


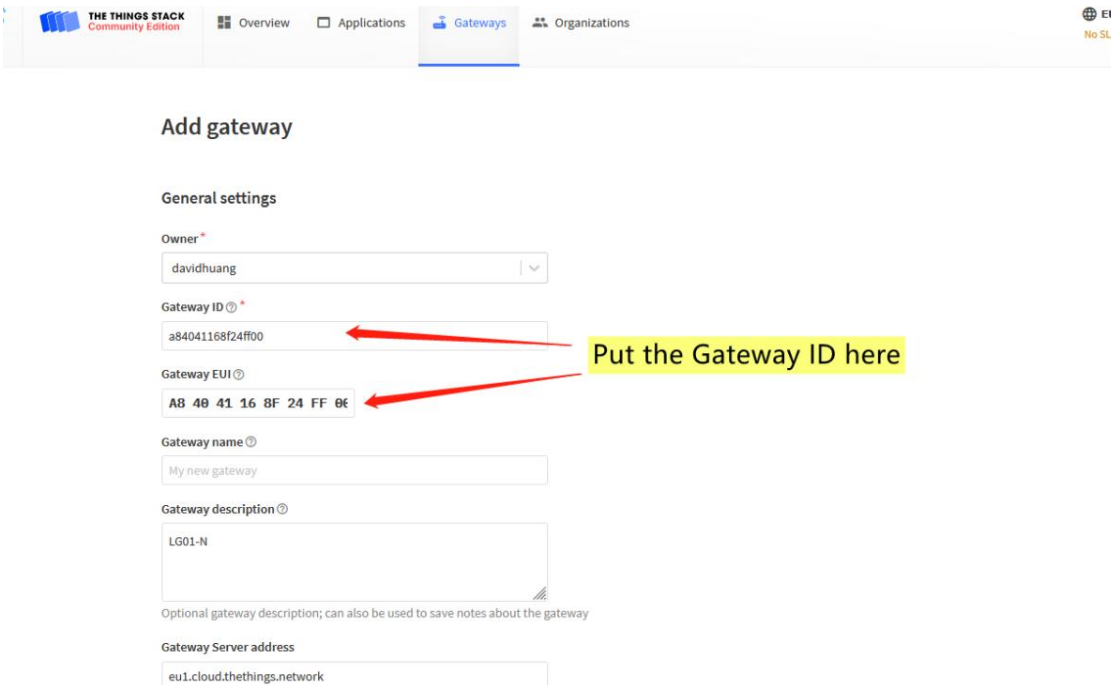
The gateway id is: **a840411b6fc44150**

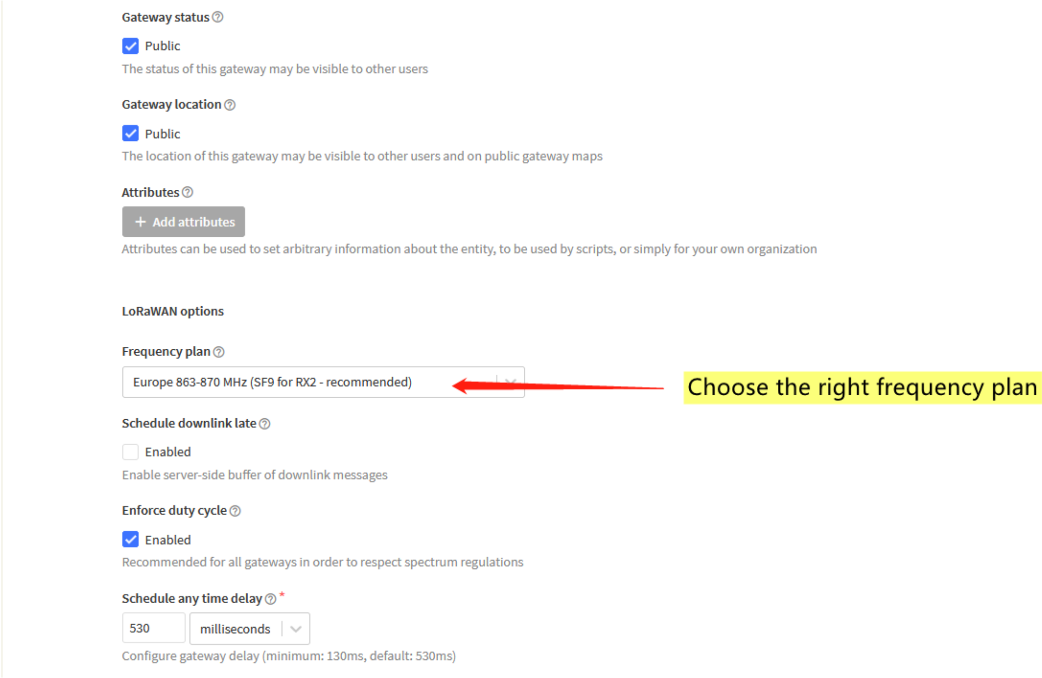
Step 2: Sign up a user account in TTNV3 server



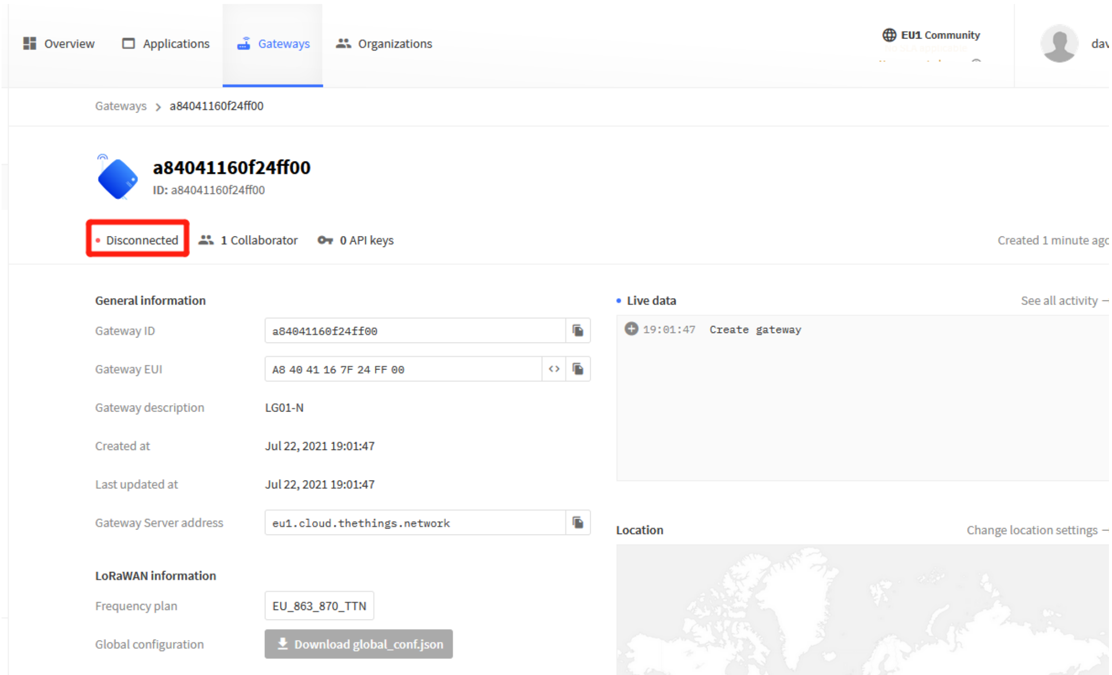
Step 3: Create a Gateway in TTNV3







After create the gateway, we can see the gateway info, as below, the Status shows "not connected" because the LG01-N doesn't configure to send update status yet.

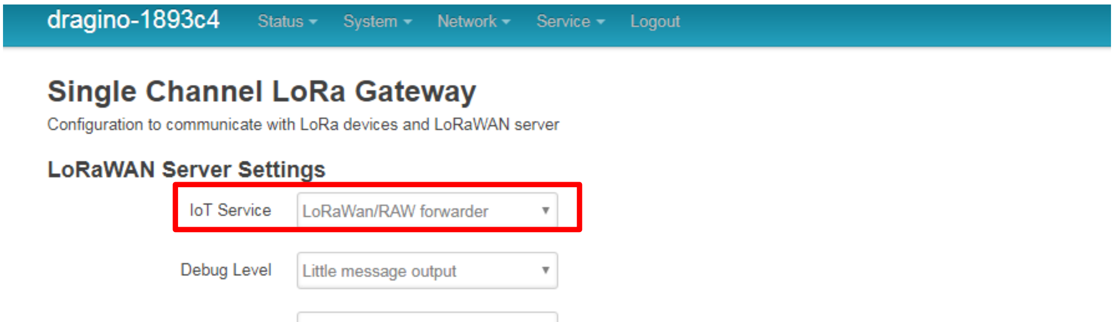


3.3 Configure LG01-N Gateway

3.3.1 Configure to connect to LoRaWAN server

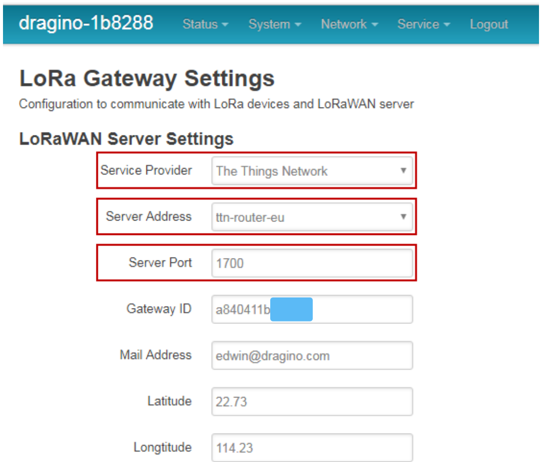
We should configure the LG01-N now to let it connect to TTNV3 network. Make sure your LG01-N has Internet Connection first.

Step1: Configure LG01-N to act as LoRaWAN forwarder mode



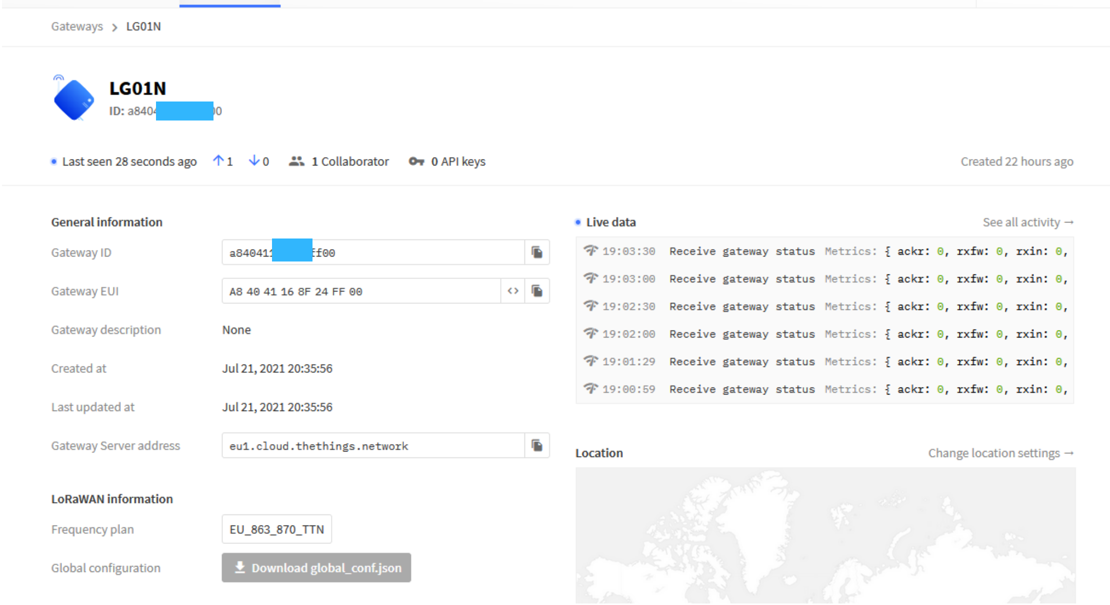
Step2: Input server info and gateway id

Choose the correct the server address and gateway ID.



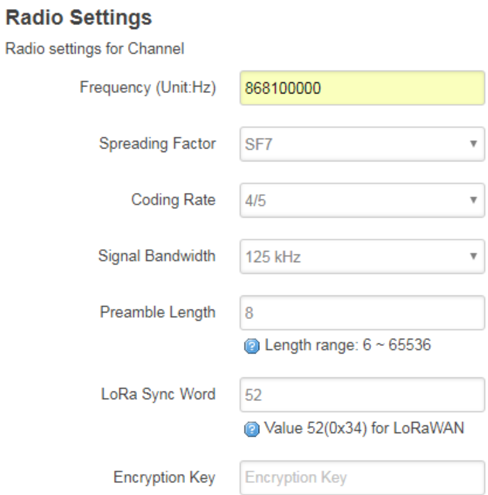
Check Result

After above settings, the LG01-N will be able to connect to TTNV3, as shown in below:



3.3.2 Configure LG01-N's LoRa Radio frequency

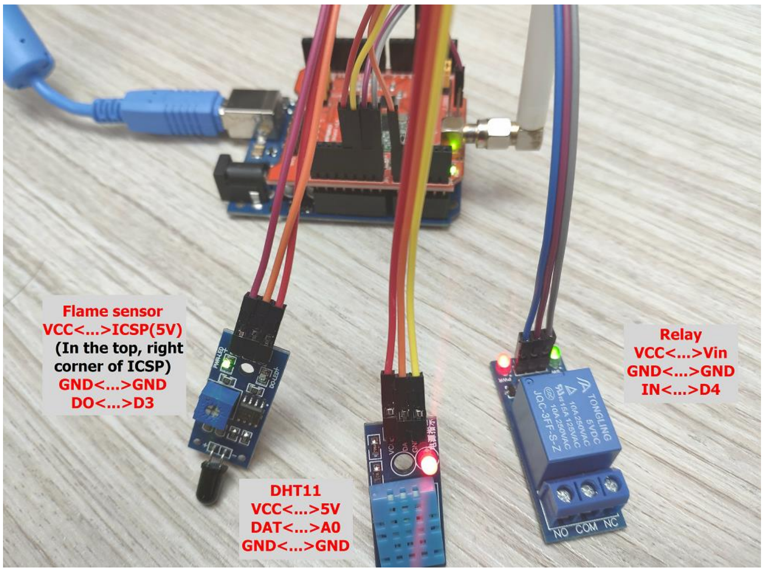
Now we should configure LG01-N's radio parameter to receive the LoRaWAN packets. We are using 868.1Mhz and other parameters as below:



This parameters set is for uplink (receive data for LoRa End Node).According to LoRaWAN spec, the downlink radio parameters frequency is defined by network server (TTNV3). LG01-N will adjust downlink parameters according to info from TTNV3.

3.4 Create LoRa Shield End Node

3.4.1 Hardware Connection



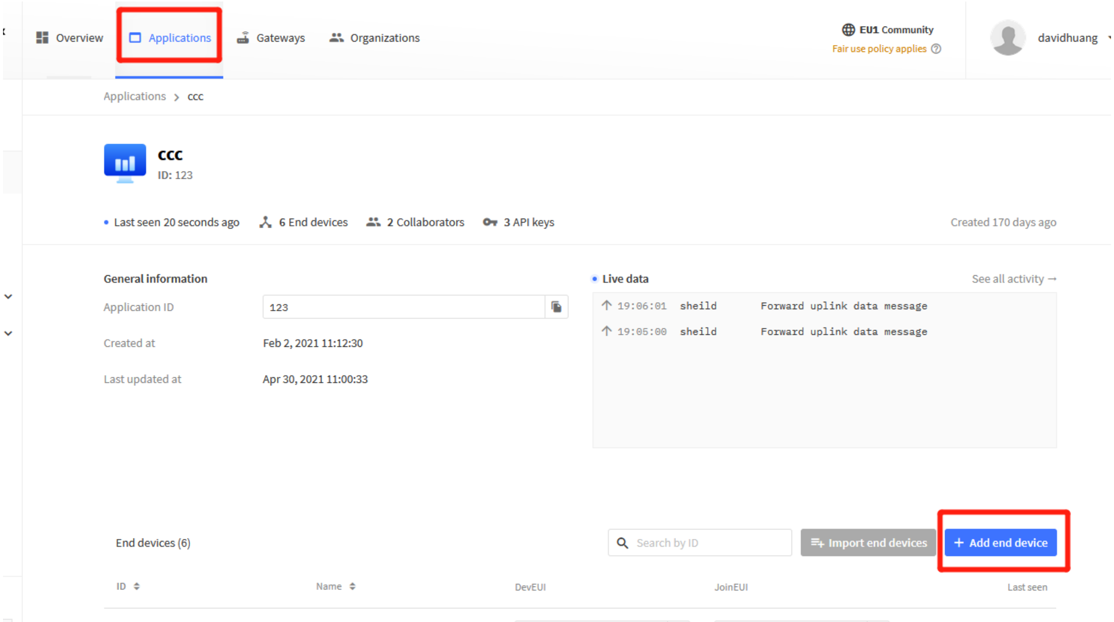
There are three sensors connect to the LoRa Shield + UNO. These sensors are flame sensors, DHT11 (Temperature & Humidity sensor) and Relay. Please use the connection as we show in the photo.

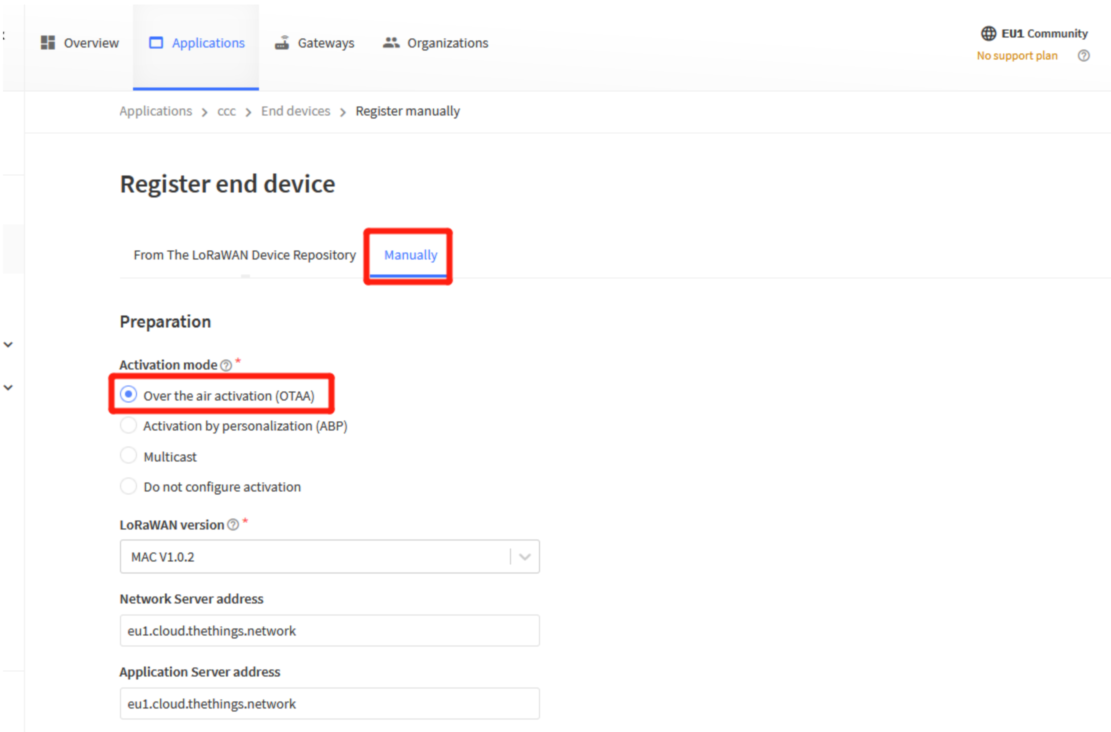
Note: There is a trick in above connection, the relay connects to VIN. In this case, The UNO can only be power via USB port. If user need to power via DC power adapter, please use another 5v pin to power the relay.

3.4.2 Set up OTAA device in TTNV3 and upload sketch to UNO

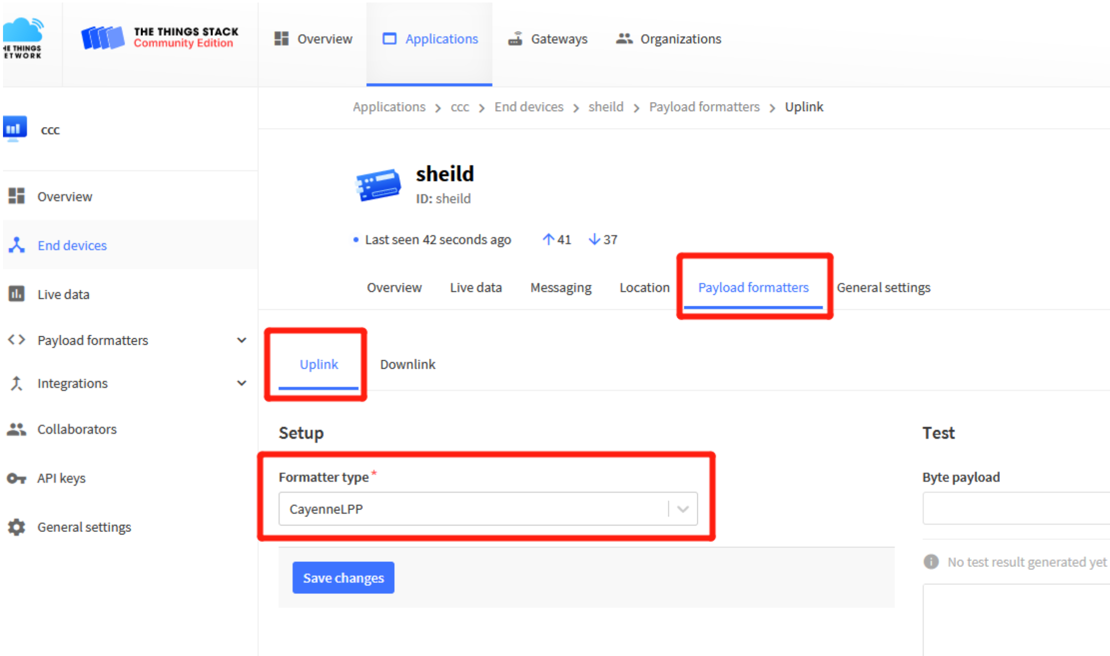
Here we set up the LoRa Shield + UNO as an OTAA device in TTNV3. We will tell the difference of OTAA and ABP mode later.

Step 1: Create an OTAA device in TTNV3 server -- > Application page.





For this device, set up to use Cayenne payload, so TTNV3 can parse the sensor data properly.



Step 2: Modify the LMIC library

To use LoRaWAN with LG01-N, we need to modify the LMIC library to support single channel mode.

Find the Arduino LMIC install path in Arduino library. Before compiling the code, user needs to change the Frequency Band to use with LG01-N. The change is in the file **arduino\libraries\arduino-lmic \src\lmic\config.h.** Changes are as below:

```
#define CFG_eu868 1
//#define CFG_us915 1
//#define CFG_au921 1
//#define CFG_as923 1
//#define CFG_in866 1

#define LG02_LG01 1

//US915: DR_SF10=0, DR_SF9=1, DR_SF8=2, DR_SF7=3, DR_SF8C=4
//       DR_SF12CR=8, DR_SF11CR=9, DR_SF10CR=10, DR_SF9CR=11, DR_SF8CR=12, DR_SF7CR
#if defined(CFG_us915) && defined(LG02_LG01)
// CFG_us915 || CFG_as923
#define LG02_UPFREQ   902320000
#define LG02_DNWFREQ  923300000
#define LG02_RXSF     3      // DR_SF7
#define LG02_TXSF     8      // DR_SF12CR
#elif defined(CFG_eu868) && defined(LG02_LG01)
// CFG_eu868
//EU868: DR_SF12=0, DR_SF11=1, DR_SF10=2, DR_SF9=3, DR_SF8=4, DR_SF7=5, DR_SF7B=1, DR_FSK, DR_NONE
#define LG02_UPFREQ   868100000
#define LG02_DNWFREQ  869525000
#define LG02_RXSF     5      // DR_SF7
#define LG02_TXSF     0       // DR_SF12
#endif
```

Choose the Frequency Band, same as in LoRaWAN server

uncomment this for LG01 / LG02

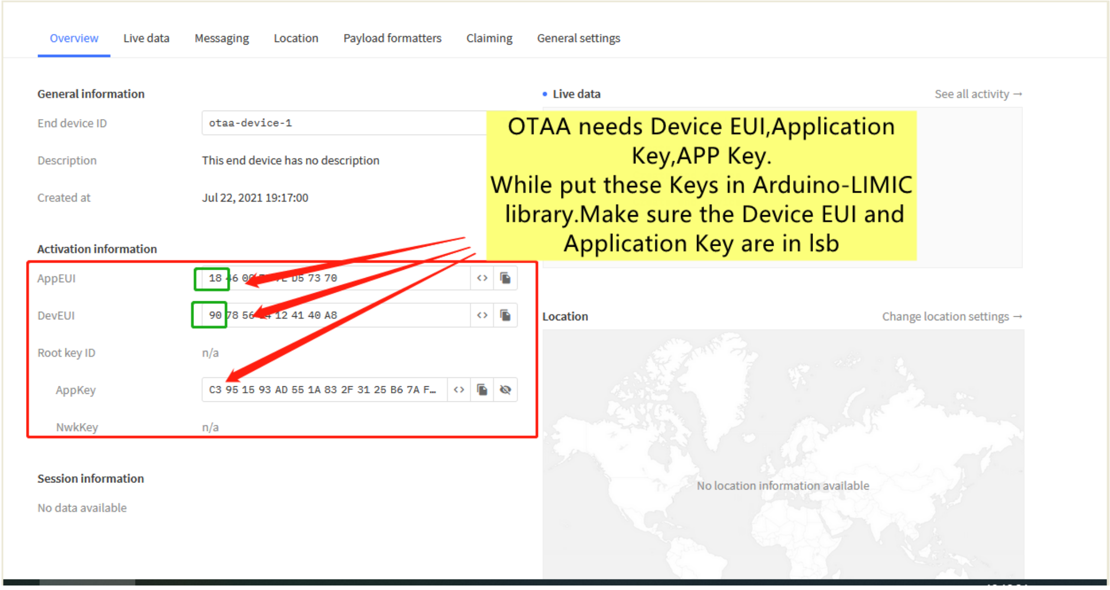
LG02_UPFREQ:End Device Uplink Frequency
LG02_DNWFREQ:End Device Uplink Frequency
LG02_RXSF: End Device Uplink (transmit) SF
LG02_TXSF: End Device Downlink (receive) SF

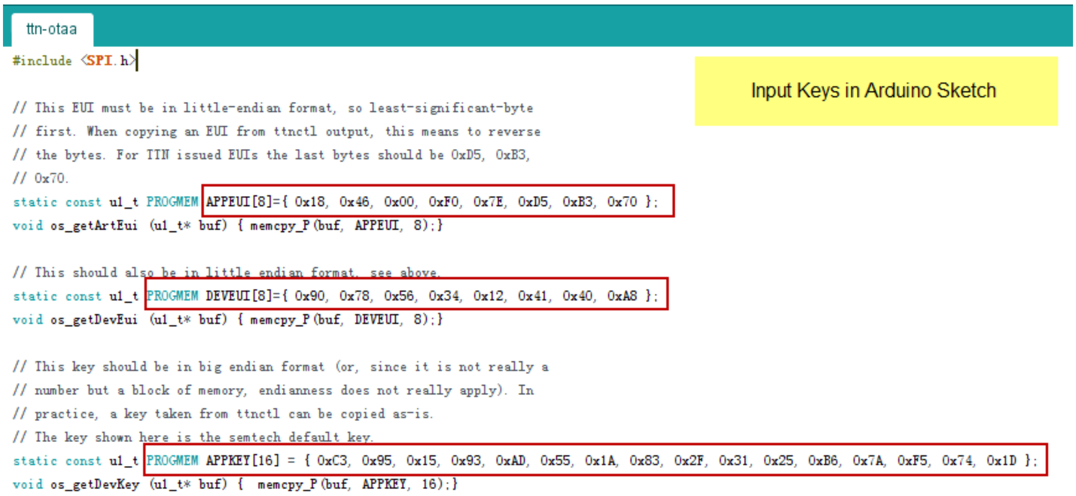
The TXSF is now set to default value:
US915/AS923 : 923300000 , SF12BW500
EU868: 869525000, SF12BW125

Step 3: Input keys in Arduino Sketch and upload to device.

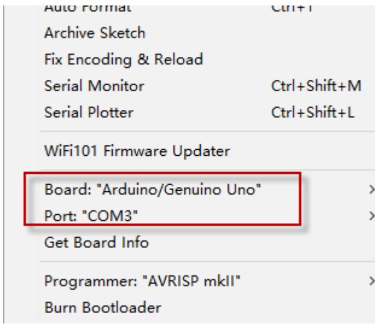
The sketch for this example is lora_shield_cayenne_and_TTNv3-otaaClient.ino. Download and open it, we need to modify the keys to match the keys in TTNV3. Get Device EUI/Application EUI

& APP Key from TTNV3 and put them in the sketch, make sure the Device EUI and Application Key are lsb and the APP key is msb.



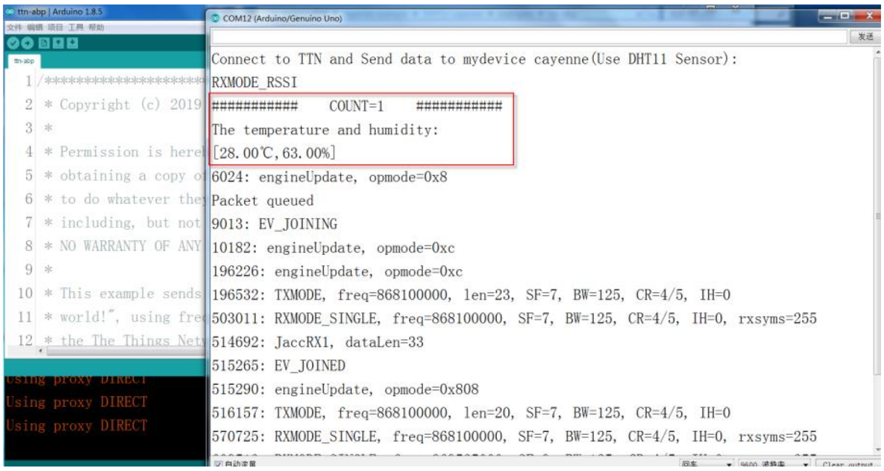


Upload the code to UNO:

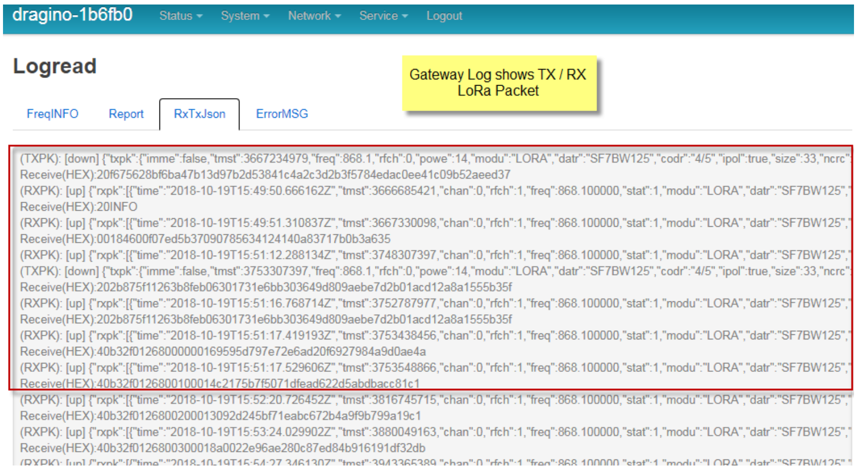


Step 4: Analyze output result

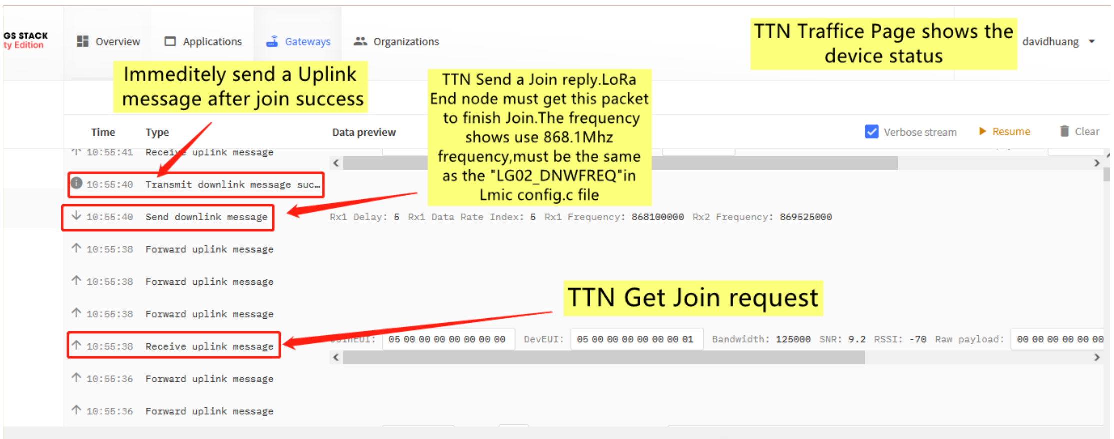
From output of LoRa Node Serial Monitor, we can see it send Joining after start(TX), then get join ACK (RX), then upload the data to TTNV3 (TX).



From gateway logread, we can see the data send from end node (txpk), dats get from server(rxpk).

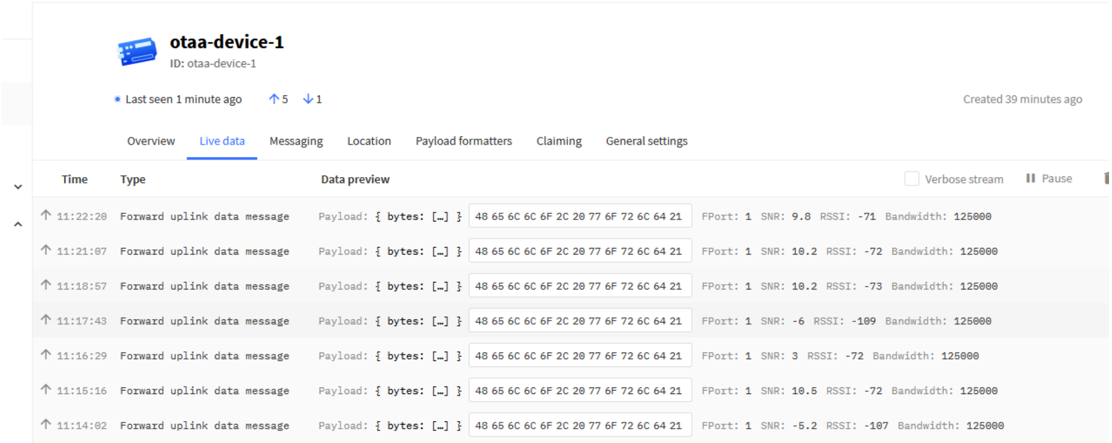


In TTNV3-Gateway page, we can also see the traffic.



Note: The LG02_DNWFREQ value in Arduino_LMIC/src/lmic/config.h should match downlink frequency from TTNV3. TTNV3 shows 868.1 here, So LG02_DNWFREQ should be 868100000

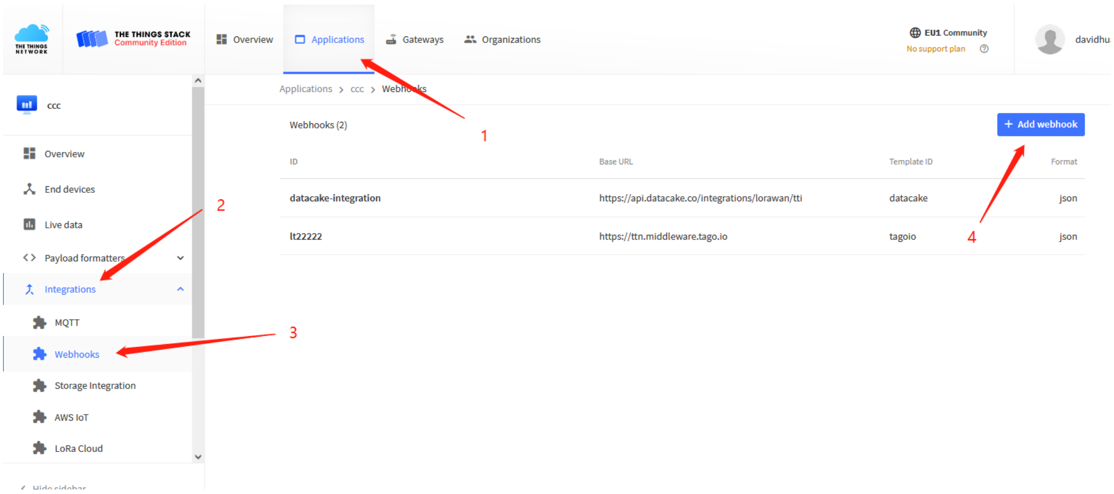
After success Joined, we can see the data in the device page:

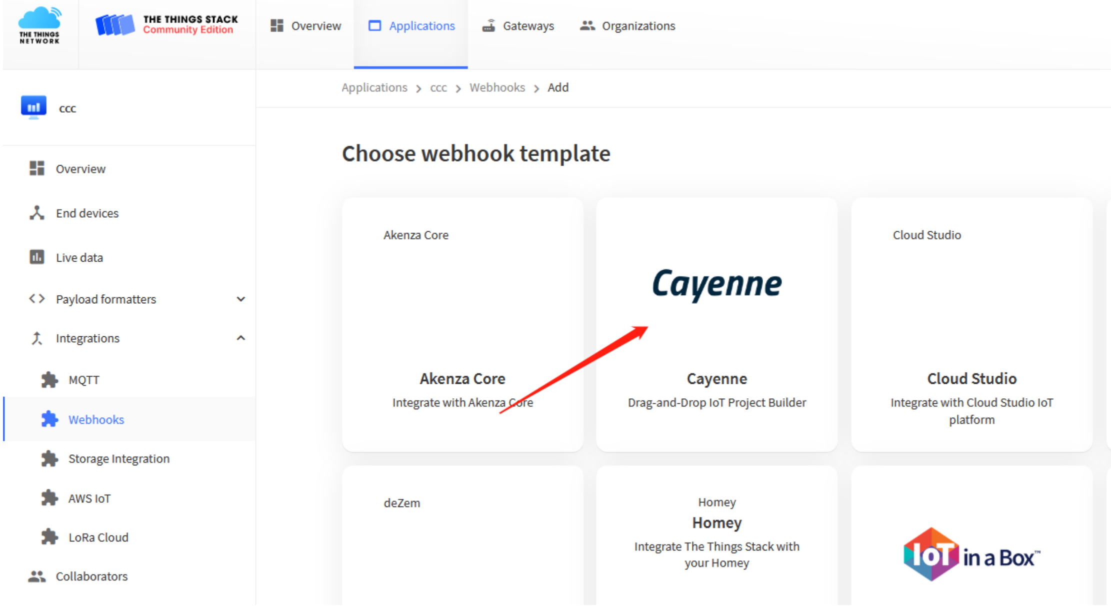


3.4.3 Configure to connect to Mydevices Application Server

In TTNV3, we can see the raw data, now we try to connect it to the application server.

Step 1: Add Mydevice in Application page

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Akenza Core
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Cayenne
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Cloud Studio
Integrate with Cloud Studio IoT platform
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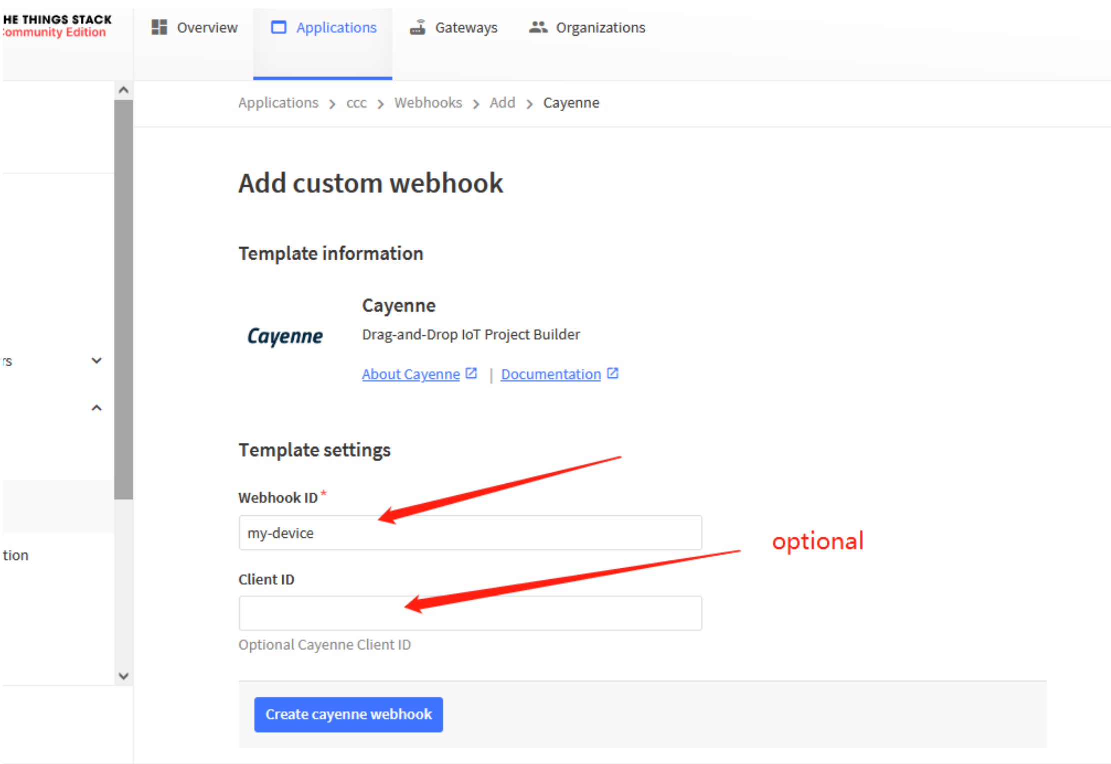
Homey
Homey
Integrate The Things Stack with your Homey
IoT in a Box


HE THINGS STACK
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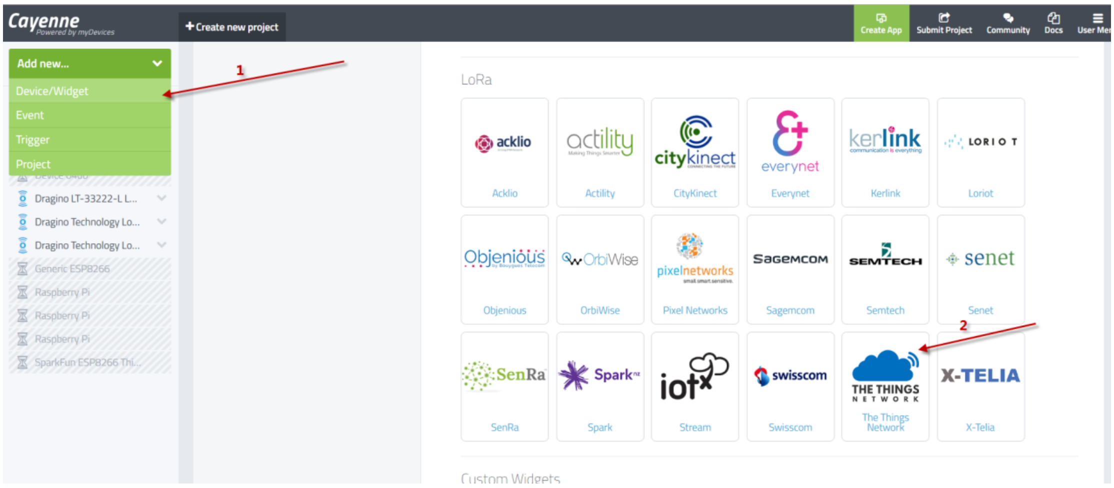
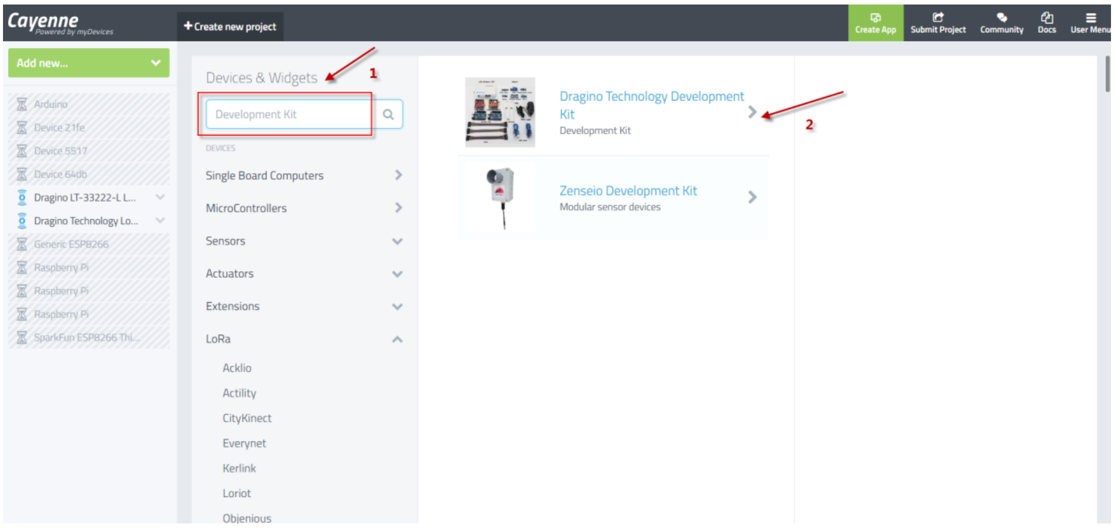
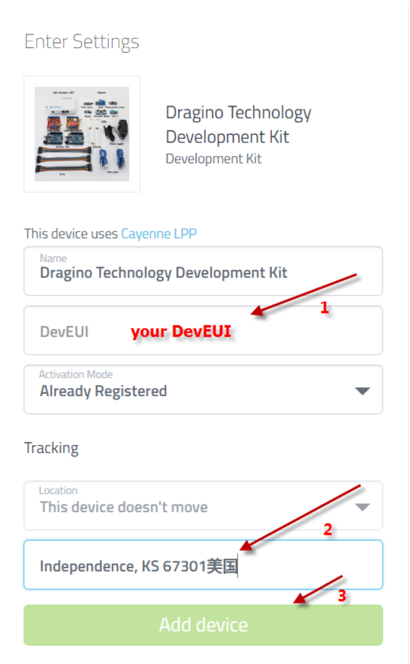
Client ID
Optional Cayenne Client ID
optional
Create cayenne webhook

Step2: Log in Mydevices account and add devices.

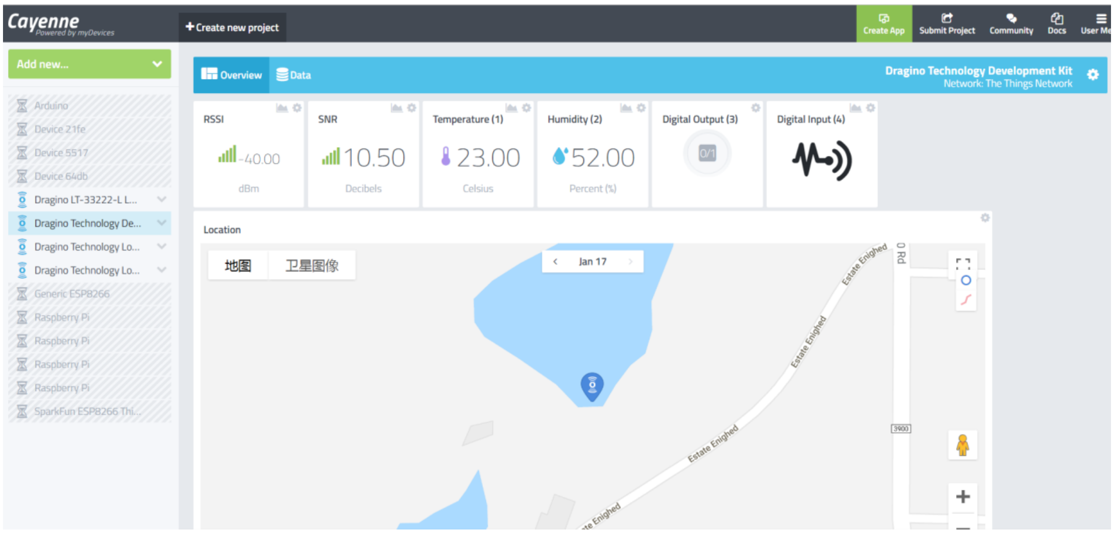




Add DevEUI of the End node



After above steps, we can now the sensor data in Mydevices:



3.4.4 Use downlink message to control relay

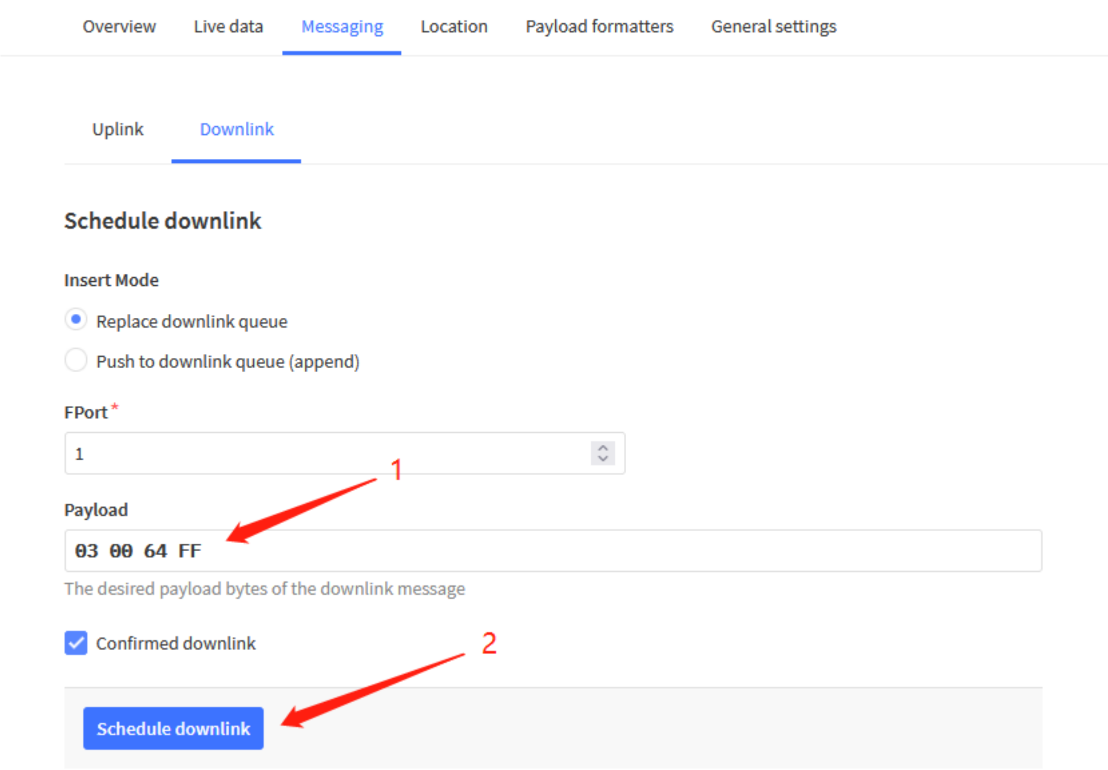
We can use either TTNV3 or Cayenne to control the relay.

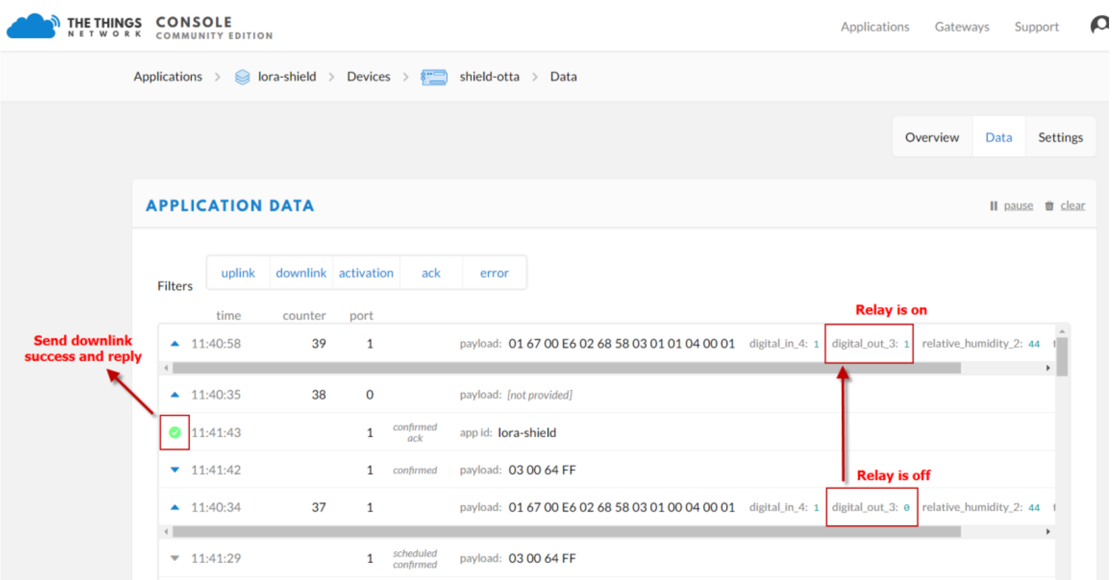
<u>Control relay via TTNV3</u>:

The string for ON is: 03 00 64 FF

The string for OFF is: 03 00 00 FF

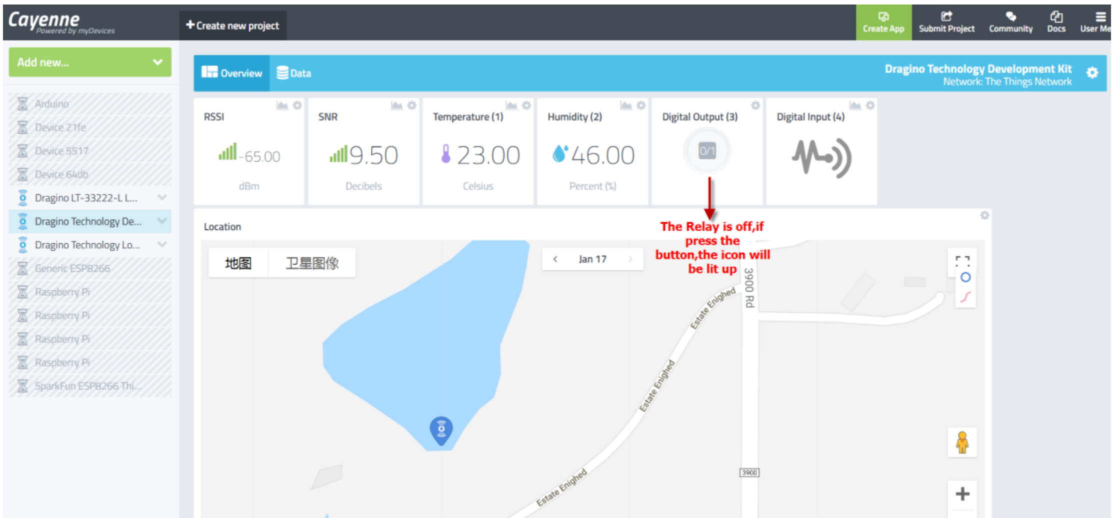
In put above value in the TTNV3 Downlink payload, we can see the relay can switch between different states, since we are in Class A, the downlink will only happen after each uplink.



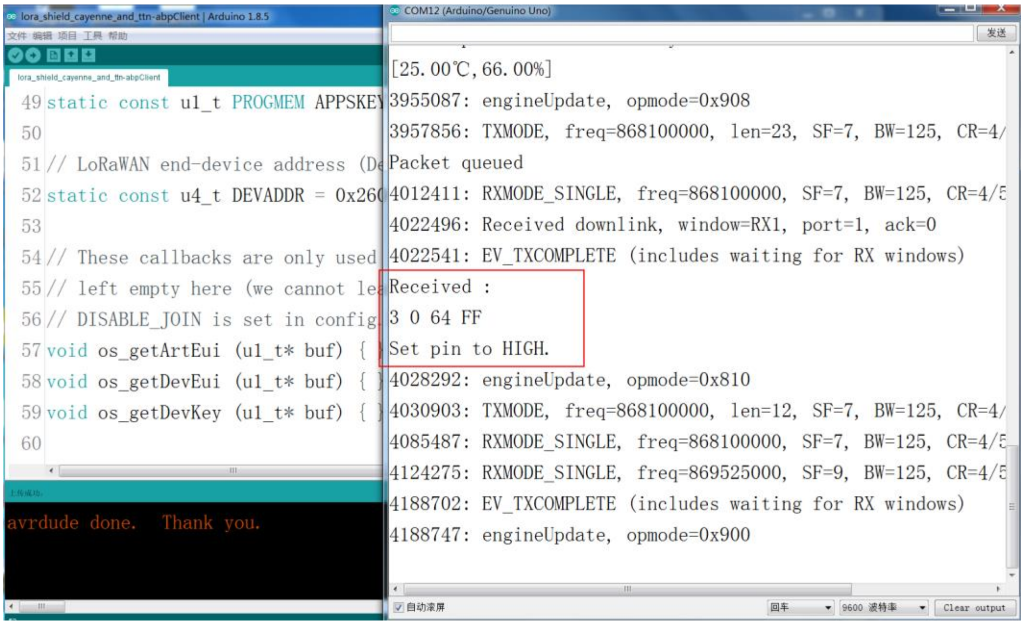


Control relay via Cayenne

In Cayenne, just click the digital output button, it will auto send out the command strings: ON: 03 00 64 FF , OFF is: 03 00 00 FF



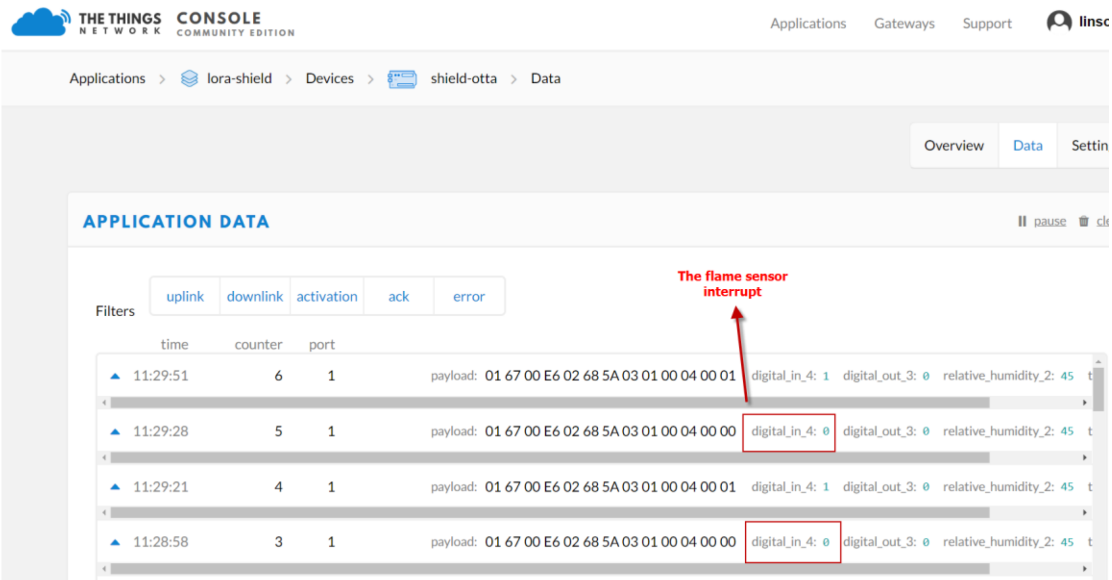
Cayenne will pass the string to TTNV3 and TTNV3 will show as above. In the serial monitor of End Node, we can see below output if downlink string arrives:



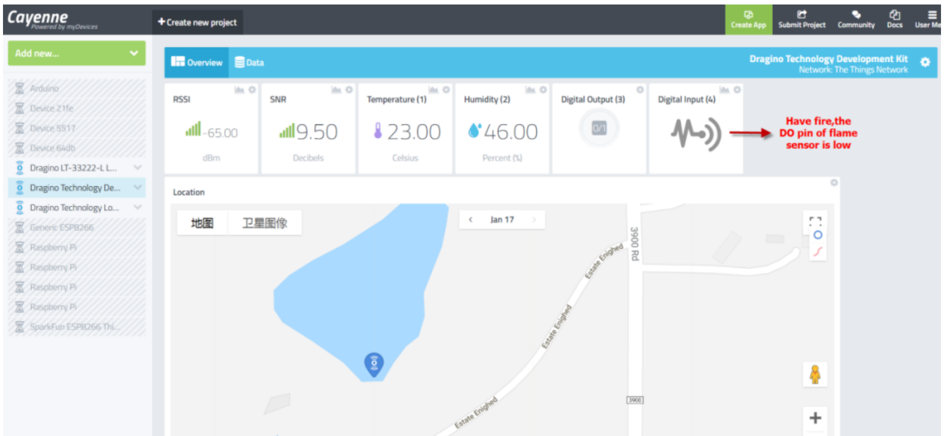
3.4.5 Test with Interrupt

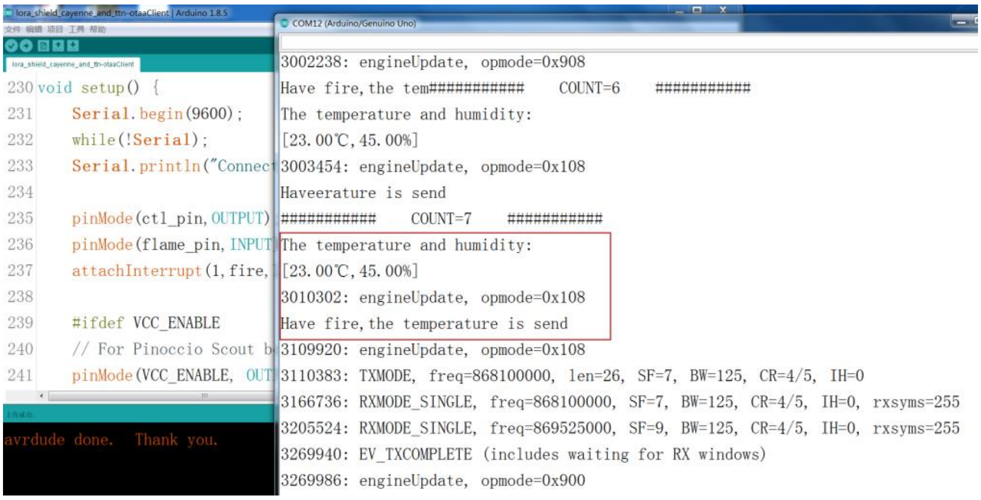
The temperature & humidity in this example are updated periodically (once several minutes/hours), in some case, we need to update the data once an action is happen. So we need to use interrupt.

The DO pin of Flame sensor is high in normal case. While it detects a flame, this pin will become low and act as an external interrupt for Arduino. The Arduino UNO will then immediately upload the temperature and humidity to TTNV3



Then we can see on the cayenne：

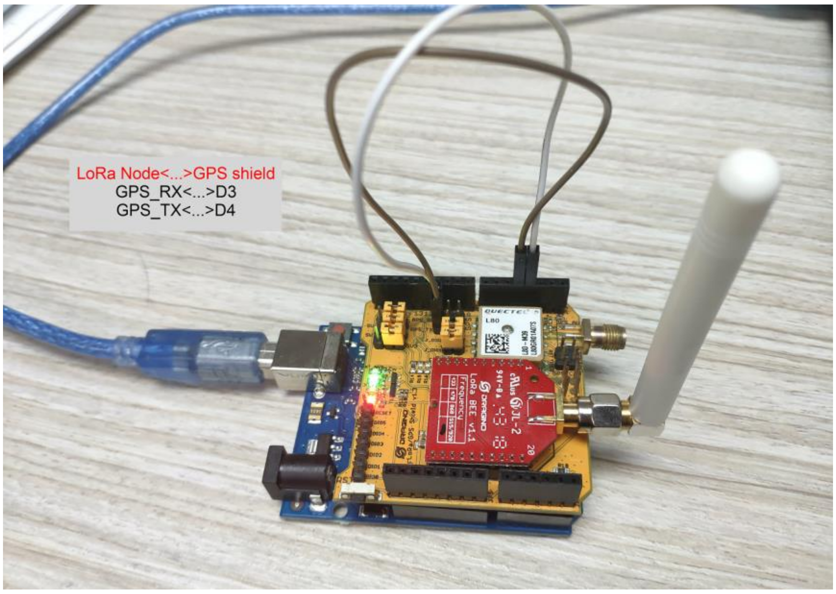




3.5 Create LoRa/GPS Shield End Node

3.5.1 Hardware connection

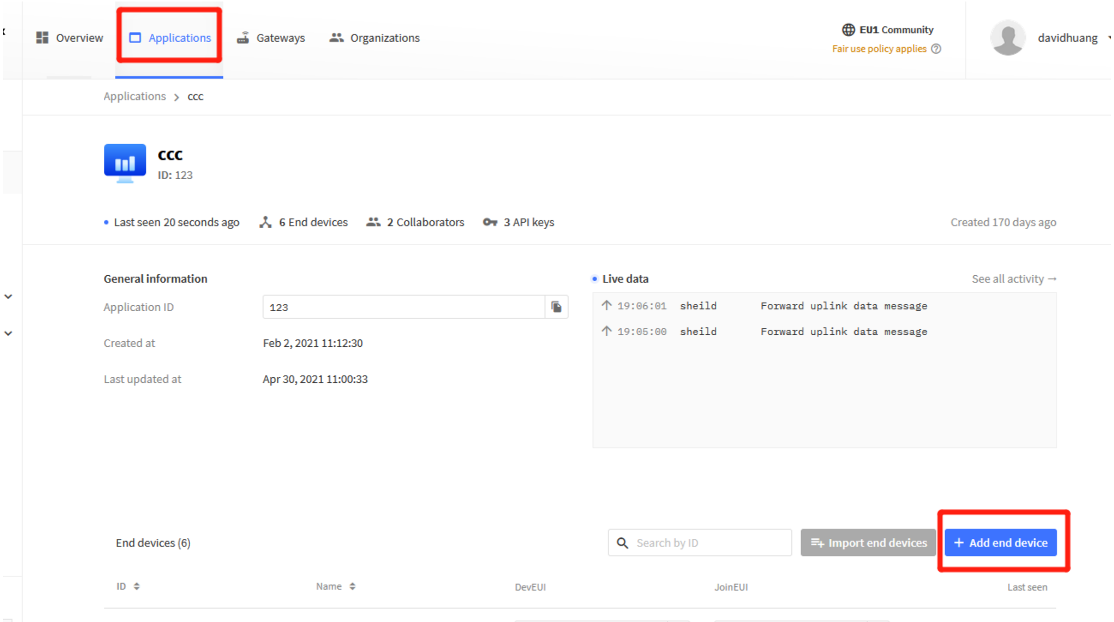
The method to use LoRa/GPS Shield is similar with LoRa Shield. Below is the hardware connection of LoRa GPS Shield.

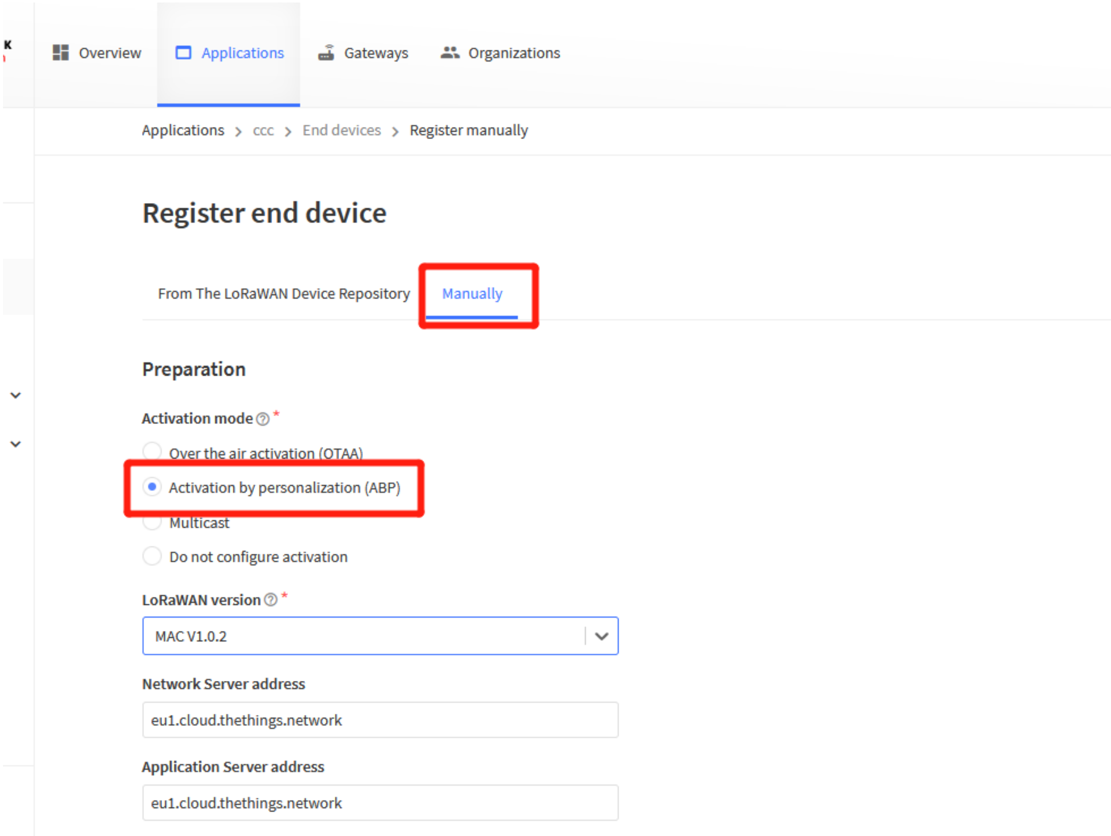


3.5.2 Set up ABP device in TTNV3 and upload software to UNO

In LoRa Shield, we set up OTAA for connection. In this example, we will try ABP mode.

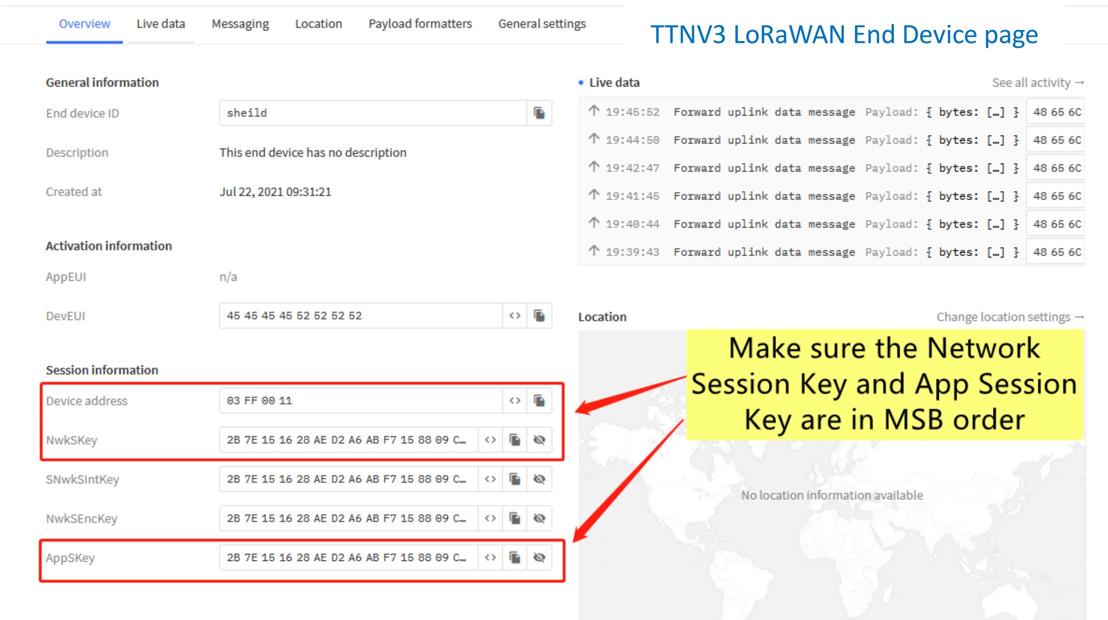
Step 1: Create an ABP device in TTNV3 server -- > Application page. And change it to ABP mode.

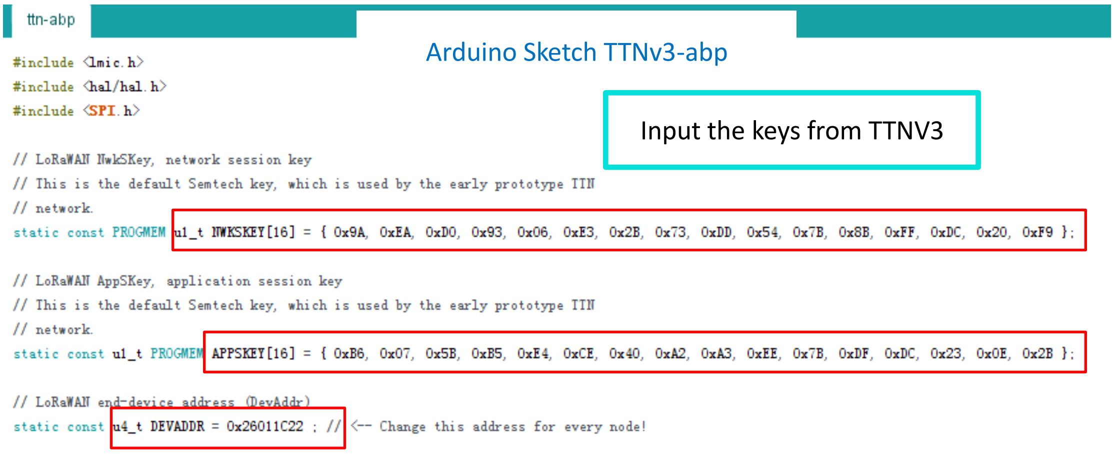




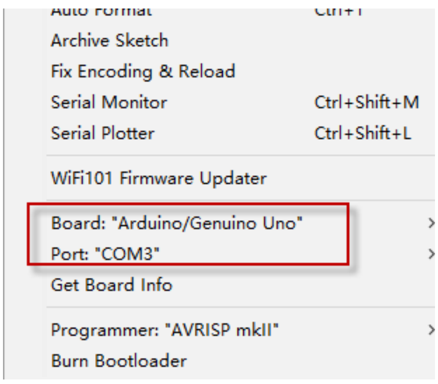
Step 2: Input keys into Arduino Sketch.

The sketch for the LoRa /GPS Shield is LoRa GPS Sketch code





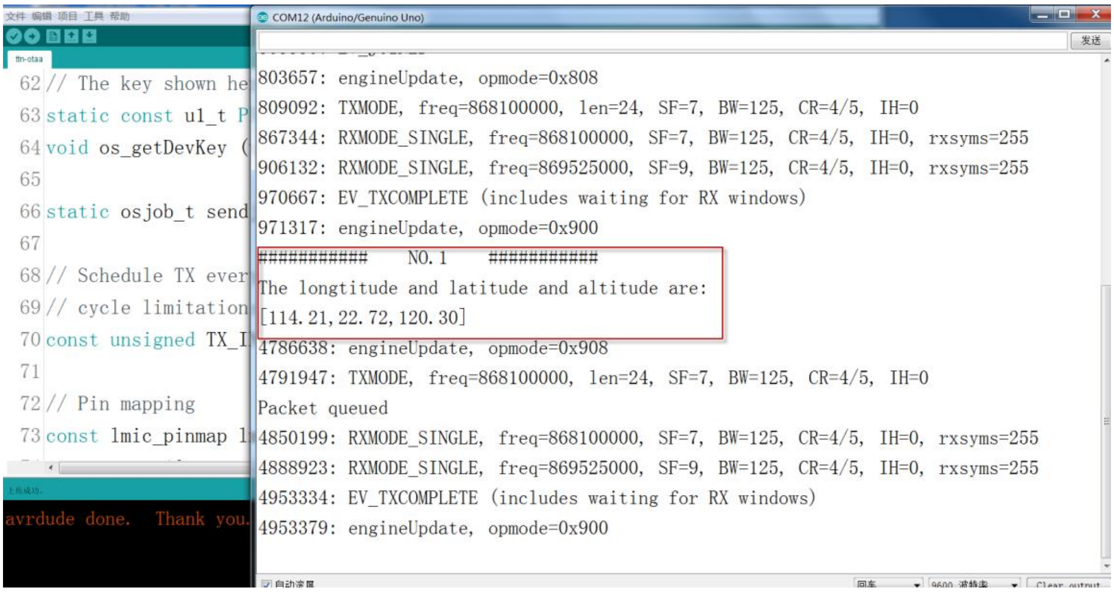
Choose Arduino UNO to upload the sketch to LoRa GPS Shield and UNO



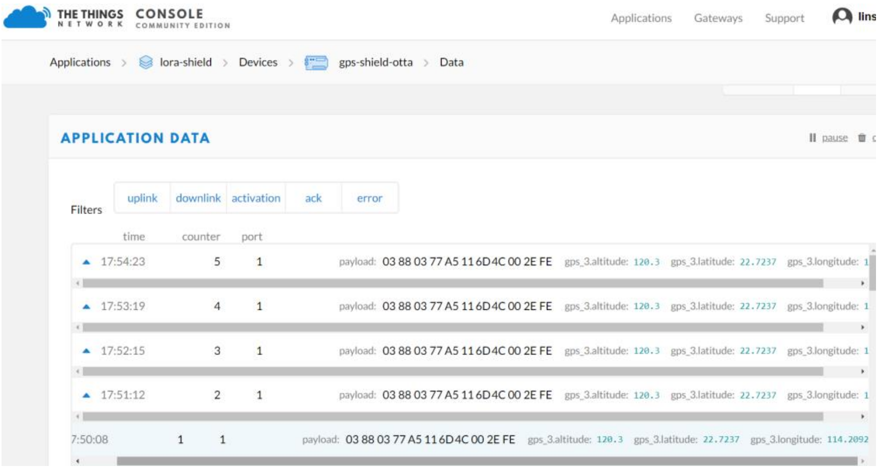
All other steps are similar with how we use with LoRa Shield.

Below are the outputs for reference:

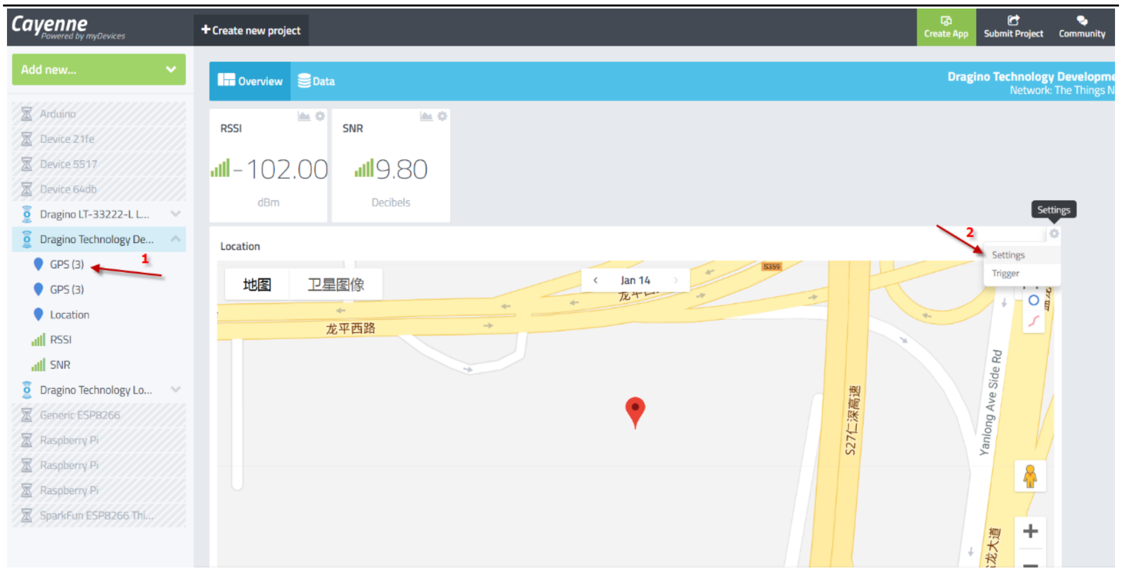
Output from LoRa GPS Shield:

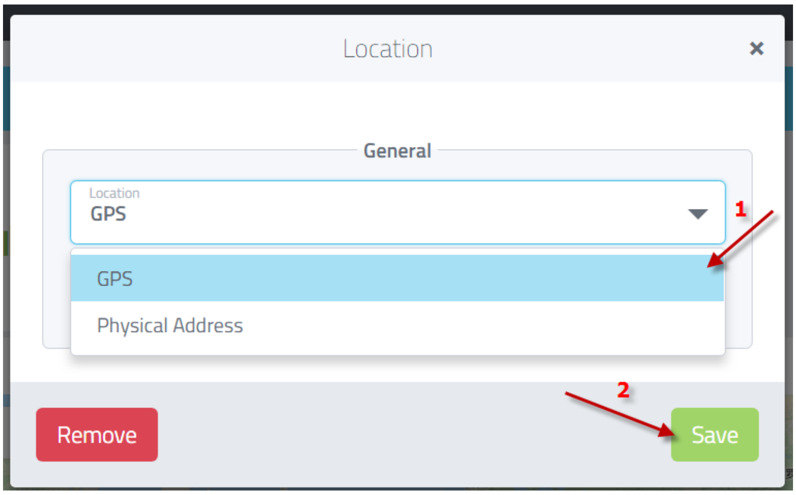


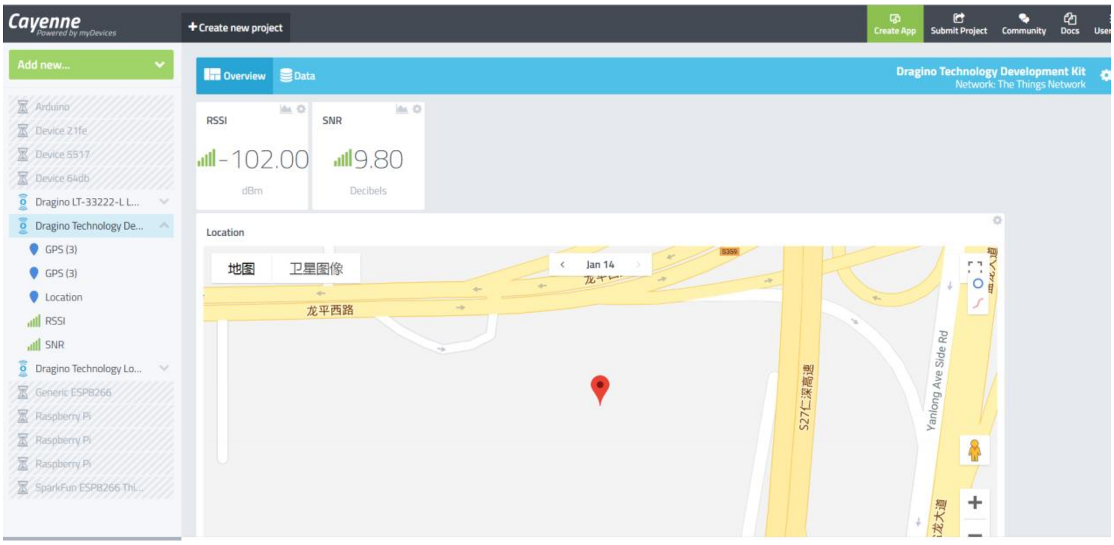
Upload GPS data to TTNV3:



Output in Cayenne:







3.6 Conclusion and limitation

3.6.1 Overview for the example

This example shows how to set up a simple LoRaWAN network with public server. The LoRaWAN specification is for easy deploy the IoT network base on LoRa wireless. It contains the encryption, MAC control, device management etc. More info about LoRaWAN, please see this link.

There are some frequently ask points for the example:

1/ Difference between OTAA & ABP mode:
We have tested OTAA and ABP mode for LoRaWAN. They are two different modes. In OTAA mode, we can see the device will send a join request, the IoT server will send back a Join confirm with dynamic device address, network session key and app session key. Then the device will use these key to communicate with the LoRaWAN server. This make sure the device will only communicate with one server.
In ABP mode, it will use the FIX device address, network session key and app session key. It doesn't have join process. So in theory, any server with match keys is possible to decrypt the data from this end device.
We can see OTAA has better security than ABP mode.

2/ AES 128 encryption:
The data between end device and server are AES128 encryption. So the gateway can't parse the packets, it just forward them.

3/ LoRaWAN Network Server:
A LoRaWAN network server is necessary in a LoRaWAN network for device control/management/data management. If user wants to build the NS , there are some open sources LoRaWAN NS such as LoRaServer can be used. And some gateways already include LoRaWAN NS (this is also a plan for LG01-N).

4/ Downlink message
In this example, we use LoRaWAN Class A. The end node will open two short downlink windows after each uplink. More info about LoRaWAN class A, please refer LoRaWAN specification.

3.6.2 Limitations

The LG01-N is a single channel gateway (Same for LG02). And there are limitations:

<u>1/ It works only on one frequency at a time</u>. It can support multiply end nodes, but all end nodes must transmit data at the same frequency so the LG01-N can receive it. For example: if the End node transmits at 868.1Mhz, The LG01-N's RX setting must be 868.1Mhz so to receive this packet.

<u>2/ It works only for one DR at a time.</u> DR specifies the Spreading Factor and Bandwidth. In LG01-N, even the rx frequency match , if DR doesn't match, it still can't get the sensor data.

<u>3/ LoRaWAN compatible issue</u>

In LoRaWAN protocol, the LoRaWAN end nodes send data in a hopping frequency. Since LG01-N only supports one single frequency, it will only be able to receive the packets sent from the same radio parameters (frequency & DR) in LG01-N.

For example, in EU868, a standard LoRaWAN device may send the data in eight frequencies with different Frequency & SF, such as:

```
LMIC_setupChannel(0, 868100000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(1, 868300000, DR_RANGE_MAP(DR_SF12, DR_SF7B), BAND_CENTI);      // g-band
LMIC_setupChannel(2, 868500000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(3, 867100000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(4, 867300000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(5, 867500000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(6, 867700000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(7, 867900000, DR_RANGE_MAP(DR_SF12, DR_SF7),   BAND_CENTI);      // g-band
LMIC_setupChannel(8, 868800000, DR_RANGE_MAP(DR_FSK,   DR_FSK),   BAND_MILLI);      // g2-band
```

So the LG01-N will only able to receive the 868100000, SF7 packet and will not receive others. Means only one packet will arrive the TTNV3 server in every 8 packet sent from the LoRaWAN end node.

If user wants to receive all packets from LoRaWAN end node, user needs to set up the LoRaWAN node to send packets in a single frequency.

<u>4/ Downlink & OTAA issue</u>

According to the LoRaWAN class A spec, the end node will open two receive windows to get the message from LoRaWAN server for OTAA or downlink function. These two receive windows are quite short (milliseconds), if LoRa packet from the gateway can't reach End Node in the receive window time, the end node won't get the rx message and Downlink / OTAA won't work.

In our example, the Arduino LMIC library is modified to enlarge the RX window to let OTAA & downlink works.

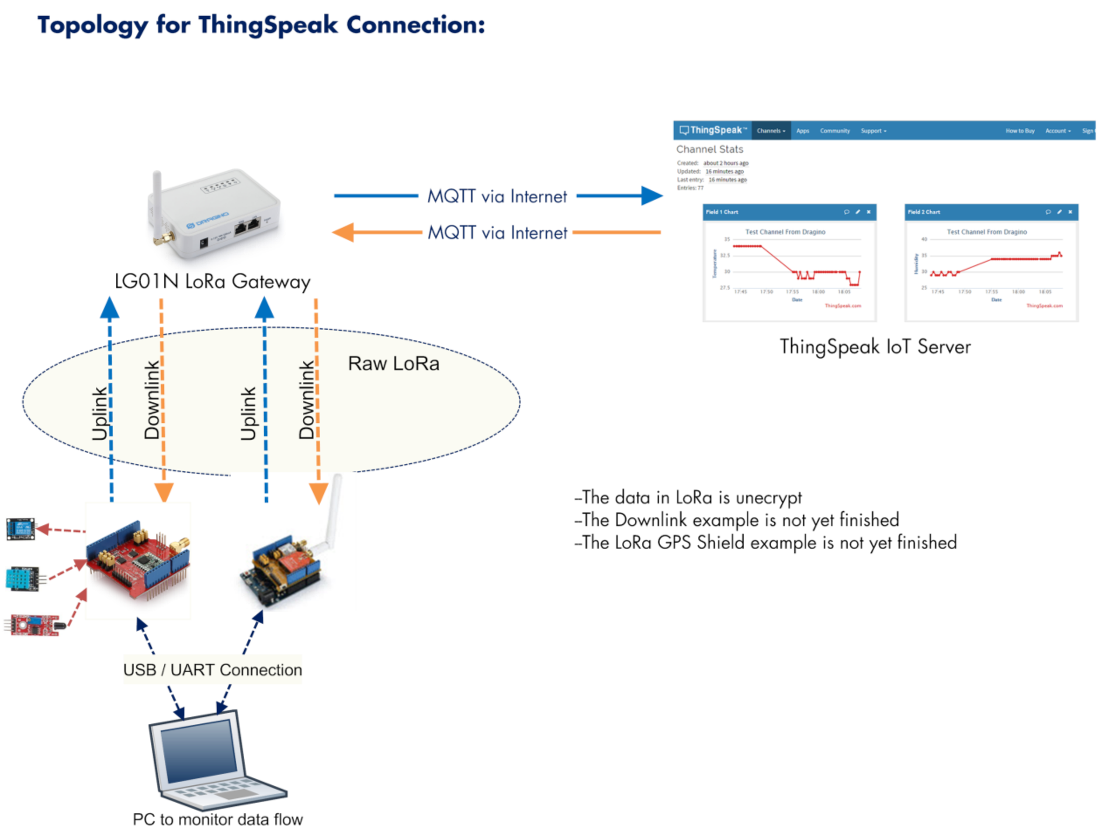
4 Example 2: Test with a MQTT IoT Server

This example describes how to use LG01-N, LoRa Shield & LoRa GPS Shield to set up a LoRa network and connect it to ThingSpeak IoT Server.

A Video Instruction of this example can be found at this url: https://youtu.be/asoNyFYZam0

4.1 Typology and Data Flow

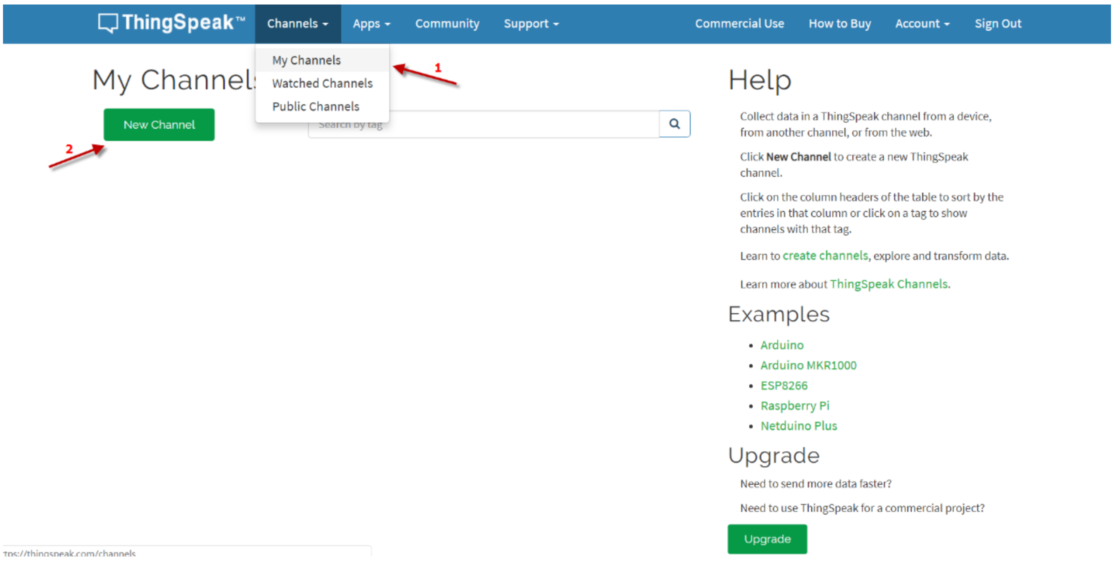
The network topology and dataflow for the example is as below:



In next section we will start to configure for this example.

4.2 Set up sensor channels in ThingSpeak

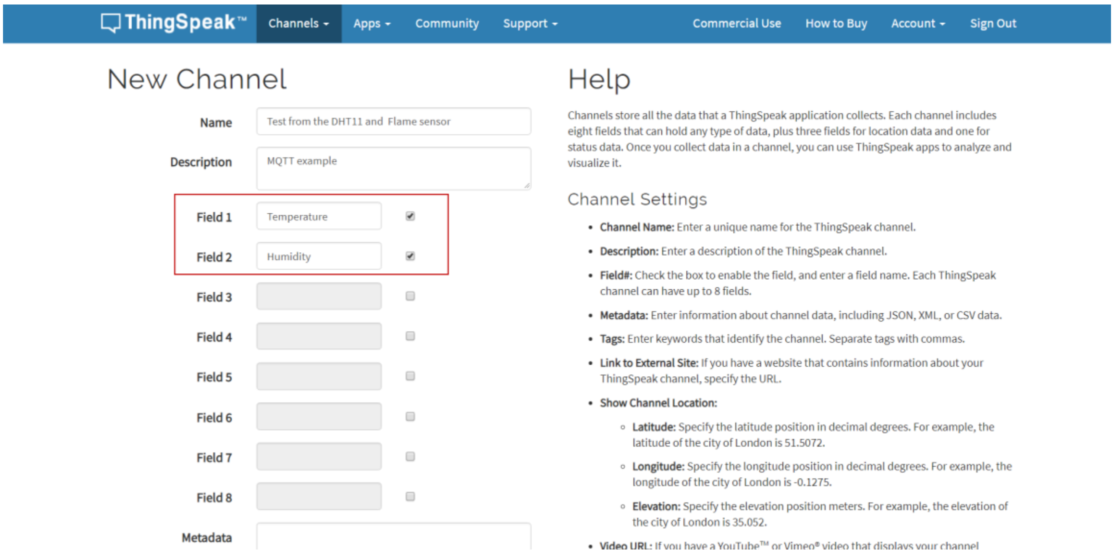
Step 1: Log in ThingSpeak and set up channels



Set up two channels:

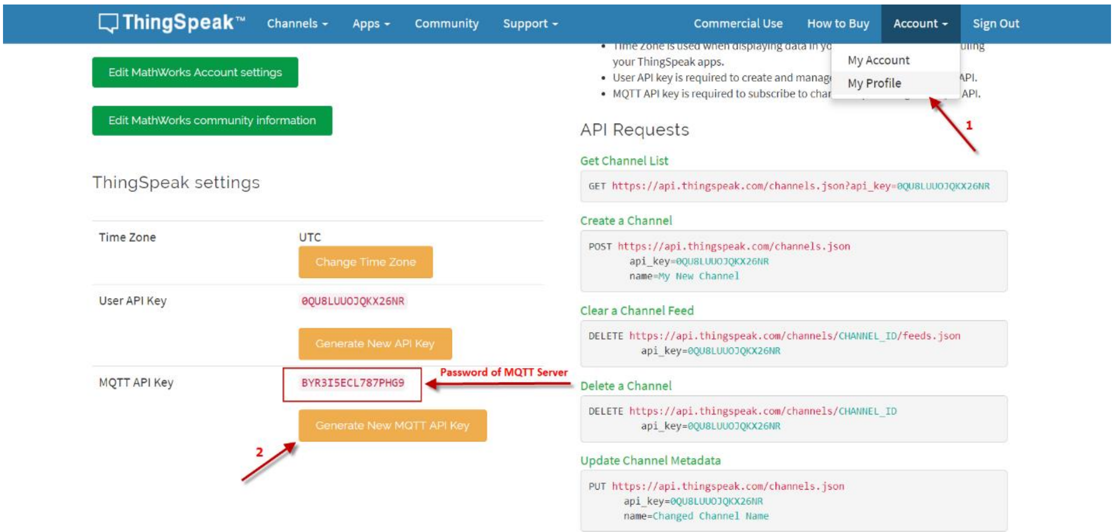
Field 1: Temperature

Field 2: Humidity



Step 2: Get MQTT keys for these channels.

Go to Account → My profile and get the MQTT API Key

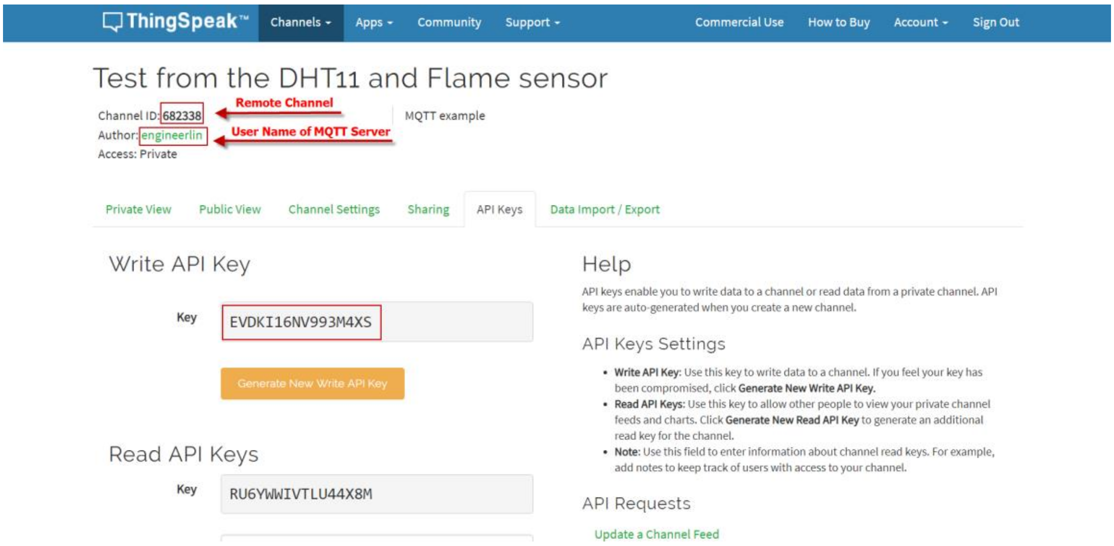


Go to channel page: get the sensor channel:

Channel ID: This is the remote Channel ID in ThingSpeak

Author: User Name for MQTT connection

Write API Key: API key for each channel



4.3 Simulate MQTT uplink via PC's MQTT tool

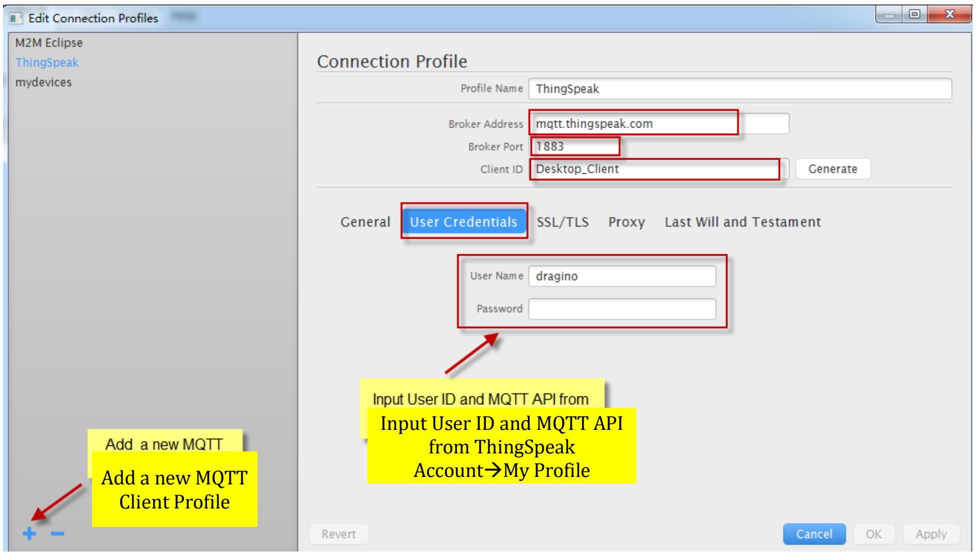
This step is not necessary, it just to help user to understand the MQTT protocol and simulate the MQTT connection to ThingSpeak. And check if the account info is valid and correct.

In the PC, download and install [MQTT.fx](). Open MQTT.fx and configure add a new MQTT client, as below:

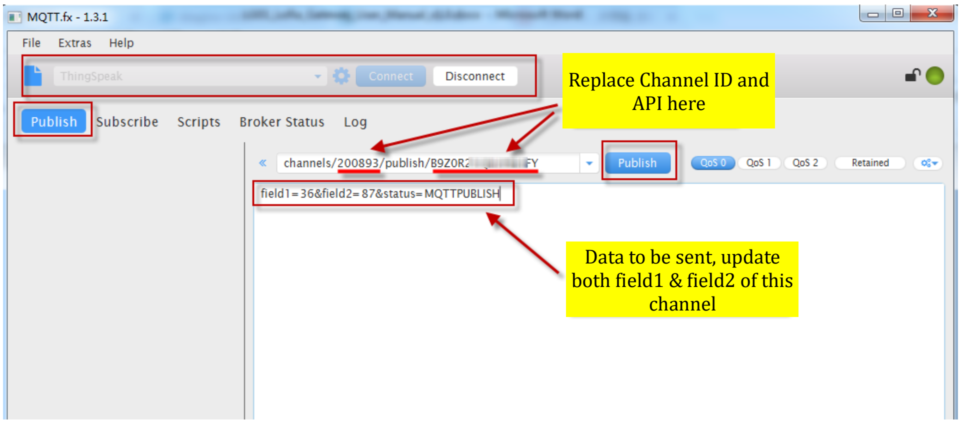
Broker Address: mqtt.thingspeak.com

Broker Port: 1883

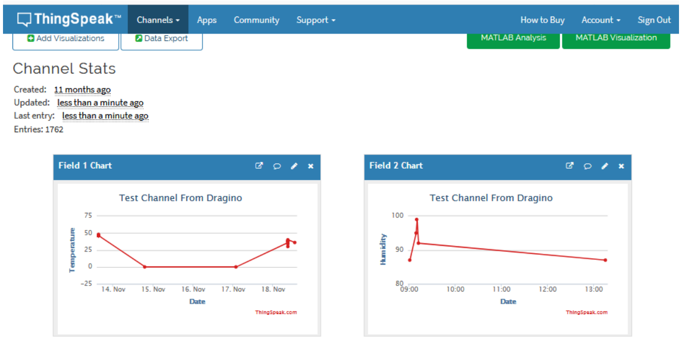
Client ID: User Defined



After add the profile, connect it and publish to the corresponding Channel with correct API key. MQTT API see [this document]():



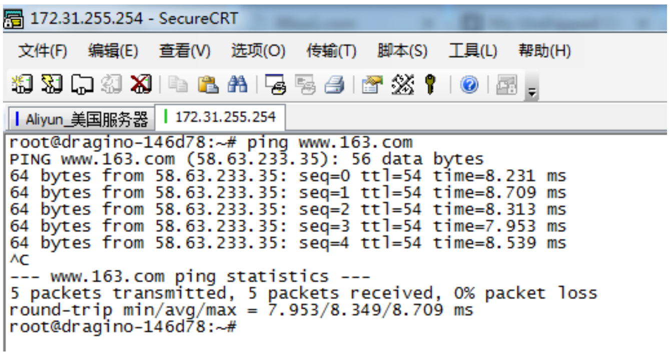
If update successful, we can see the update in the channel:



4.4 Try MQTT Publish with LG01-N Linux command

This step is also not necessary; it is to show the basic command used for MQTT connection and will help for further debug when connection fails.

First, we need to make sure the LG01-N has internet access. We can log in the SSH and ping an Internet address and see if there is reply. As below:



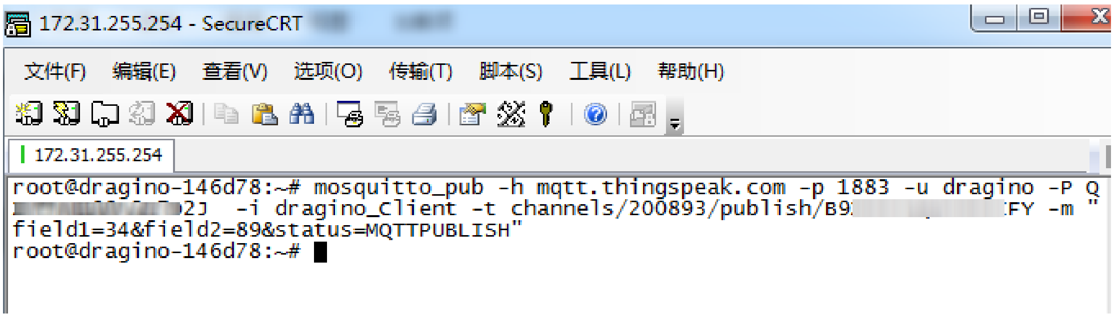
LG01-N has built-in Linux utility **mosquitto_pub**. We can use this command to publish the data to ThingSpeak.

The command to update a feed is as below:

mosquitto_pub -h mqtt.thingspeak.com -p 1883 -u dragino -P QZXTxxxxxxO2J -i dragino_Client -t channels/200893/publish/B9Z0R25QNVEBKIFY -m "field1=34&field2=89&status=MQTTPUBLISH"

(Make sure the "" is included, otherwise only one data will be uploaded)

Below is the output window:



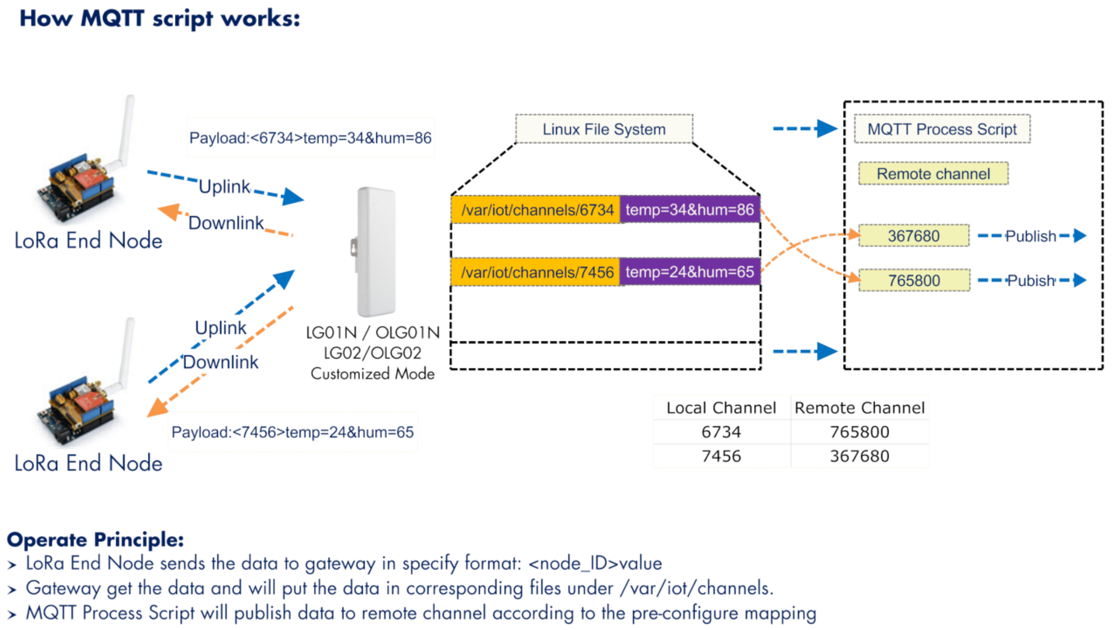
After running this command, we can see the data are updated to ThingSpeak, which has same result as what we did at mqtt.fx.

So we success to use LG01-N to uplink data to ThingSpeak, the **mosquitto_pub** command is executed in the Linux side, finally, we will have to call **mosquitto_pub** command while the LoRa sensor data arrive. We will explain how to do that in next step.

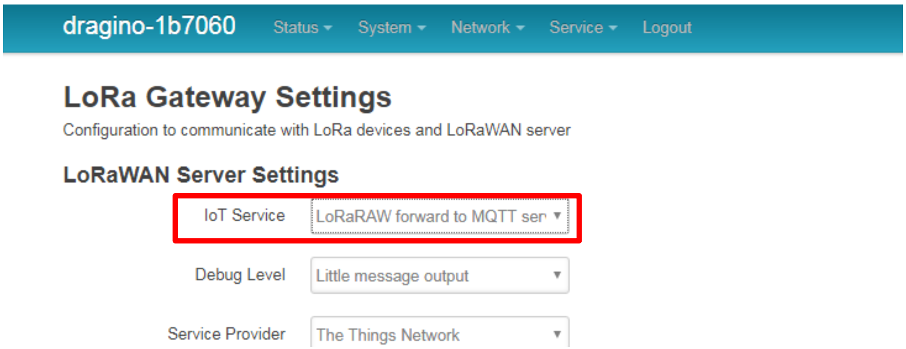
4.5 Configure LG01-N Gateway

4.5.1 Publish Logic

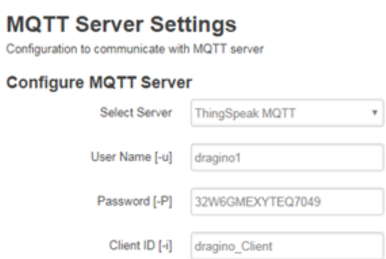
In LG01-N (firmware version > LG02_LG08--build-v5.1.1545908833-20181227-1908), there is a built-in script to process the MQTT data. The logic of this flow is as below:



Step1: Configure LG01-N to act as MQTT mode



Step2: Configure MQTT server info



In step 2, we have below settings:

- ✓ UserName[-u option]: Input Author (user name for MQTT Connection)
- ✓ Password[-P option]: Input MQTT API key

- ✓ Client_ID[-i]: dragino_Client (can put any string)
- ✓ Because we choose Thingspeak so we have below pre-set options but not show in web
  - ➢ Broker Address[-h]: mqtt.thingspeak.com
  - ➢ Broker Port[-p]: 1883
  - ➢ Topic Format[-t]: channels/CHANNEL/publish/WRITE_API.
  - ➢ Data String Format[-m]: DATA&status=MQTTPUBLISH

And we configure this channel:

- ✓ Local Channel ID: 10009
- ✓ Remote Channel ID: 396640
- ✓ Write_api_key: Write API key for this channel.

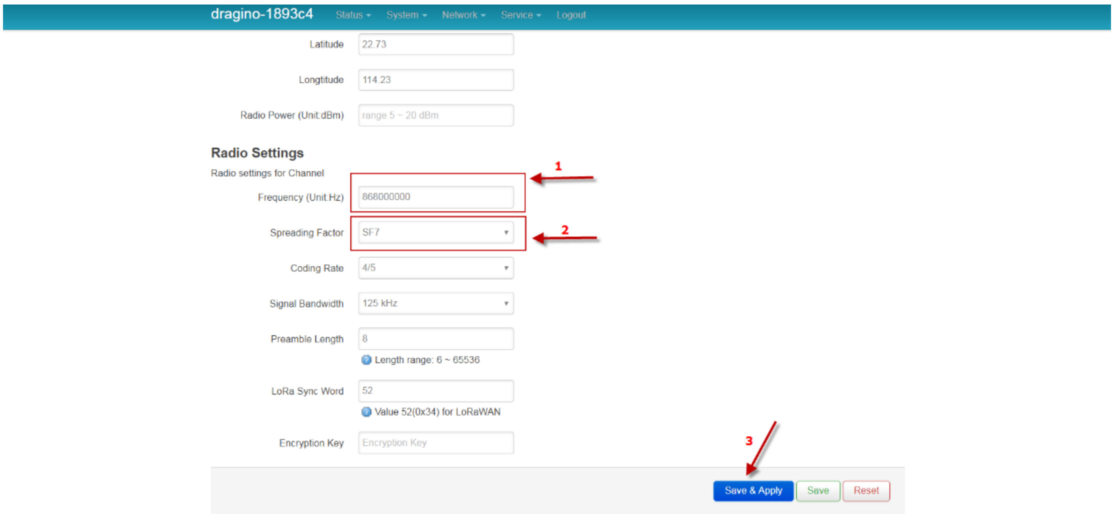
In the mqtt script, the upper **CHANNEL** will be replaced by the parameter (remote channel in IoT server). and the **WRITE_API** will be replaced by the settings in write api key. The **DATA** will be replaced by the value stored in the /var/iot/channels/LOCAL_CHANNEL file.

MQTT script will keep checking the files in /var/iot/channels/ . If it finds a match Local channel, then the MQTT script will send out the data of this local channel to a remote channel according to the setting above.

User can also enable MQTT debug level and run logread in Linux console to see how the mqtt command is compose. Below is an example:

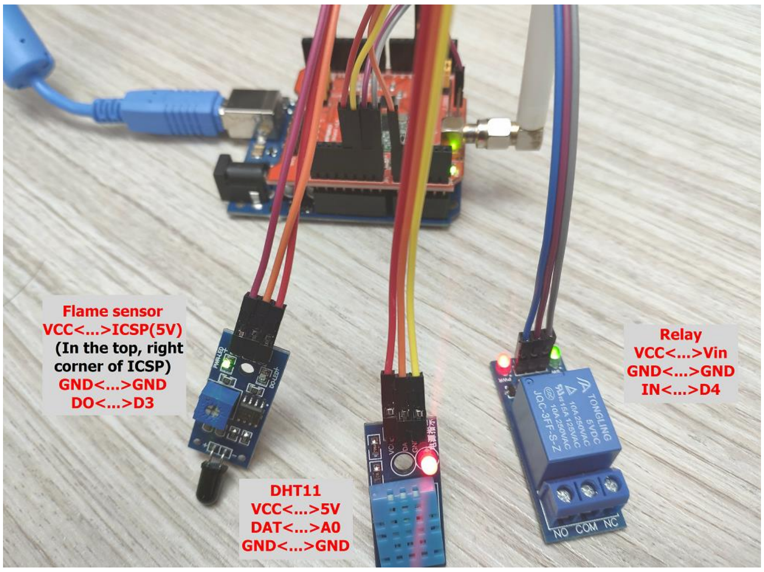
4.5.2 Configure LG01-N's Radio frequency

Now we should configure LG01-N's radio parameter to receive the LoRaWAN packets. We are using 868.0Mhz (868000000 Hz) as below:


dragino-1893c4
Status
System
Network
Service
Logout
Latitude
22.73
Longtitude
114.23
Radio Power (Unit:dBm)
range 5 ~ 20 dBm
Radio Settings
Radio settings for Channel
Frequency (Unit:Hz)
868000000
Spreading Factor
SF7
Coding Rate
4/5
Signal Bandwidth
125 kHz
Preamble Length
8
Length range: 6 ~ 65536
LoRa Sync Word
52
Value 52(0x34) for LoRaWAN
Encryption Key
Encryption Key
1
2
3
Save & Apply
Save
Reset

4.6 Create LoRa Shield End Node

4.6.1 Hardware Connection



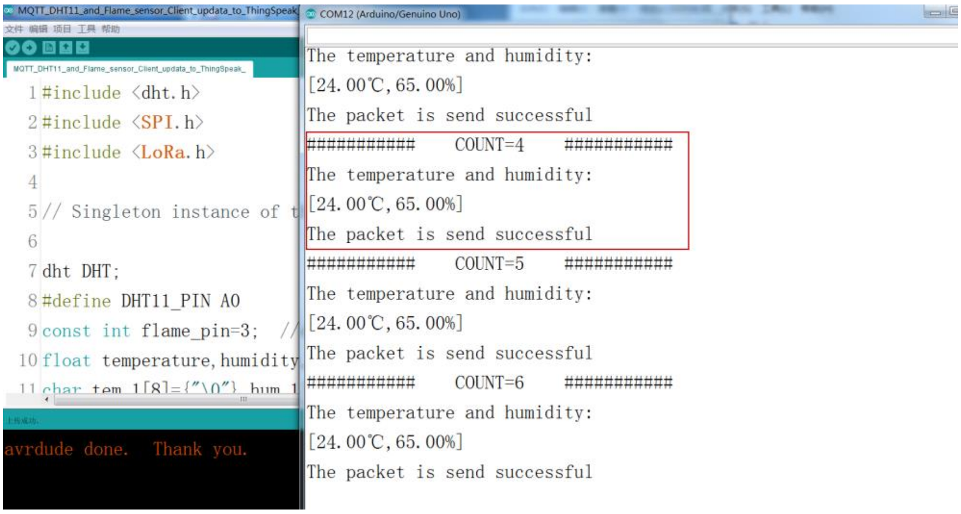
There are three sensors connect to the LoRa Shield + UNO. These sensors are flame sensors, DHT11 (Temperature & Humidity sensor) and Relay. Please use the connection as we show in the photo.

Note: There is a trick above, the relay is connected to VIN. In this case, The UNO can only be power via USB port. If need to power via DC power adapter, please use another 5v pin to power relay.

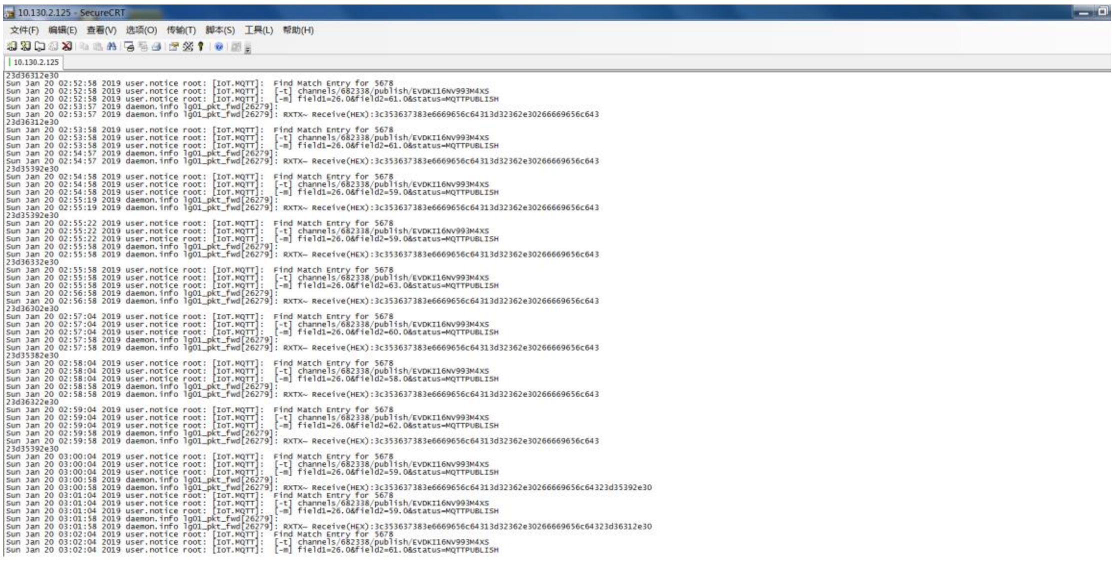
Upload this sketch to the UNO, this sketch will send temperature and humidity data to gateway at every 60 seconds. If there is a flame detect, it will then immediately send the value to gateway and then upload to the IoT Server.

4.6.2 Test with uplink

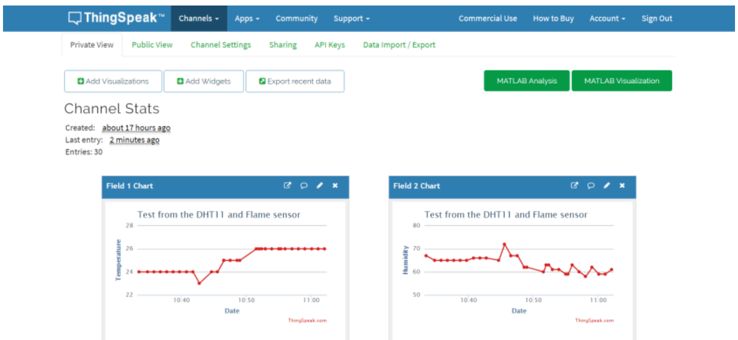
After we upload the sketch to UNO, we can see below output from Arduino



And we can see the logread of gateway as below, means the packet arrive gateway:



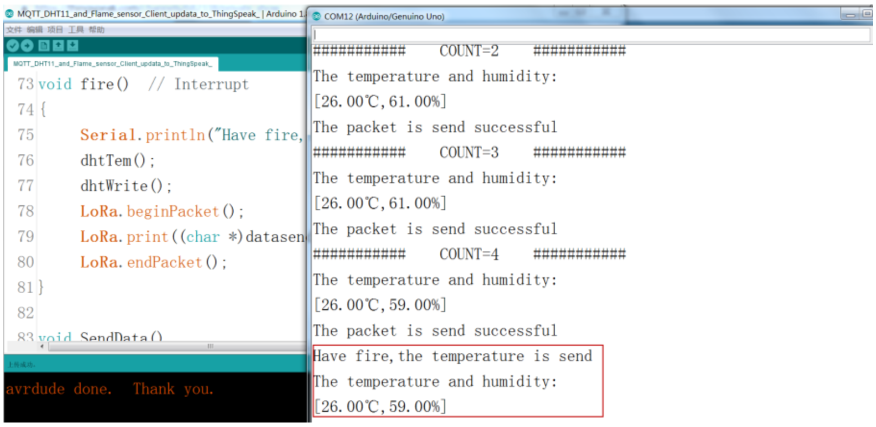
Finally, we can see on the ThingSpeak:



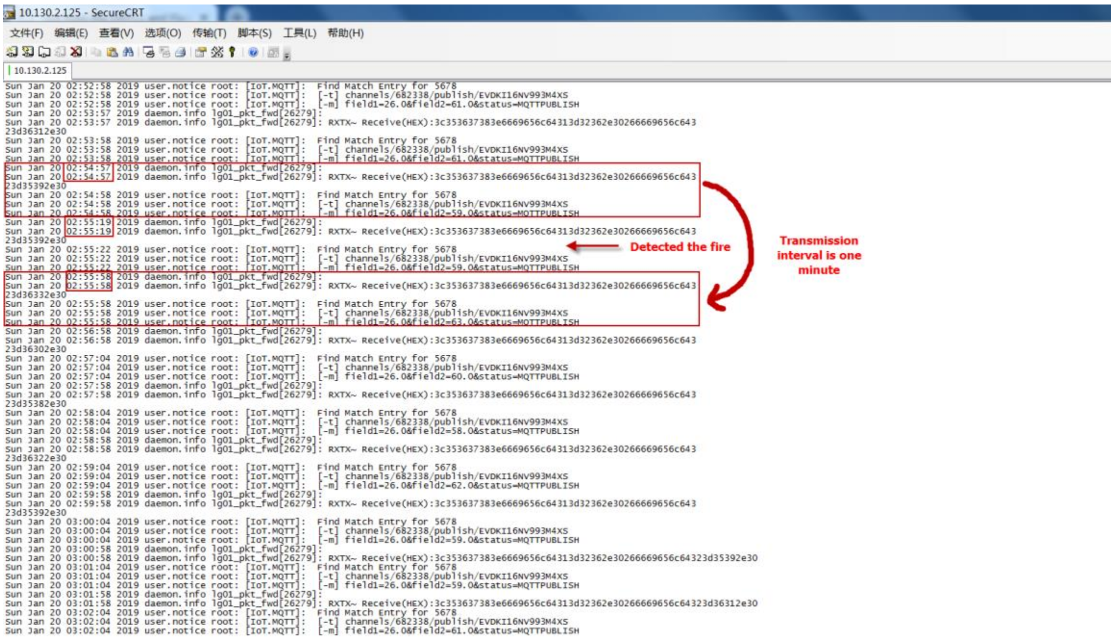
4.6.3 Test with interrupt by flame detect

The DO pin of Flame sensor is high in normal state. When a flame is detected, the DO pin of Flame sensor will become low, then, the UNO generates an external interrupt, and immediately uploads the temperature and humidity to the server.

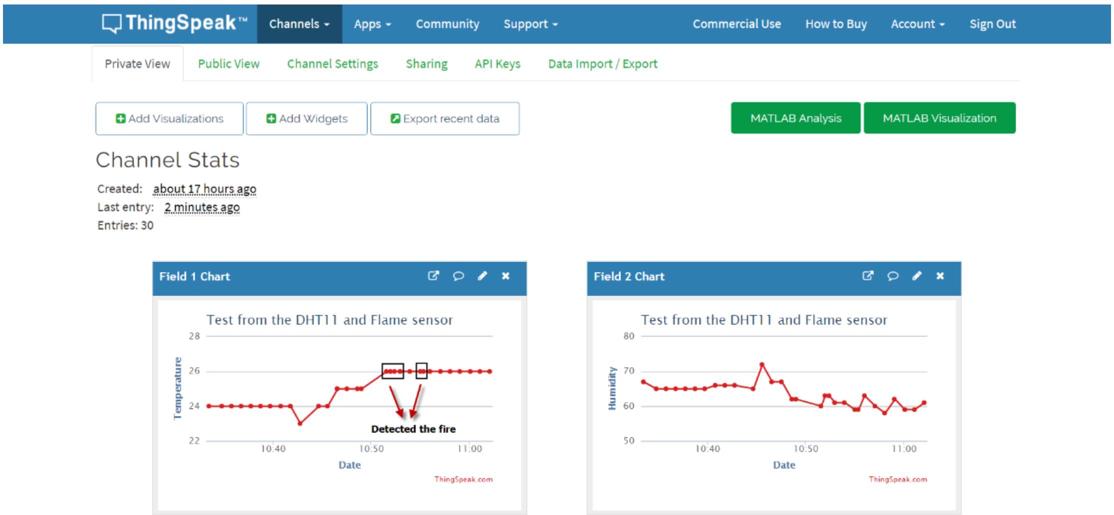
The DO pin of Flame sensor is low when a flame is detected, and we can see on the Serial Monitor：



Similarly, we can see the logread of gateway via SSH access:



Finally, we can see on the ThingSpeak:

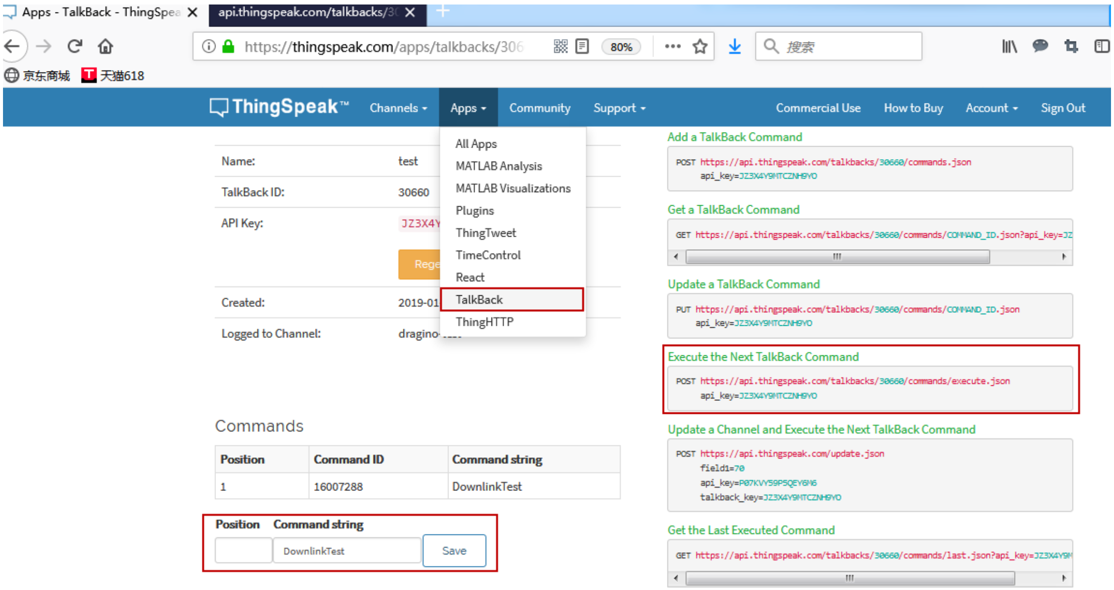


4.6.4 Test with downlink

The http downlink feature is now support since firmware LG02_LG08--build--v5.2.1560931576--20190619-1607.

ThingSpeak downlink command can be found in TalkBack App.

The **Command String input box** is the command you want to send to LoRa device.

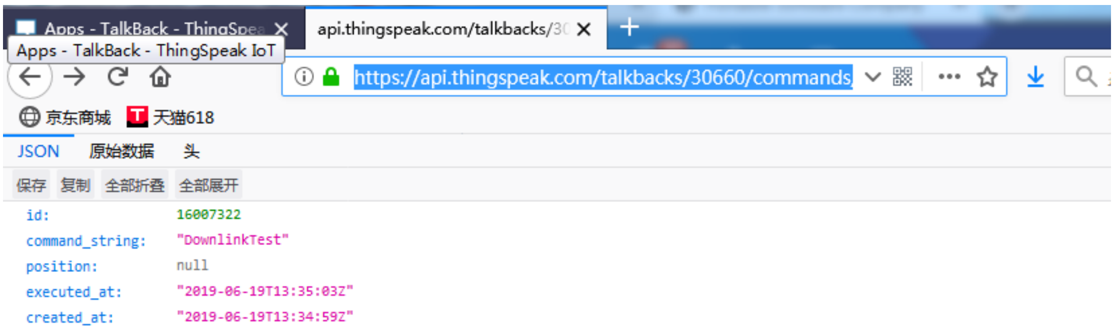


Execute The next Talkback Command is the API to get one command from the commands queue.

We can test in the web with this API. Format is:

https://api.thingspeak.com/talkbacks/**XXXXX**/commands/execute.json?api_key=**XXXXXXXXX**

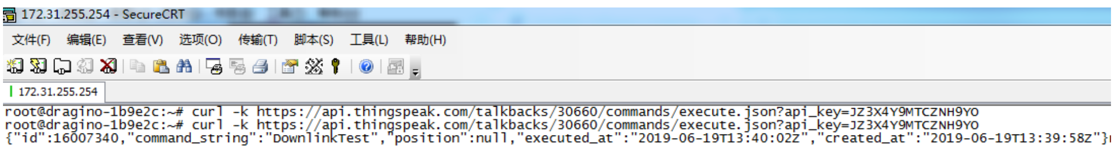
Result as below:



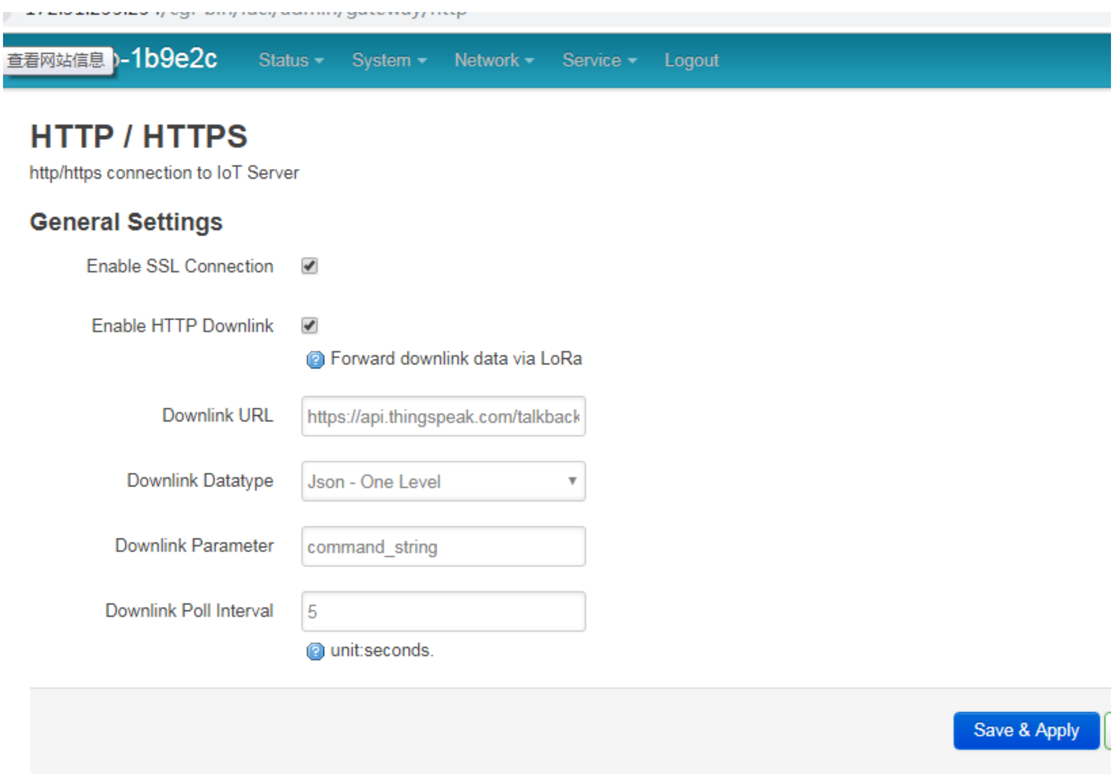
We can also test this API in LG01-N Linux console:

By using:

*curl -k https://api.thingspeak.com/talkbacks/**XXXXX**/commands/execute.json?api_key=**XXXXXXXXX***

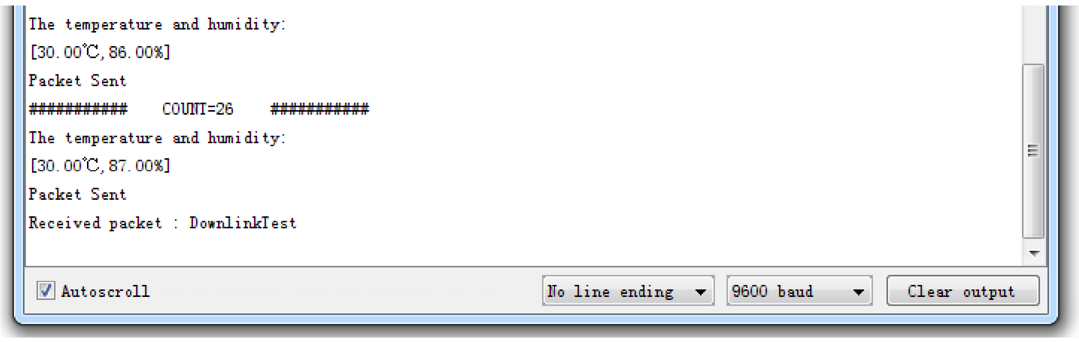


To get this result automatically in LG01-P and send out via LoRa, we can configure as below:



- Because URL is https, So need to Enable SSL Connection
- Downlink URL use the URL we use in Web and Curl
- Downlink datatype for ThingSpeak is Json.
- Downlink Parameter is command_string. We will fetch the value of command_string from the downlink data string.
- LG01-N will poll the URL every 5 seconds. When there is valid command_string found, it will send out via LoRa (Radio parameter is defined in LoRaWAN gateway Radio settings or Radio2 settings for LG02)

Result in the LoRa Shield:



4.7 Conclusion and limitation

4.7.1 Overview for the example

This example shows how to set up a simple LoRa network with ThingSpeak IoT server. In this example, we use the raw LoRa protocol (private protocol) for transmission. It is simpler compare via LoRaWAN protocol

There are some frequently ask points for the example:

1/ Difference between LoRaWAN & Private LoRa protocol:

- The private LoRa protocol here doesn't have MAC control/management, (of course developer can develop this). In LoRaWAN protocol, this feature is supported already.
- The transmission is unencrypted in this example, user can see the data in gateway. In LoRaWAN, the transmission is designed in AES encryption.
- Private LoRa protocol means the gateway only works with specify LoRa End node which runs the same protocol, the gateway can't work with a standard LoRaWAN devices.
- Private LoRa protocol doesn't need the LoRaWAN IoT Server. Gateway can send data to user defined IoT server, in terms the gateway and the server can communicate with each other.
- User can more features in the private protocol such as MAC control, encryption, that is how LoRaWAN protocol comes, the advantage of LoRaWAN protocol is that it is designed for carrier level use, and developer can use it directly with many features and compatible with the LoRaWAN node from different manufacturers.

5 Order Info

LoRa_IoT_Kit-v2-XXX-YYY

XXX: Frequency Band

433: For Bands: EU433, CN470

868: For Bands: EU868,IN865

915: For Bands: US915,AU915,AS923,KR920

YYY: 4G Cellular Option

EC25-E: EMEA, Korea, Thailand, India.

EC25-A: North America/ Rogers/AT&T/T-Mobile.

EC25-AU: Latin America, New Zeland, Taiwan

EC25-J: Japan, DOCOMO/SoftBank/ KDDI

More info about valid bands, please see EC25-E product page

(https://www.quectel.com/product/ec25.htm)

6 FAQ & Trouble Shooting

6.1 I can't upload sketch to LoRa Shield in MAC OS, shows " dev/cu.usbmodem1421 is not available "

Error Info as below:

Arduino: 1.8.3 (Mac OS X), Board: "Arduino/Genuino Uno"
Archiving built core (caching) in:
/var/folders/jq/8fnvlfj90tgbnbcyd16_bbw00000gn/T/arduino_cache_833512/core/core_arduino_avr_uno_fc9a32205aafa27e4eda988d5ed9b7ac.a
Sketch uses 20142 bytes (62%) of program storage space. Maximum is 32256 bytes.
Global variables use 1189 bytes (58%) of dynamic memory, leaving 859 bytes for local variables. Maximum is 2048 bytes.
Board at /dev/cu.usbmodem1421 is not available

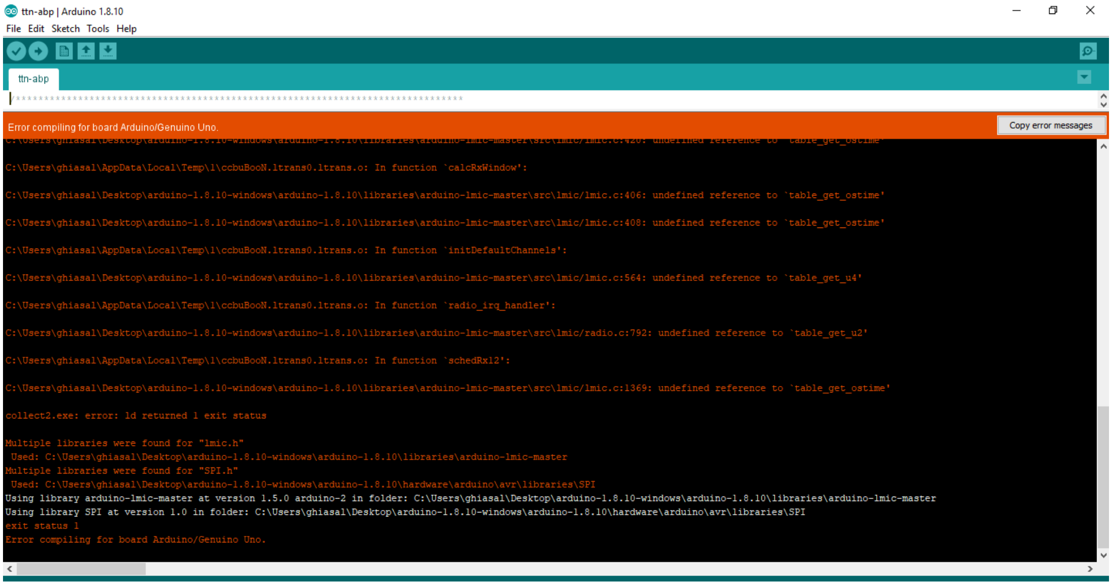
The Arduino UNOs in the Kit are clone version and use CH340 USB to serial chip. User has to install the CH340 driver in PC to make it work. Above issue means the MAC OS doesn't has CH340 driver.

6.2 My IoT Kit has the model LG01-P instead of LG01-N, Can I still use this manual.

The gateway part of this manual is for LG01-N, if user has the LG01-P version, please check the LG01-P gateway manual.

6.3 Duplicate library issue while upload in Arduino IDE 1.8.10.

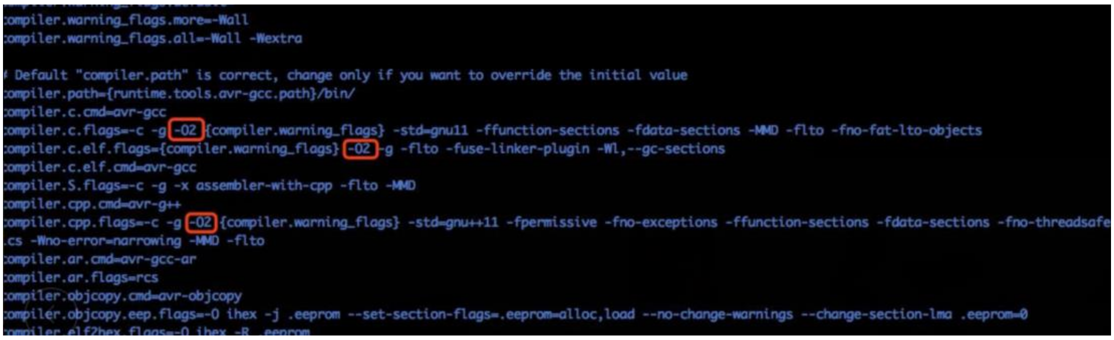
While compile the LMIC library in Arduino IDE 1.8.10. This error will happen:



To solve this, user can modify the file:

~/Dev/Arduino.app/Contents/Java/hardware/arduino/avr/platform.txt

, Change the compile flag from –Os to –O2. Like below:



6.4 How can I set to use CN470 band?

```
//#define CFG_au921 1
//#define CFG_as923 1
//#define CFG_in866 1

#define LG02_LG01 1

//US915: DR_SF10=0, DR_SF9=1, DR_SF8=2, DR_SF7=3, DR_SF8C=4
//       DR_SF12CR=8, DR_SF11CR=9, DR_SF10CR=10, DR_SF9CR=11, DR_SF8CR=12, DR_SF7CR
#if defined(CFG_us915) && defined(LG02_LG01)
// CFG_us915 || CFG_as923
#define LG02_UPFREQ   902320000
#define LG02_DNWFREQ  923300000
#define LG02_RXSF     3      // DR_SF7  For LG01/LG02 Tx
#define LG02_TXSF     8      // DR_SF12CR For LG02/LG02 Rx
#elif defined(CFG_eu868) && defined(LG02_LG01)
// CFG_eu868
//EU868: DR_SF12=0, DR_SF11=1, DR_SF10=2, DR_SF9=3, DR_SF8=4, DR_SF7=5, DR_SF7B=1, DR_FSK, DR_
#define LG02_UPFREQ   505300000
#define LG02_DNWFREQ  505300000
#define LG02_RXSF     0      // DR_SF7 For LG01/LG02 Tx
#define LG02_TXSF     0       // DR_SF12 For LG02/LG02 Rx
#endif
```

7 Technical Support

- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different timezones we cannot offer live support. However, your questions will be answered as soon as possible in the before-mentioned schedule.
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to

support@dragino.com

8 Reference

1) LoRaWAN official website. And Technicel document for LoRaWAN.
2) LG01-N LoRa Gateway User Manual
3) LoRa Low Energy design guide and Calculator Tool.
4) About Distance: LoRa Modem Design Guide
5) SX1276 download resource.
6) User Manual: LG01-N, LoRa Shield, LoRa/GPS Shield