LPS8N LoRaWAN Gateway User Manual

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Version	Description	Date
1.0	Release	2022-Apr-8

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1 Introduction

1.1 What is the LPS8N

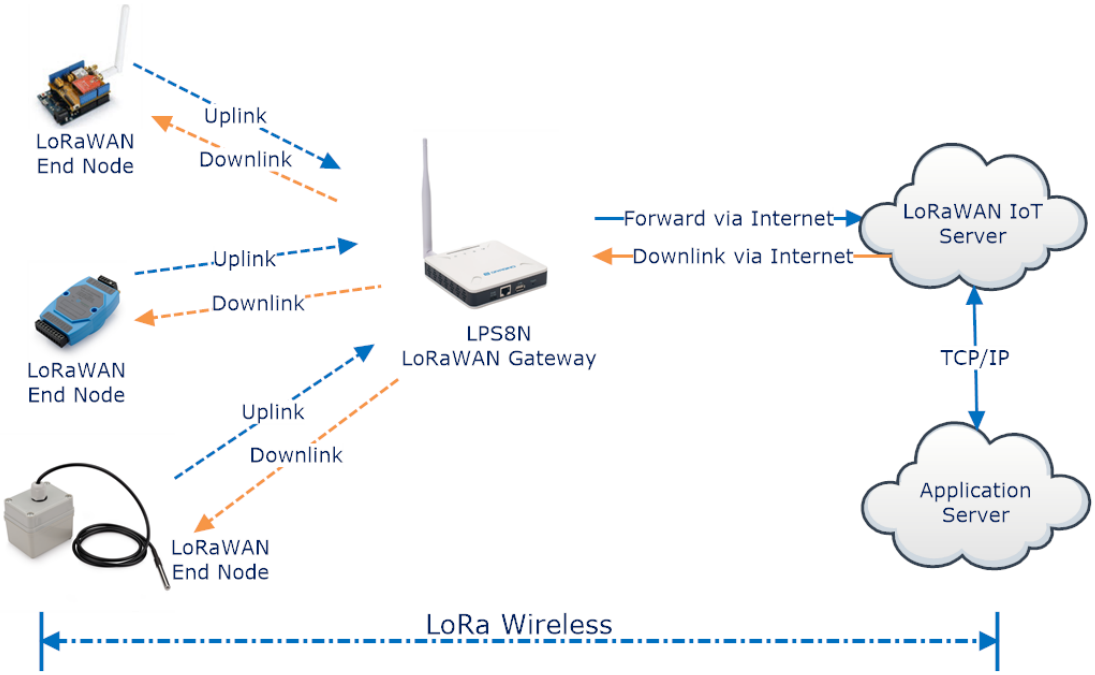
The LPS8N is an open source **LoRaWAN Indoor Gateway**. It lets you bridge LoRa wireless network to an IP network via WiFi, Ethernet. The LoRa wireless allows users to send data and reach extremely long ranges at low data-rates.

The LPS8N uses **Semtech packet forwarder & LoRaWAN Basic Station** and fully compatible with LoRaWAN protocol. It includes a **SX1302 LoRa concentrator**, which provides 10 programmable parallel demodulation paths.

LPS8N has **pre-configured standard LoRaWAN frequency bands** to use for different countries. User can also **customized the frequency bands** to use in their own LoRa network.

LPS8N can communicate with ABP LoRaWAN end node without LoRaWAN server. System integrator can use it to integrate with their existing IoT Service without set up own LoRaWAN server or use 3rd party LoRaWAN service.

LPS8N In a LoRaWAN IoT Network:



1.2 Specifications

Hardware System:

Linux Part:

- 400Mhz ar9331 processor
- 64MB RAM
- 16MB Flash

Interface:

- 10M/100M RJ45 Ports x 1
- WiFi : 802.11 b/g/n
- LoRaWAN Wireless
- Power Input: 5V DC, 2A, Type C
- USB 2.0 host connector x 1
- Mini-PCI E connector x 1
- SX1302 + 2 x SX1250

WiFi Spec:

- IEEE 802.11 b/g/n
- Frequency Band: 2.4 12~ 2.462GHz
- Tx power:
  - ✓ 11n20 tx power : 11db
  - ✓ 11n40 tx power : 9db
  - ✓ 11b tx power: 15db
  - ✓ 11g tx power: 12db
- Wifi Sensitivity
  - ✓ 11g 54M : -71dbm
  - ✓ 11n 20M : -67dbm

LoRa Spec:

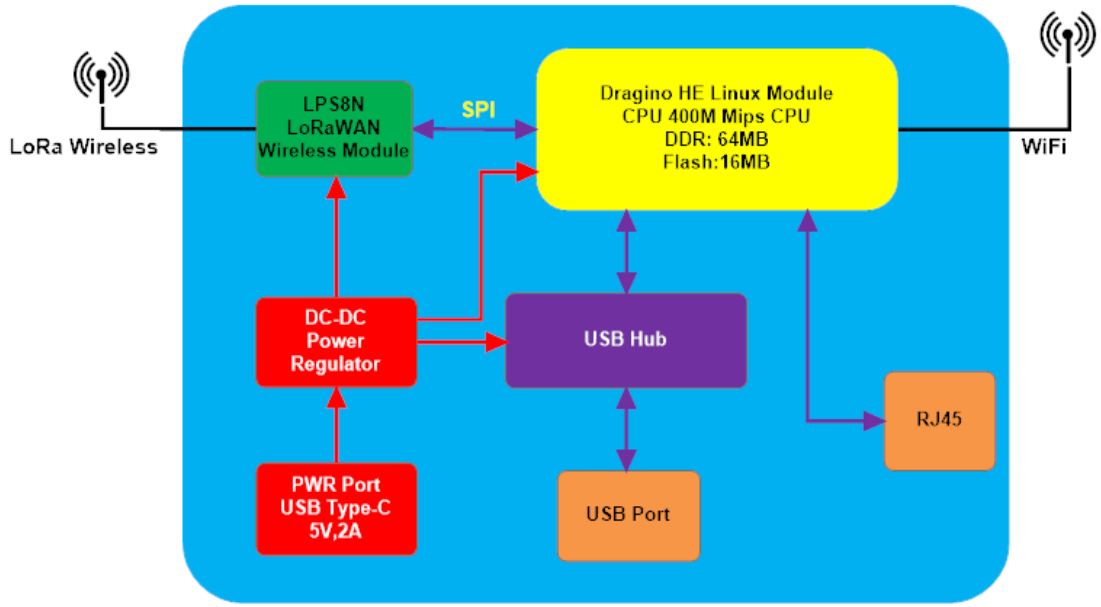
- Up to -140 dBm sensitivity
- 70 dB CW interferer rejection at 1 MHz offset
- Able to operate with negative SNR, CCR up to 9dB
- Emulates 49 x LoRa demodulators and 1 x (G)FSK demodulator
- Dual digital TX & RX radio front-end interfaces
- 10 programmable parallel demodulation paths
- Dynamic data-rate (DDR) adaptation
- True antenna diversity or simultaneous dual-band operation

1.3 Features

- ✓ Open Source OpenWrt system
- ✓ Managed by Web GUI, SSH via WAN or WiFi
- ✓ Remote access with Reverse-SSH or remote.it
- ✓ Emulates 49x LoRa demodulators
- ✓ LoRaWAN Gateway
- ✓ 10 programmable parallel demodulation paths
- ✓ Pre-configure to support different LoRaWAN regional settings.
- ✓ Allow to customize LoRaWAN regional parameters.
- ✓ Support Local decode ABP end node info and transfer to MQTT server
- ✓ Support different level log in.
- ✓ Support Semtech Packet Forwarder
- ✓ Support LoRaWAN basic station.

1.4 Hardware System Structure

LPS8N System Overview:



1.5 LPS8N Applications

1.6 LED Indicators

LPS8N has totally four LEDs, They are:

- **Power LED** : This **RED LED** will be **solid on** if the device is properly powered.
- **LoRa LED** : This **RGB LED** will **blink GREEN** when LoRaWAN module starts or transmit a packet.
- **SYS LED** :This **RGB LED** will shows different colors on different state:
  - ✓ **SOLID BLUE**: Device is alive with LoRaWAN server connection.
  - ✓ **BLINKING BLUE**: a) Device has internet connection but no LoRaWAN Connection. or b) Device is in booting stage, in this stage, it will **BLINKING BLUE** for several seconds and then with **SOLID RED** and **BLINKING BLUE** together
  - ✓ **SOLID RED**: Device doesn't have Internet connection.
- **ETH LED** : This LED shows the ETH interface connection status.

2 Access and Configure LPS8N

The LPS8N is configured as a WiFi Access Point by factory default. You can access and configure the LPS8N after connecting to its WiFi network, or via its WAN Ethernet port.

2.1 Find IP address of LPS8N

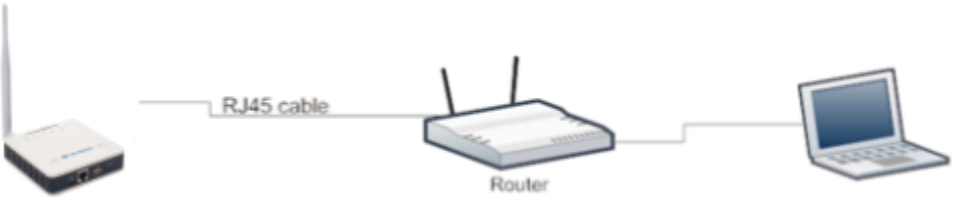
2.1.1 Connect via WiFi

At the first boot of LPS8N, it will auto generate a WiFi network called ***dragino-xxxxxx*** with password:

dragino+dragino

You can use a PC to connect to this WiFi network. The PC will get an IP address 10.130.1.xxx and the LPS8N has the default IP 10.130.1.1

2.1.2 Connect via Ethernet with DHCP IP from router



Alternatively, connect the LPS8N Ethernet port to your router and LPS8N can obtain an IP address from your router. In the router's management portal, you should be able to find what IP address the router has assigned to the LPS8N. You can also use this IP to connect.

2.1.3 Connect via WiFi with DHCP IP from router

If the LPS8N already connect to the router via WiFi, use can use the WiFi IP to connect to LPS8N.

2.1.4 Connect via Ethernet with fall back ip

The WAN port also has a fall back ip address for access if user doesn't connect to uplink router.
Click here to see how to configure.

2.2 Access Configure Web UI

Web Interface

Open a browser on the PC and type in the LPS8N ip address (depends on your connect method)

http://10.130.1.1/ (Access via WiFi AP network)

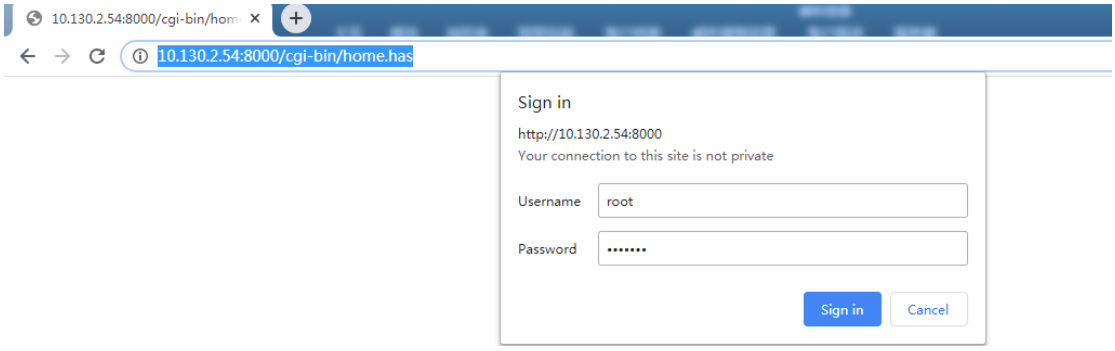
or

http://IP_ADDRESS or http:// IP_ADDRESS:8000 (The web port has been changed to 8000 in **WAN interface**(WAN port or WiFi Client Mode) since firmware 5.3.xxx firmware)

You will see the login interface of LPS8N as shown below.
The account details for Web Login are:

User Name: root

Password: dragino



3 Typical Network Setup

3.1 Overview

The LPS8N supports flexible network set up for different environments. This section describes the typical network topology can be set in LPS8N. The network set up includes:

- ✓ **WAN Port Internet Mode**
- ✓ **WiFi Client Mode**
- ✓ **WiFi AP Mode**

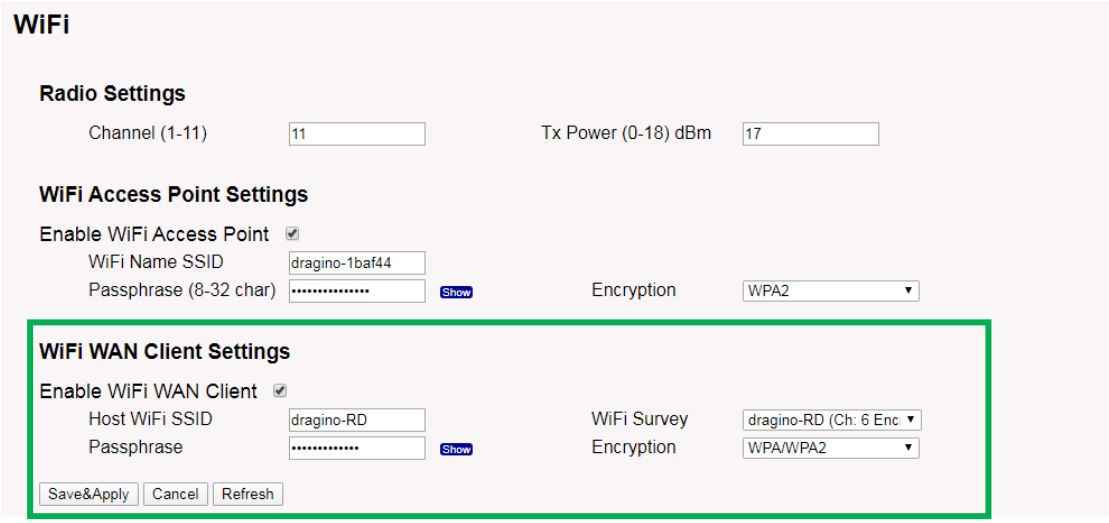
3.2 Use WAN port to access Internet

By default, the LPS8N is set to use the WAN port to connect to an upstream network. When you connect the LPS8N's WAN port to an upstream router, LPS8N will get an IP address from the router and have Internet access via the upstream router. The network status can be checked as below:

3.3 Access the Internet as a WiFi Client.

In the WiFi Client Mode, LPS8N acts as a WiFi client and gets DHCP from an upstream router via WiFi.

The settings for WiFi Client is under page **System → WiFi → WiFi WAN Client Settings**



In the WiFi Survey Choose the WiFi AP, and input the Passphrase then click Save & Apply to connect.

3.4 Check Internet connection

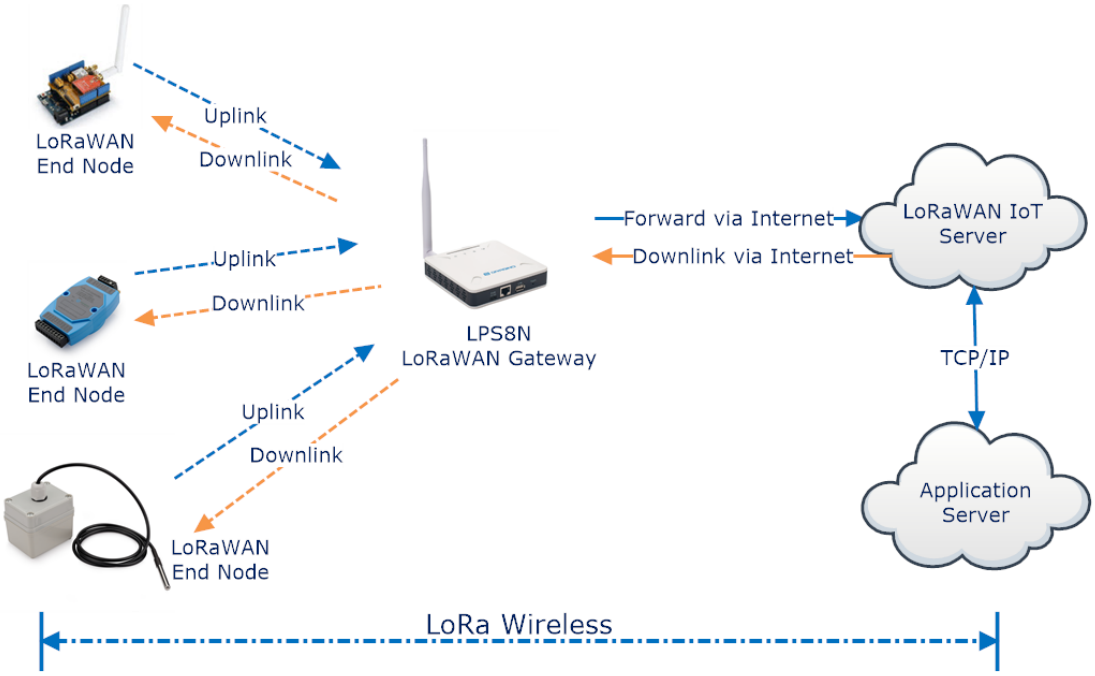
In the **Home** page, we can check the Internet connection.

- GREEN Tick : This interface has Internet connection.
- Yellow Tick : This interface has IP address but don't use it for internet connection.
- RED Cross : This interface doesn't connected.

4 Example: Configure as a LoRaWAN gateway

LPS8N is fully compatible with LoRaWAN protocol. It uses the legacy Semtech Packet forwarder to forward the LoRaWAN packets to server. The structure is as below.

LPS8N In a LoRaWAN IoT Network:

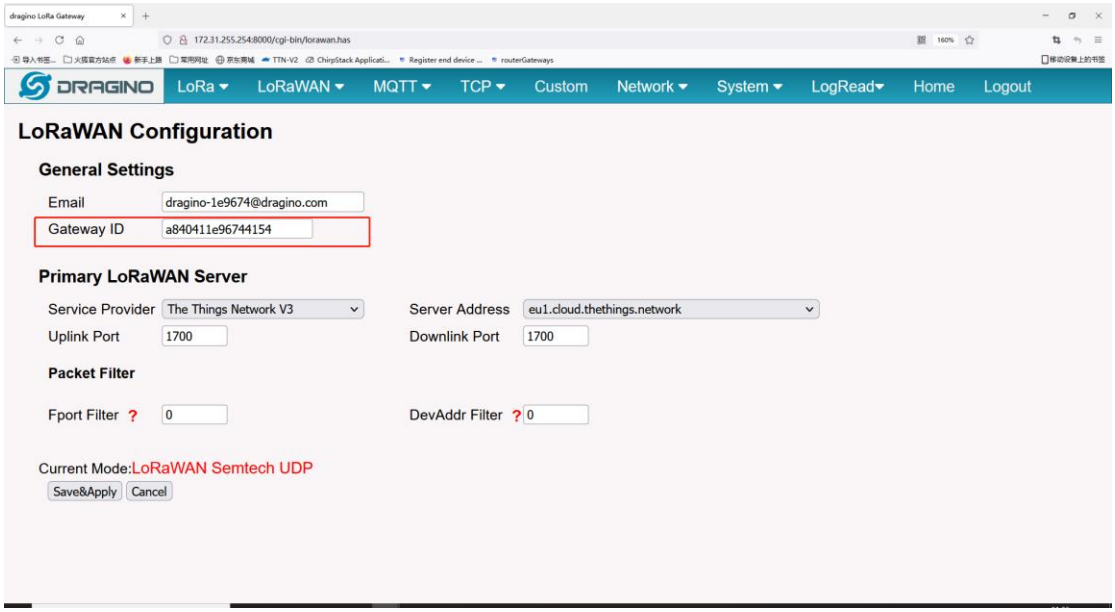


This chapter describes how to use the LPS8N to work with (TTN v3)。
(www.thethingsnetwork.org)

4.1 Create a gateway in TTN V3 Server

Step 1: Get a Unique gateway ID.

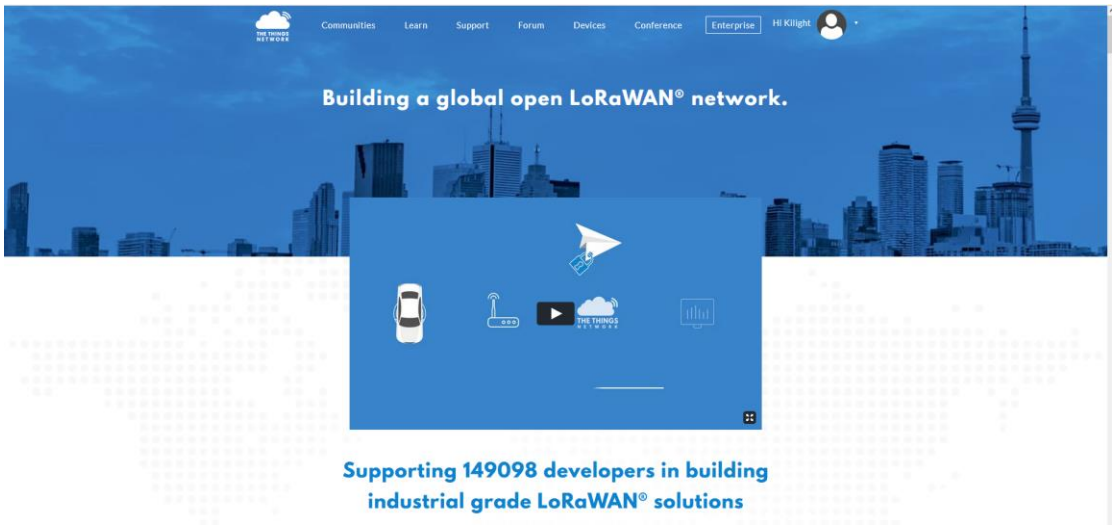
Every LPS8N has a unique gateway id. The ID can be found at LoRaWAN page:



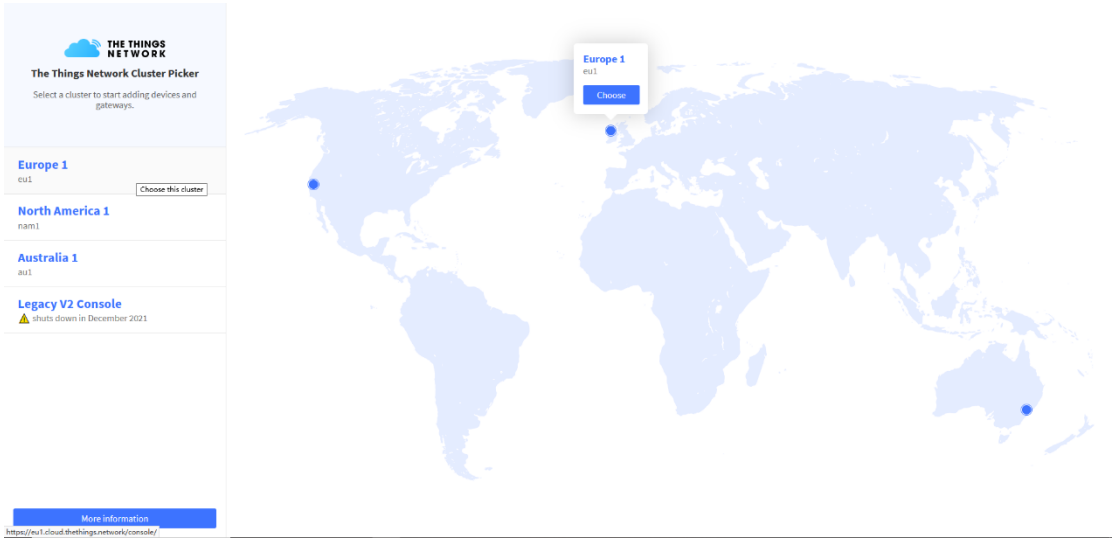
The example gateway id is: **a840411e96744154**

Step 2: Sign up a user account in TTN server

https://account.thethingsnetwork.org/register



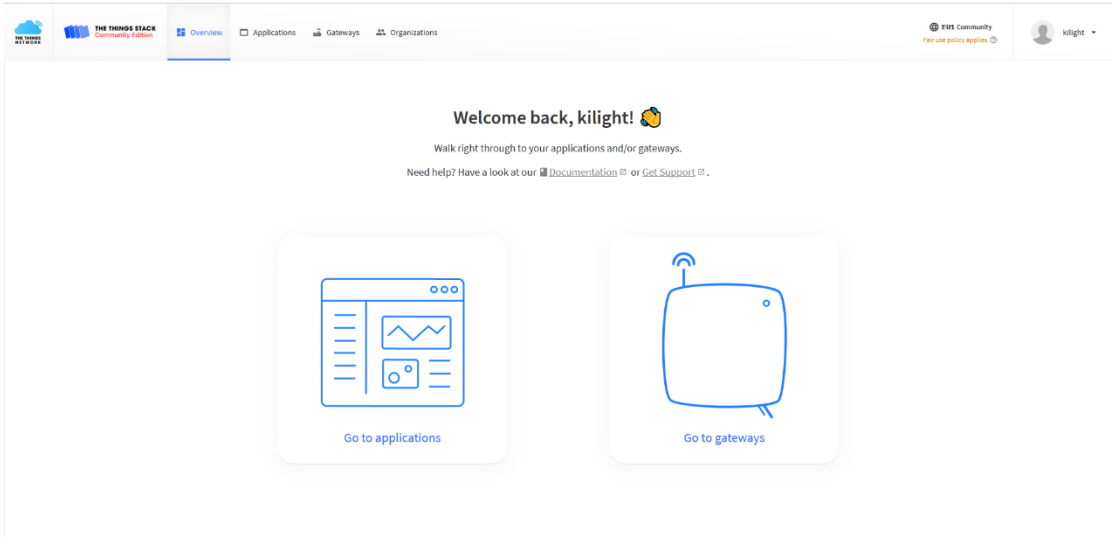
Step 3: Choose the TTNv3 Cluster Picker



Note: Choose the cluster corresponds to a specific Gateway server address

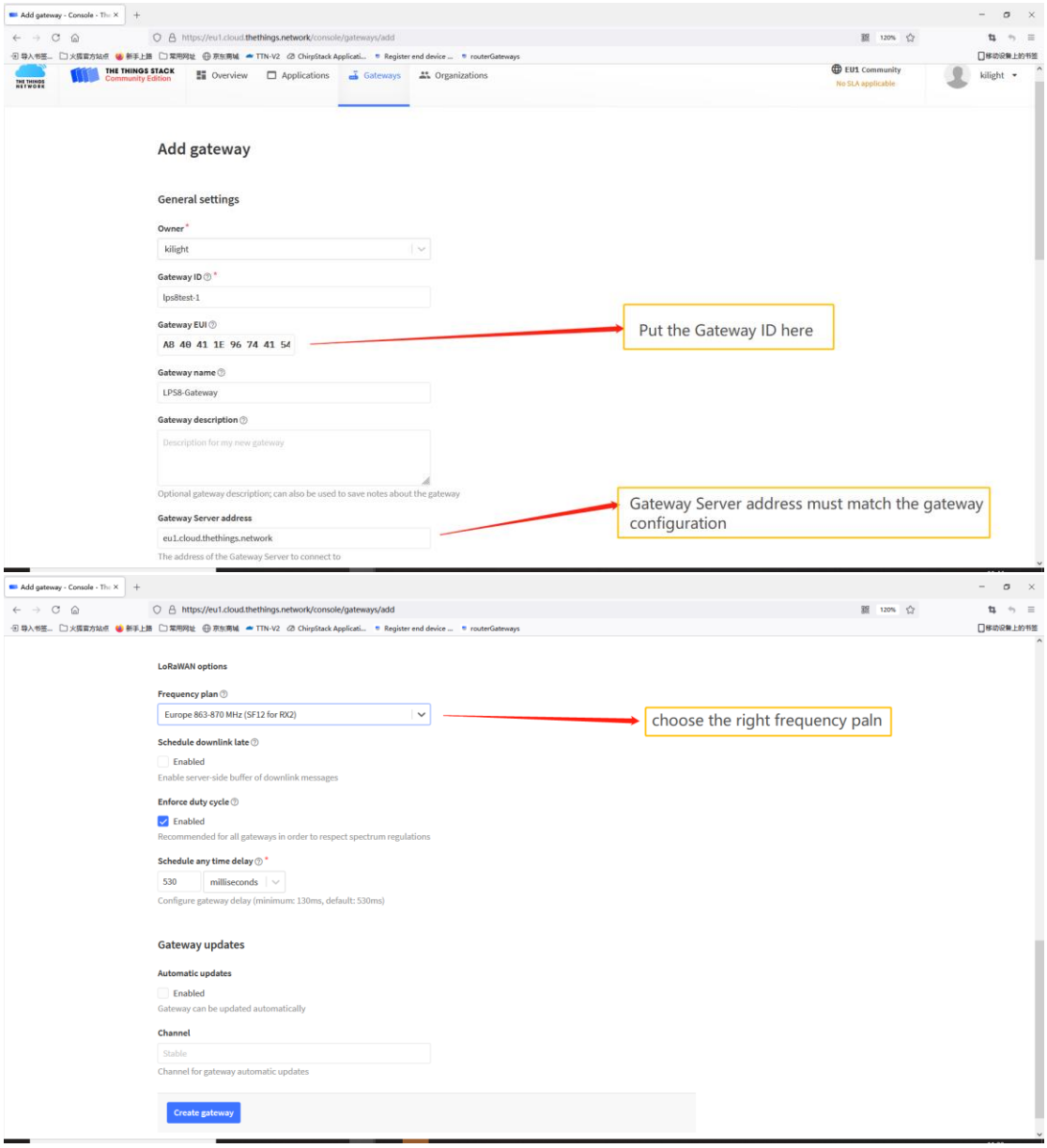
- Europe 1 **corresponding Gateway server address:** eu1.cloud.thethings.network
- North America 1 **corresponding Gateway server address:** nam1.cloud.thethings.network
- Australia 1 **corresponding Gateway server address:** au1.cloud.thethings.network
- Legacy V2 Console : **TTN v2 shuts down in December 2021**

Step 4: Create a Gateway



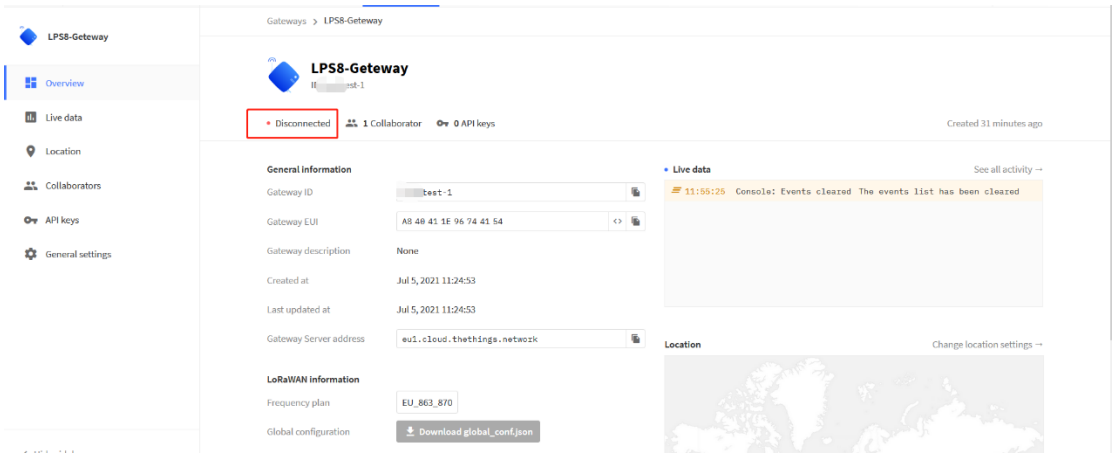
Click the Gateway icon and then click Add gateway.

Open the following page:



Notice: Gateway Server address must match the gateway configuration, otherwise you will have problem for End Node to join the network.

After creating the gateway, you can see the gateway info, as below.

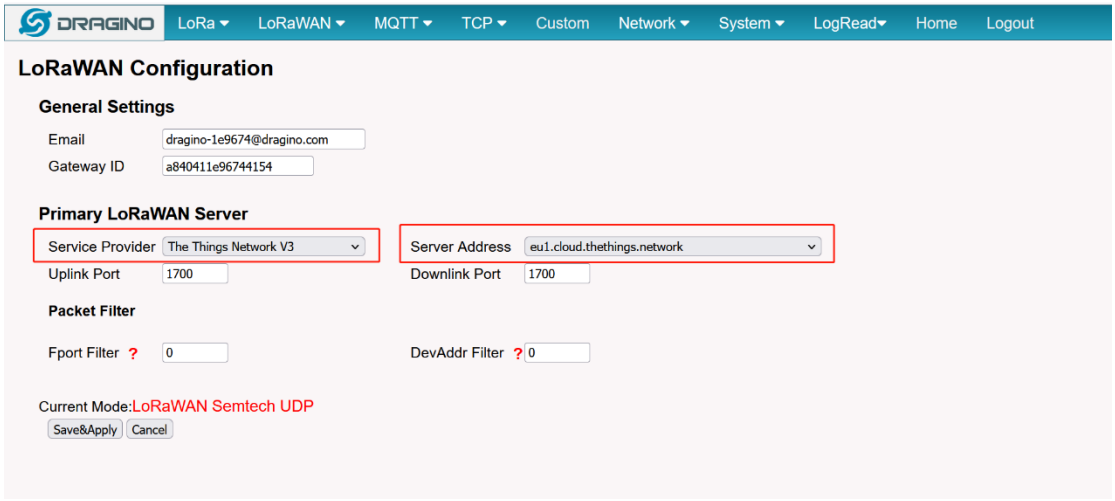


4.2 Configure LPS8N to connect to TTN v3

You can now configure the LPS8N to let it connect to TTN network V3.

Make sure your LPS8N has a working Internet Connection first.

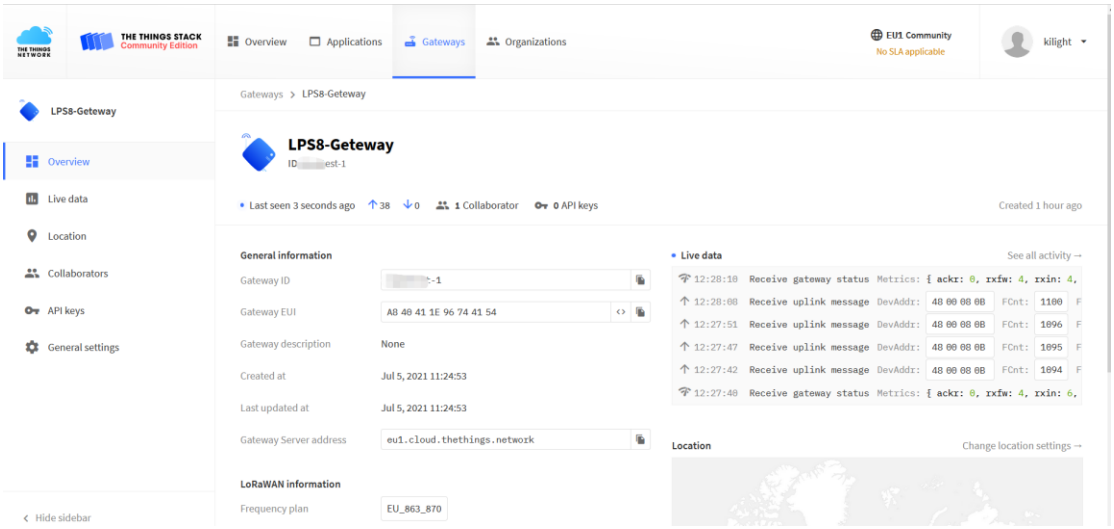
Choose the right server provider and click **Save&Apply**



Note: The server address must match the Gateway server address you choose in TTN V3.

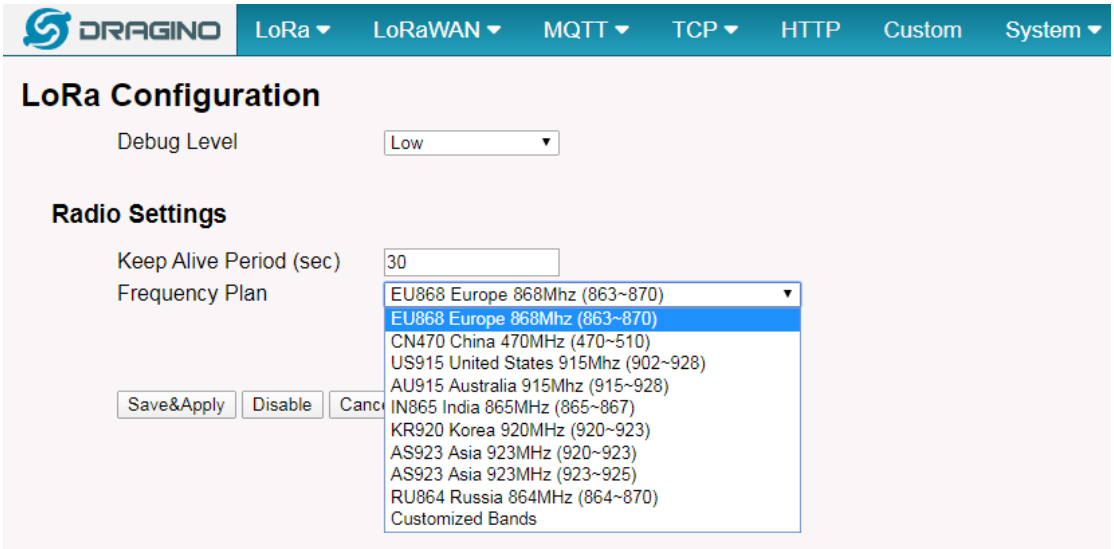
In the home page, we can see the LoRaWAN connection is ready now.

In TTN v3 portal, we can also see the gateway is connected.

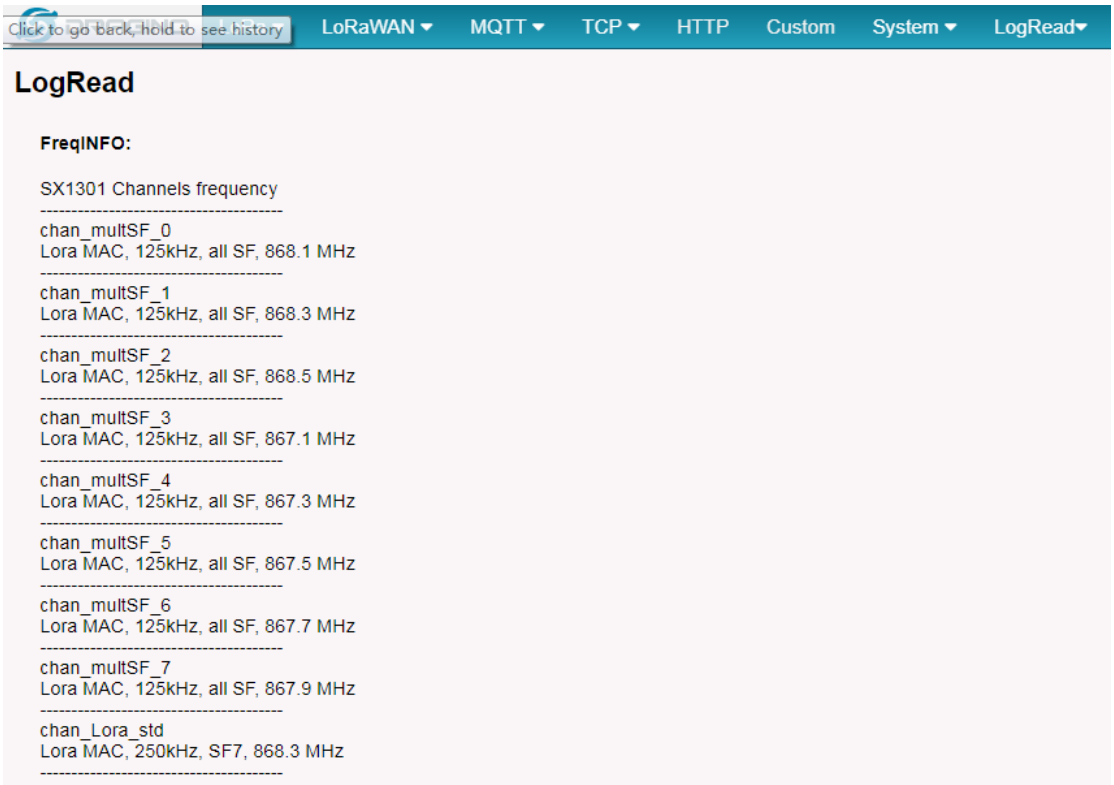


4.3 Configure frequency

We also need to set the frequency plan in LPS8N to match the end node we use, so to receive the LoRaWAN packets from the LoRaWAN sensor.



In logread page, user can check the frequency actually used.



4.4 Add a LoRaWAN End Device

This section shows how to add a LoRaWAN End device to a LoRaWAN network and see the data from TTN web site.

We use LT-22222-L IO Controller as a reference device - the setup for other LoRaWAN devices will be similar.

Step 1: Create a Device definition in TTN v3 with the OTAA keys from the example LT-22222-L IO Controller device.

Three codes are required to define the device in TTN v3:

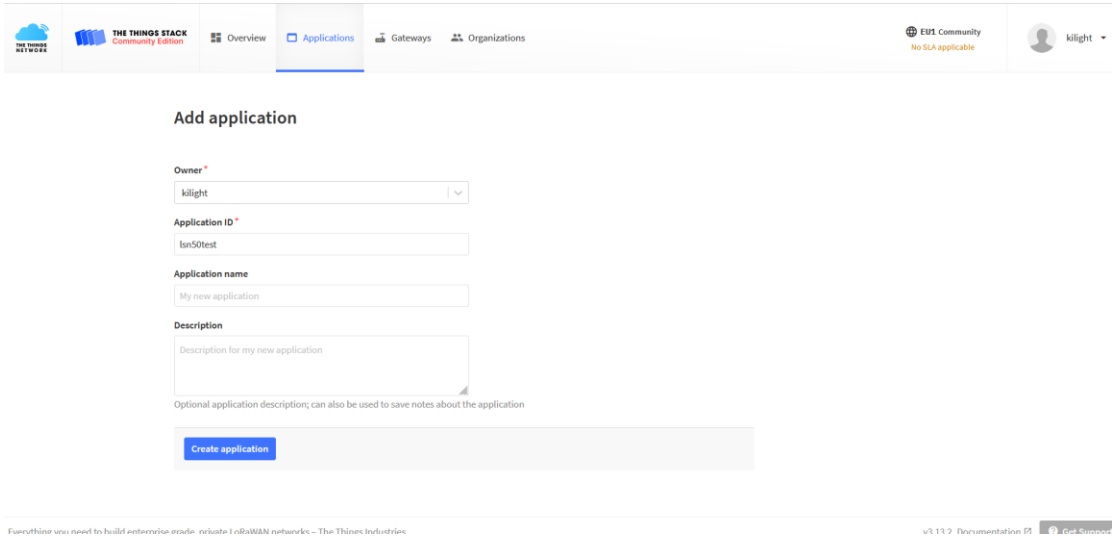
- ✓ DEV EUI - Unique ID code for a particular device.
- ✓ APP EUI - ID code for an Application defined in TTN v3.
- ✓ APP Key - Unique key to secure communications with a particular device.

A set of these codes are stored in each device by the manufacturer as the default codes for that particular device. Each device is shipped with a sticker with the default Device EUI as shown below.

Note: You may be able to change these codes in a device by using a configuration facility on the device e.g. the LT-22222 uses a serial port access and a series of AT commands. Changing the codes may be necessary in the case where you have to use codes assigned by a LoRa WAN server.

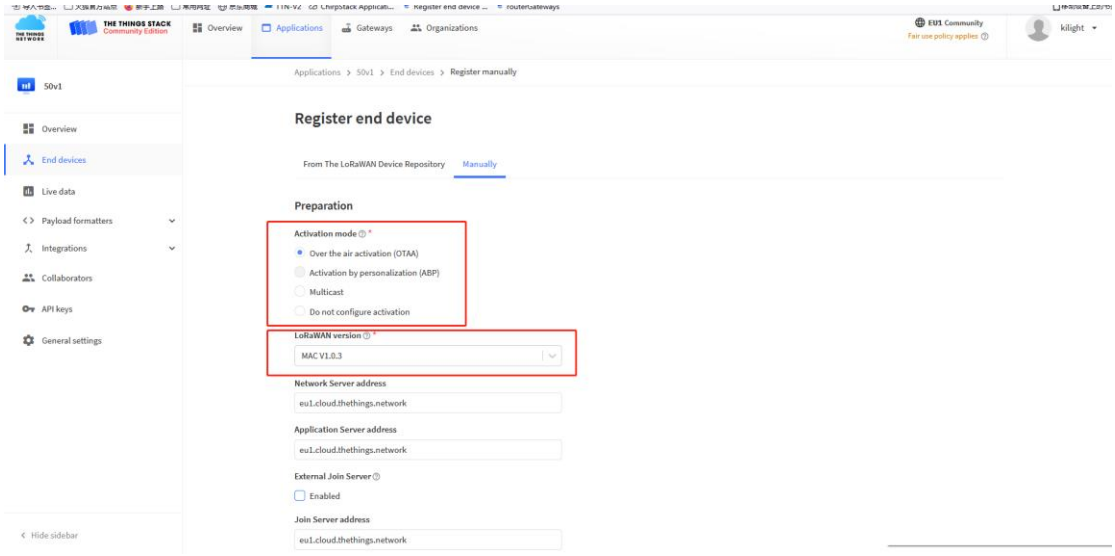
For the TTN v3 server, you can use the codes set in the device as in the following example.

Select **Add Application** to open the screen below.



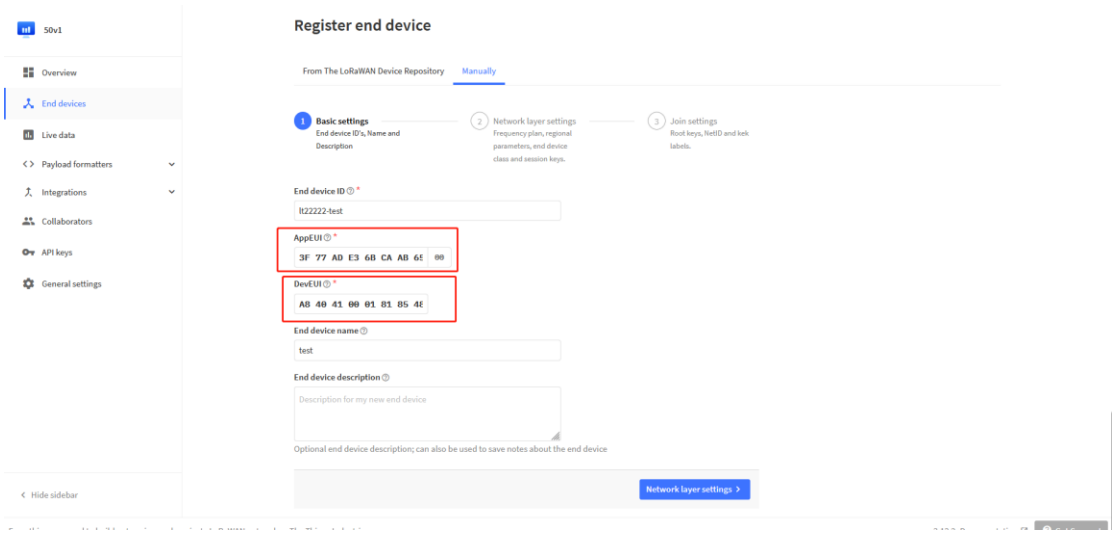
Open the **Application** select **Add end device**

Start Register the end device

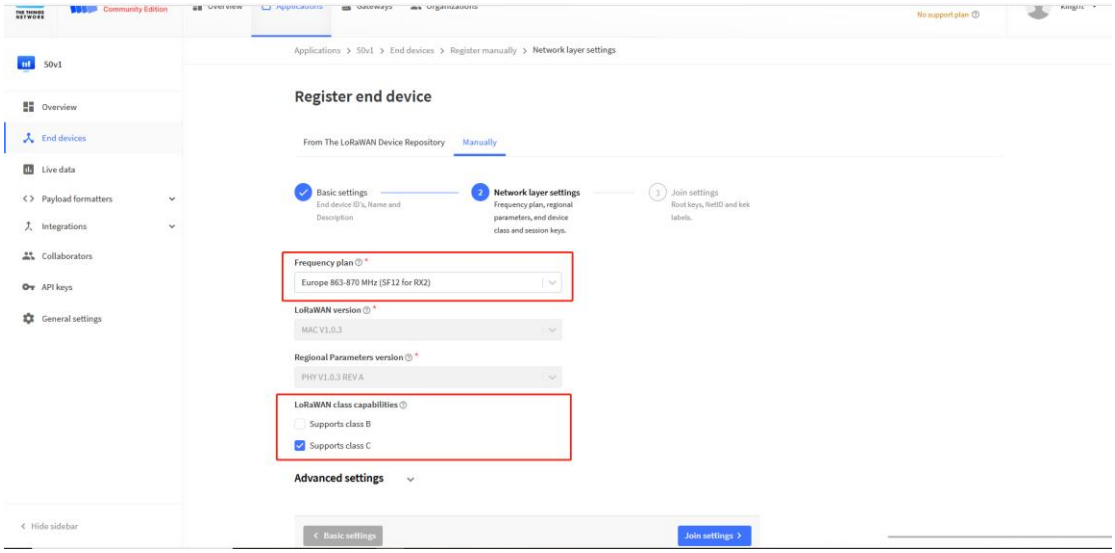


Select OTAA activation mode

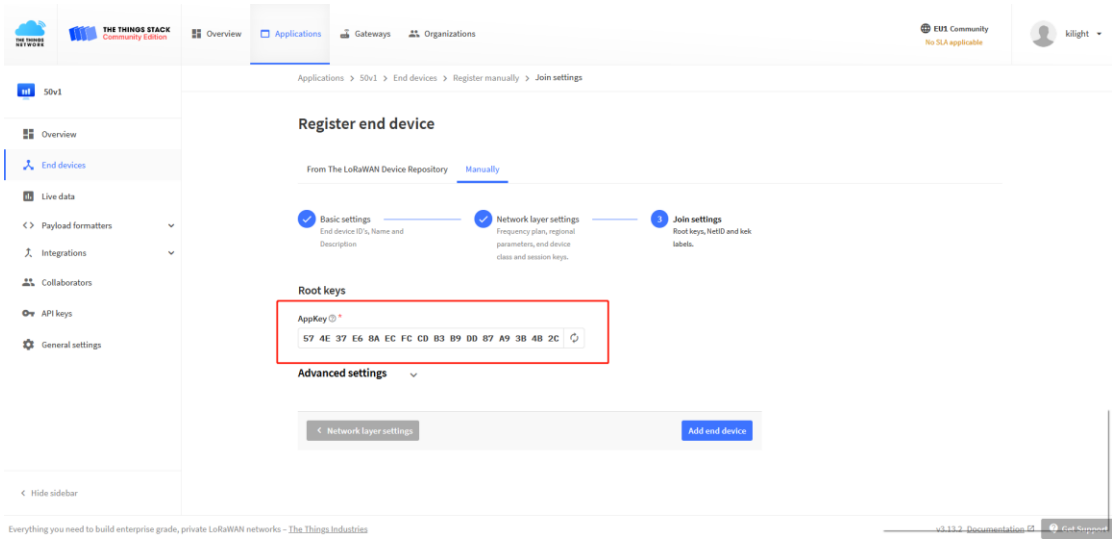
The LoRaWAN version for your device should be provided by the manufacturer in a datasheet as LoRaWAN version or LoRaWAN specification. The most commonly used LoRaWAN versions are v1.0.2 and v1.0.3.



First, input the End device ID, AppEUI and DevEUI.



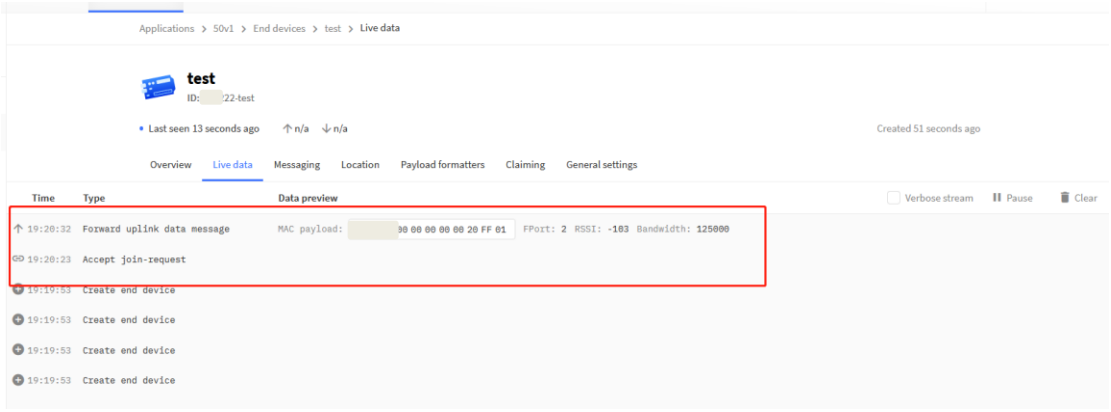
Secondly, choose the corresponding frequency and LoRaWAN class capabilities.



Finally, Application layer settings input the corresponding AppKey. Before saving the configuration, check that the data matches the device.

Step 2: Power on LT-22222-L device and it will automatically join the TTN network. After joining successfully, it will start to upload messages to the TTN v3. Select the Live data tab and you will see the data appearing in the panel.

Note that it may take some time for the device data to appear in the TTN v3 display.



5 Web Configure Pages

5.1 Home

Shows the system running status:

5.2 LoRa Settings

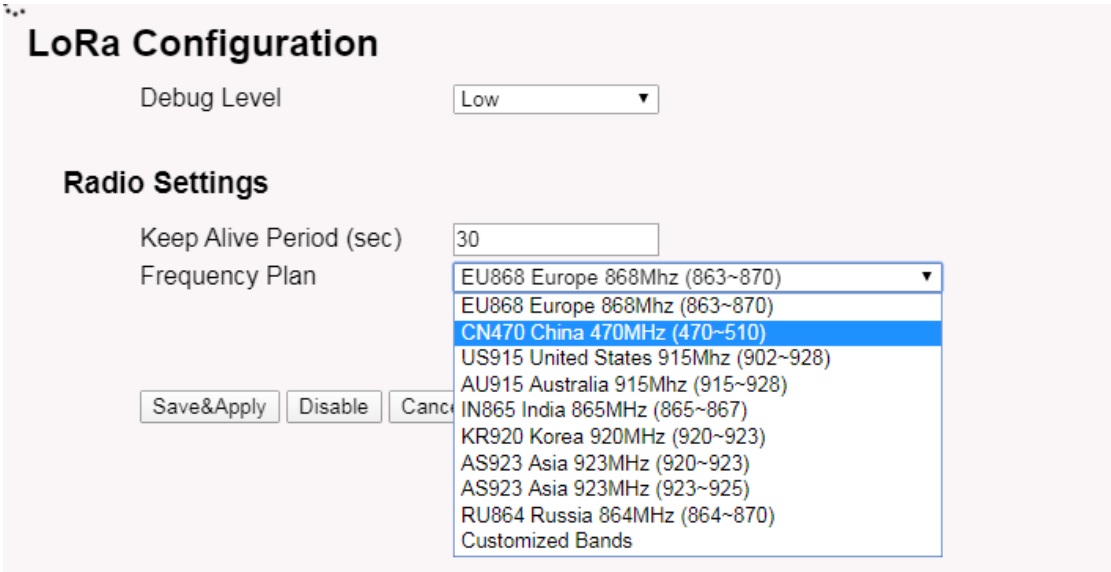
5.2.1 LoRa --> LoRa

This page shows the LoRa Radio Settings. There are a set of default frequency band according to LoRaWAN protocol, and user can customize the band* as well.

Different LPS8N hardware version can support different frequency range:

- **868**: valid frequency: 863Mhz ~ 870Mhz. for bands EU868, RU864, IN865 or KZ865.
- **915**: valid frequency: 902Mhz ~ 928Mhz. for bands US915, AU915, AS923 or KR920

After user choose the frequency plan, he can see the actually frequency in used by checking the page **LogRead --> LoRa Log**



Note *: See this instruction for how to customize frequency band:
http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20customized%20LoRaWAN%20frequency%20band/

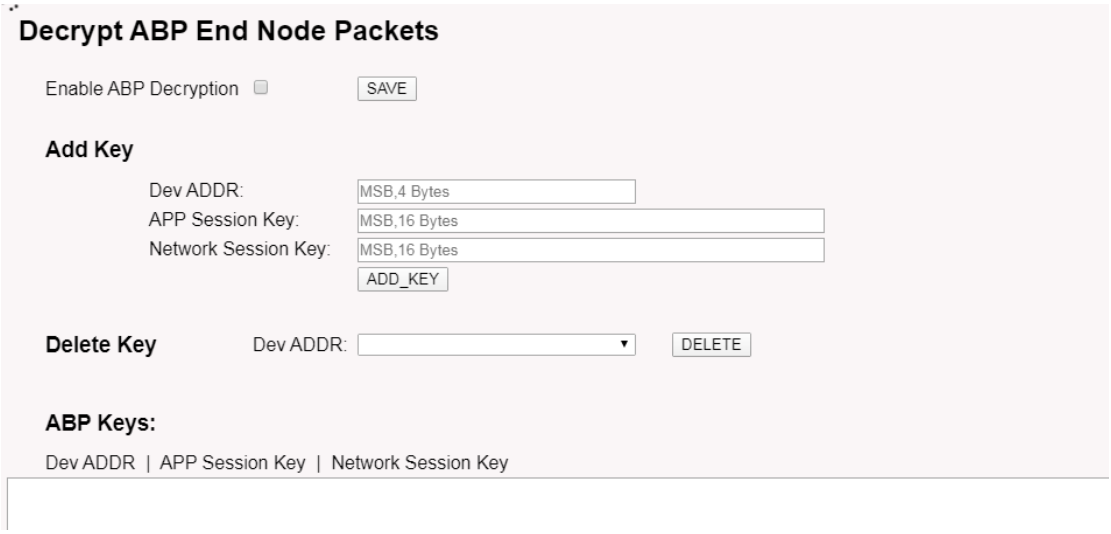
5.2.2 LoRa --> ABP Decryption

The LPS8N can communicate with LoRaWAN ABP End Node without the need of LoRaWAN server. It can be used in some cases such as:

- No internet connection.
- User wants to get data forward in gateway and forward to their server based on MQTT/HTTP, etc. (Combine ABP communication method and MQTT forward together).

Detail of this feature:

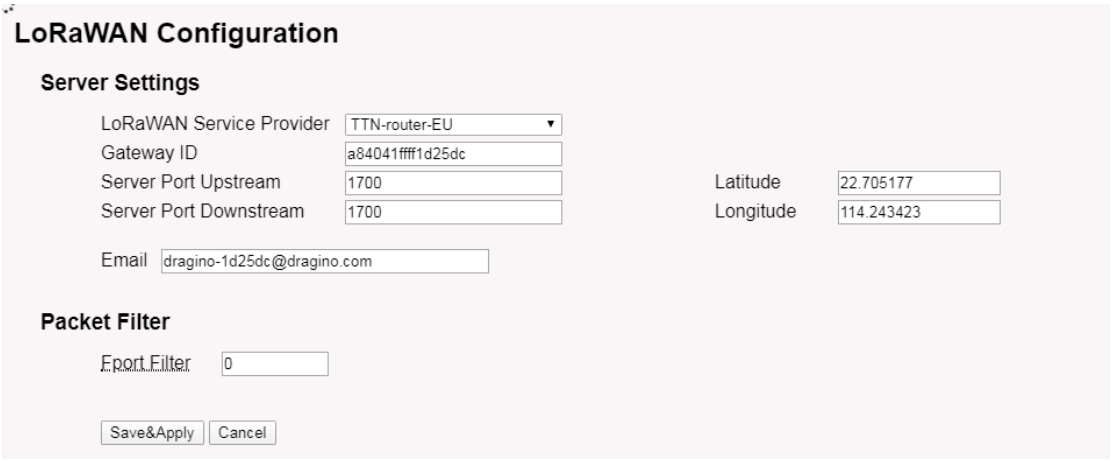
http://wiki.dragino.com/xwiki/bin/view/Main/Communicate%20with%20ABP%20End%20Node%20without%20LoRaWAN%20Network%20Server%20---%20LG308/



5.3 LoRaWAN Settings

5.3.1 LoRaWAN --> LoRaWAN

This page is for the connection set up to a general LoRaWAN Network server such as: TTN, ChirpStack etc

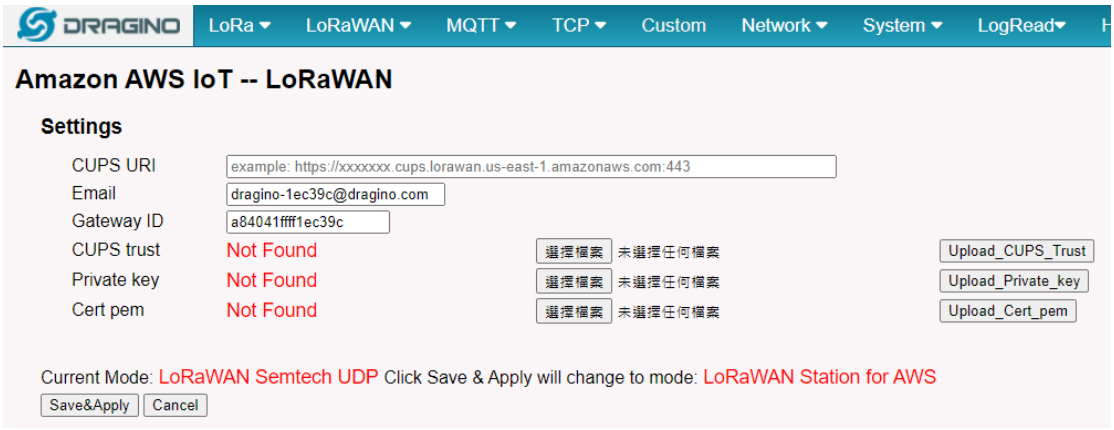


Note

**: Packet filter is to drop the unwanted LoRaWAN packet, instruction see here:

See http://wiki.dragino.com/xwiki/bin/view/Main/Filter%20unwanted%20LoRaWAN%20packets/

5.3.2 LoRaWAN --> Amazon AWS-IoT



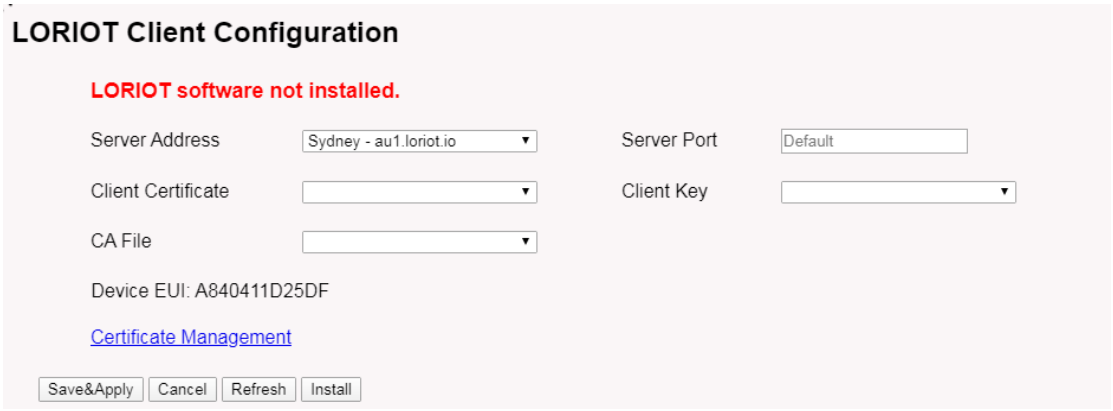
Please see this instruction to know more detail and demo for how to connect to AWS-IoT LoRaWAN Core:

http://wiki.dragino.com/xwiki/bin/view/Main/AWS%20IoT%20Core%20for%20LoRaWAN/

5.3.3 LoRaWAN --> LORIOT

Settings to communicate to LORIOT LoRaWAN Network Server: https://www.loriot.io/

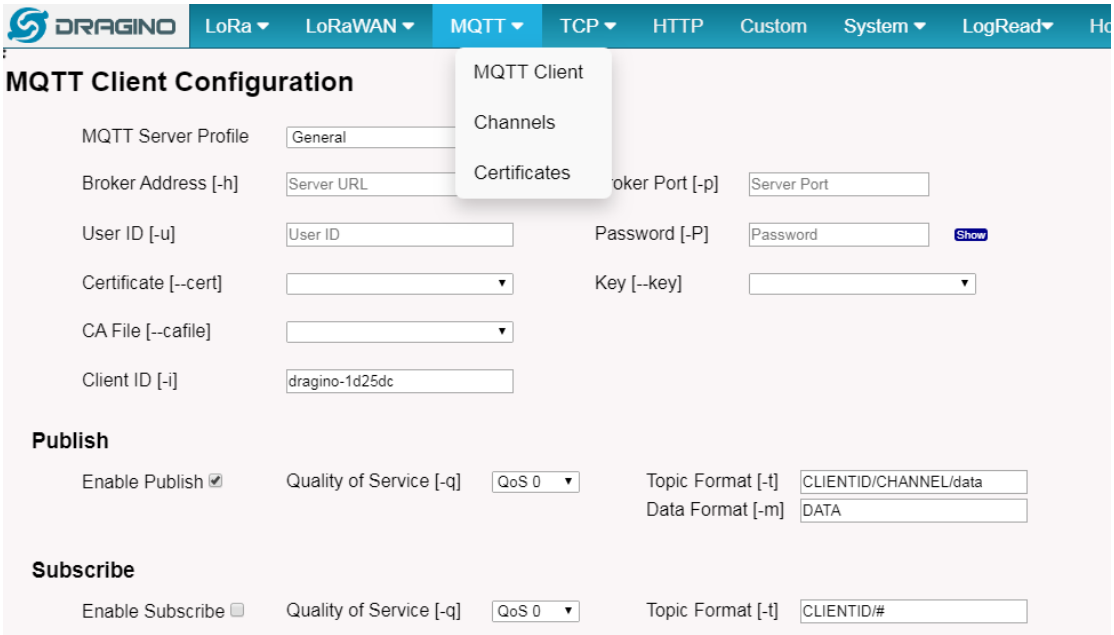
Instruction: http://wiki.dragino.com/xwiki/bin/view/Main/Notes%20for%20LORIOT/



5.4 MQTT Settings

If end nodes work in ABP mode, user can configure LPS8N to transfer the data to MQTT broker, Instruction:

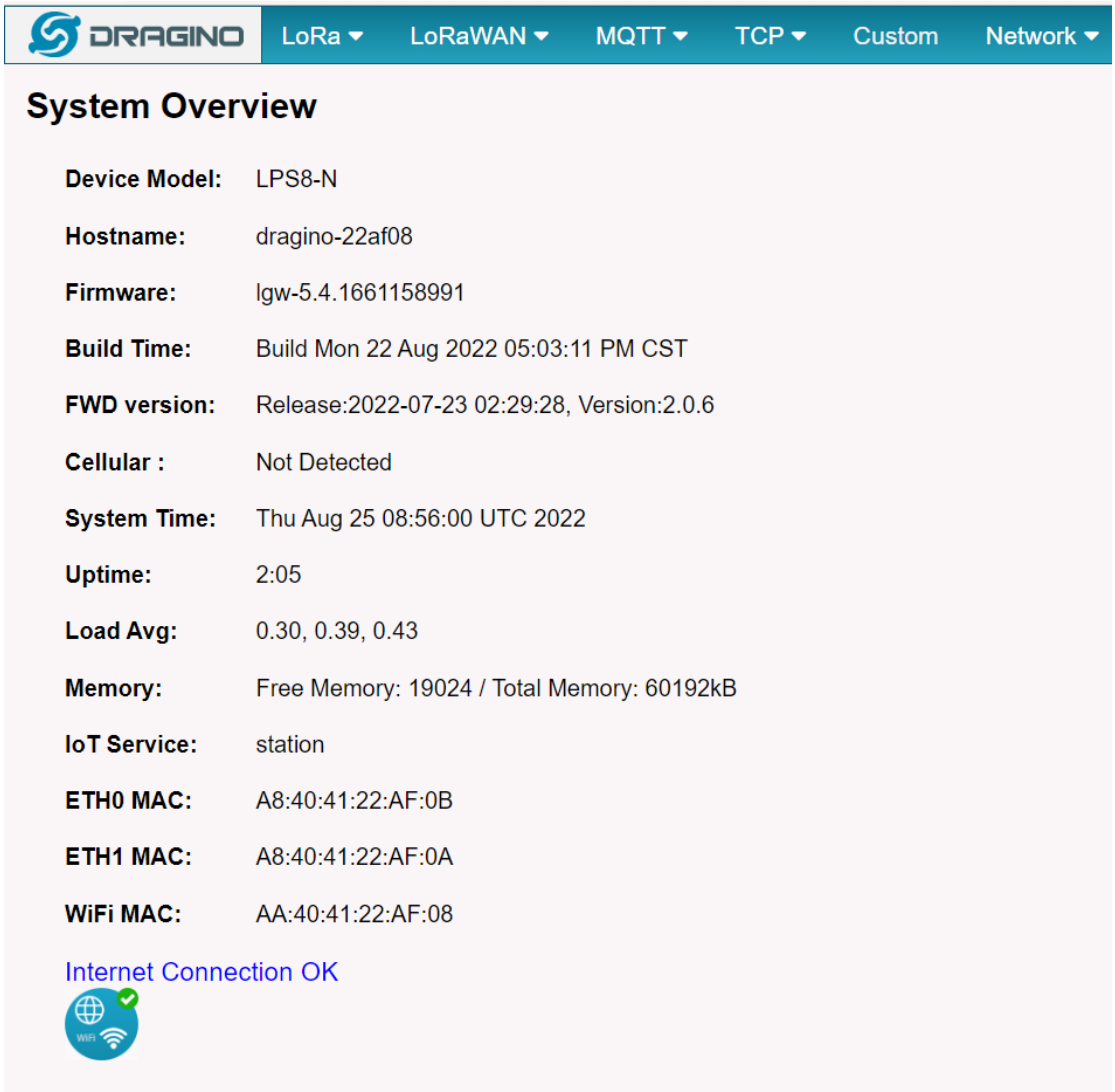
http://wiki.dragino.com/xwiki/bin/view/Main/MQTT%20Forward%20Instruction/



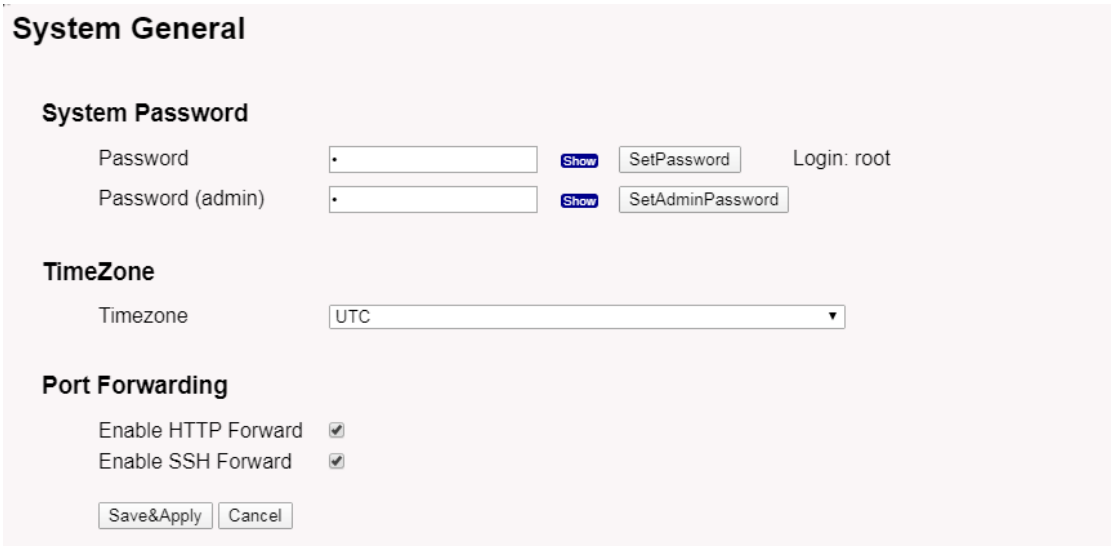
5.5 System

5.5.1 System --> System Overview

Shows the system info:



5.5.2 System --> General (login settings)



System Password:

There are two logins for LPS8N: **root /dragino** or **admin /dragino**. Both root and admin have the same right for WEB access. But root user has also the right to access via SSH to Linux system. admin only able to access WEB interface.

This page can be used to set the password for them.

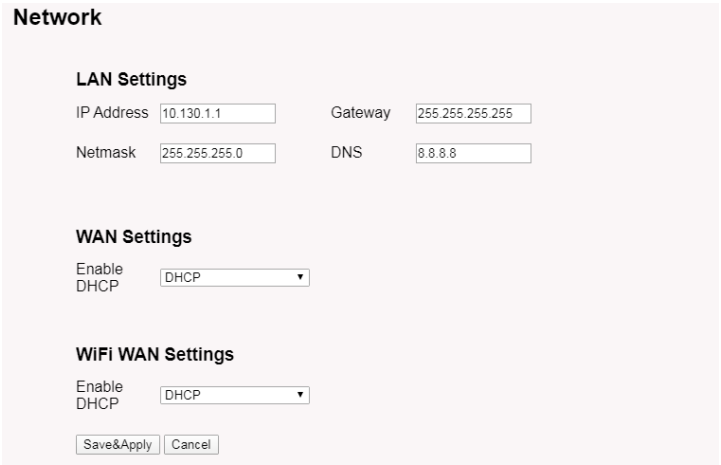
Timezone:

Set device timezone.

Port forwarding:

Enable/Disable the HTTP and SSH access via WAN interface.

5.5.3 System --> Network



LAN Settings:

When the LPS8N has the AP enable, LAN settings specify the network info for LPS8N's own network.

WAN Settings:

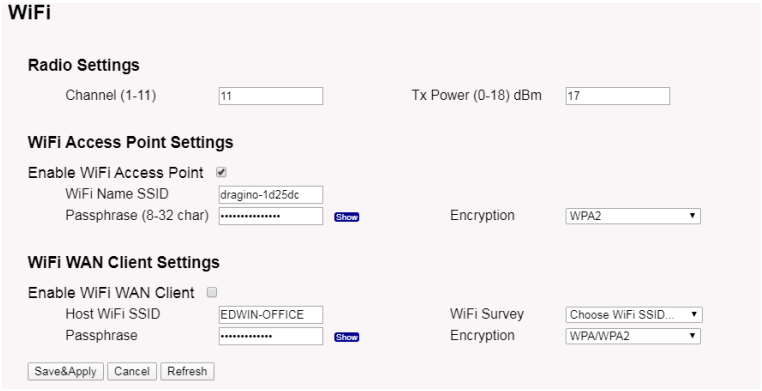
Setting for LPS8N WAN port

WiFi Settings:

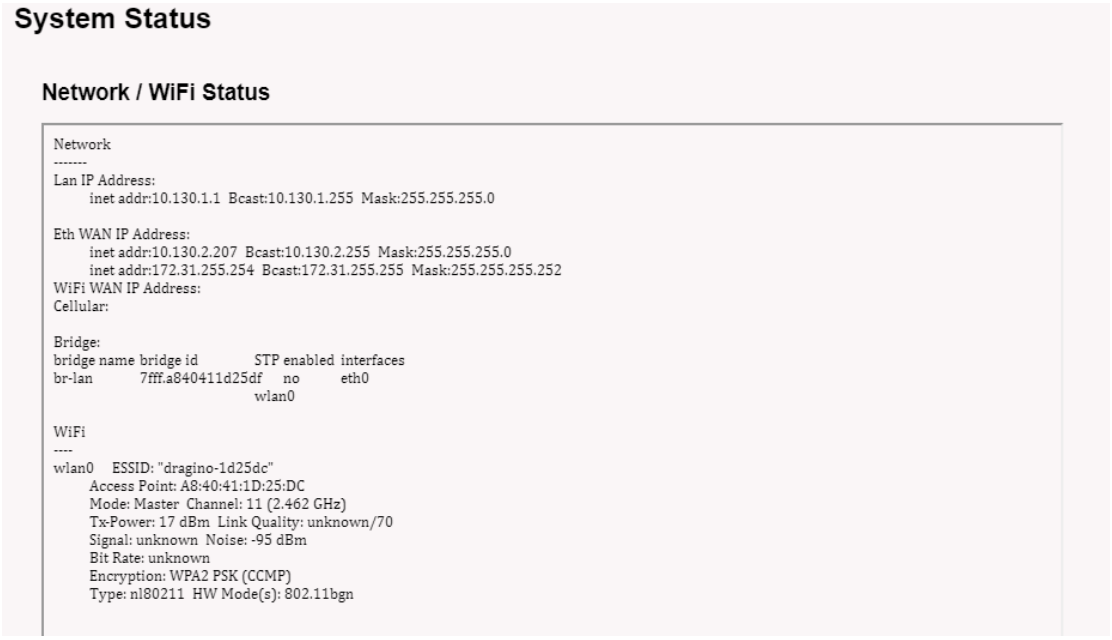
Setting for LPS8N WiFi IP when use it as WiFi Client

5.5.4 System --> WiFi

LPS8N WiFi Settings.



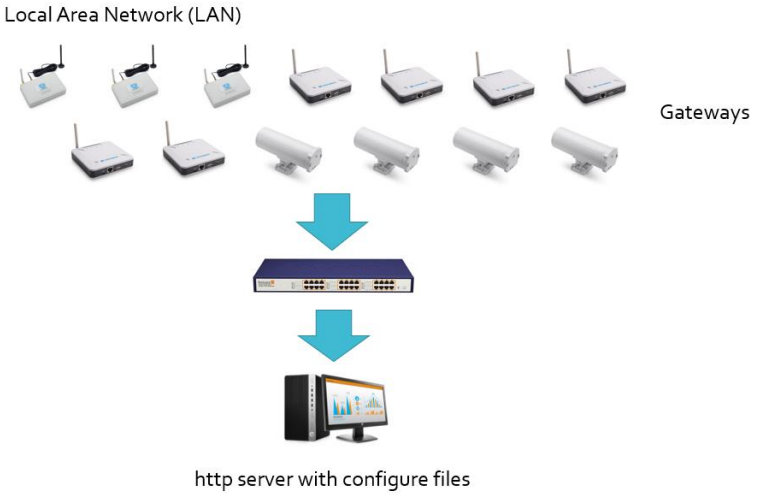
5.5.5 System --> Network Status



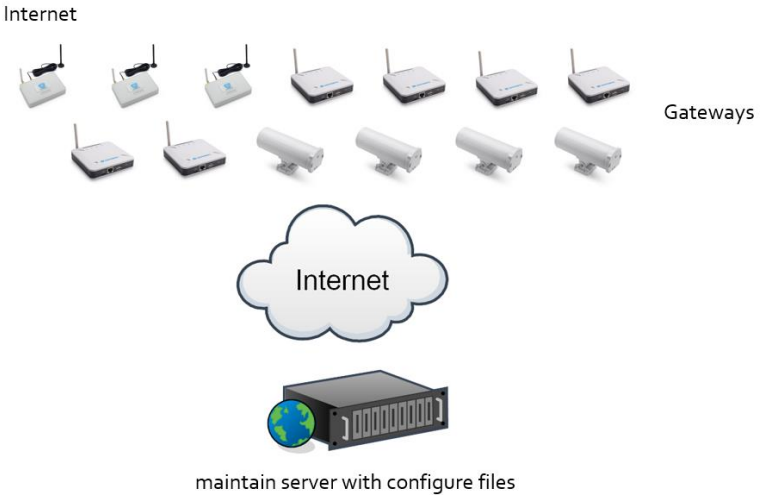
5.5.6 System --> Remote Mgnt & Auto Update

Auto Provision is the feature for batch configure and remote management. It can be used in below two cases:

Case 1: Batch configure gateways before deploy



Case 2: Maintain gateway configure from cloud

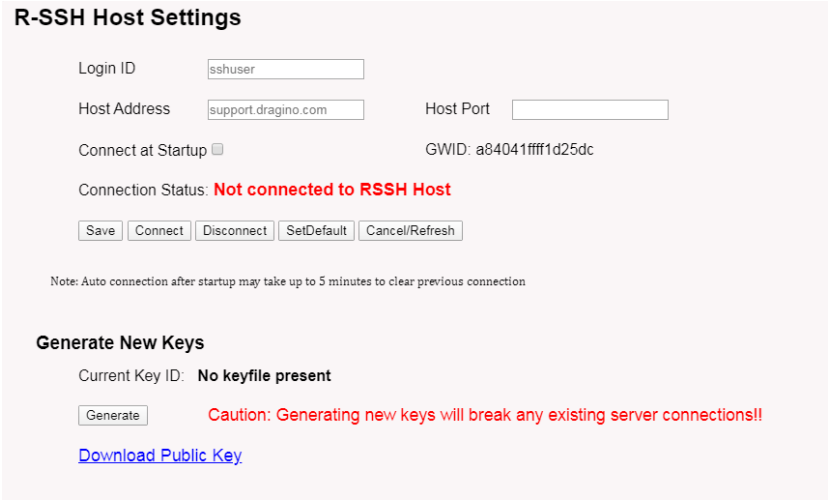


How it works

Please see this document for detail:

http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LPS8N/Firmware/Application_Note/&file=Auto-update-feature.pdf

R-SSH is for remote access device and management, introduction for how to use: http://wiki.dragino.com/xwiki/bin/view/Main/Monitor%20%26%20Remote%20Access%20Gateway/?Remote%20Access



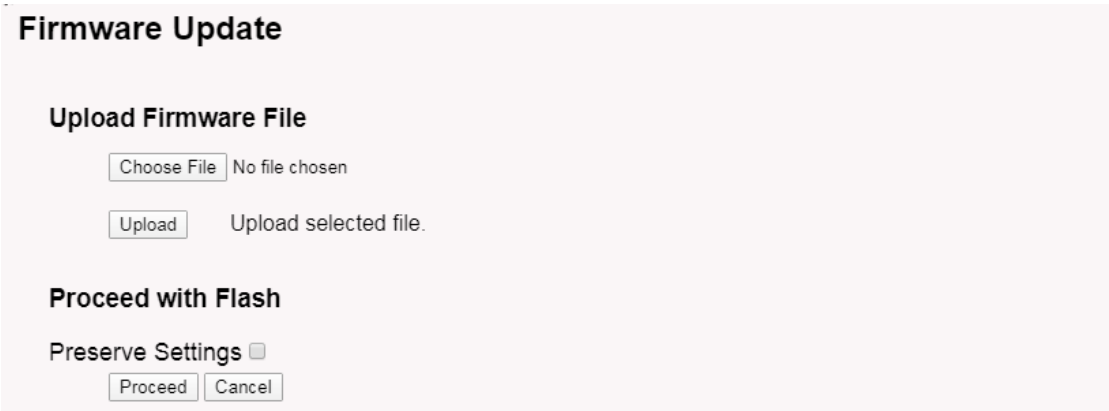
5.5.7 System --> Firmware Upgrade

We keep improving the LPS8N firmware for new features and bug fixes. Below are the links for reference.

- **Latest firmware**: LoRa Gateway Firmware,
(http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LPS8N/Firmware)
- **Change Log**: Firmware Change Log.
(http://www.dragino.com/downloads/downloads/LoRa_Gateway/LPS8N/Firmware/ChangeLog)

The file named as **dragino-lgw–xxxxx-squashfs-sysupgrade.bin** is the upgrade Image. as below.

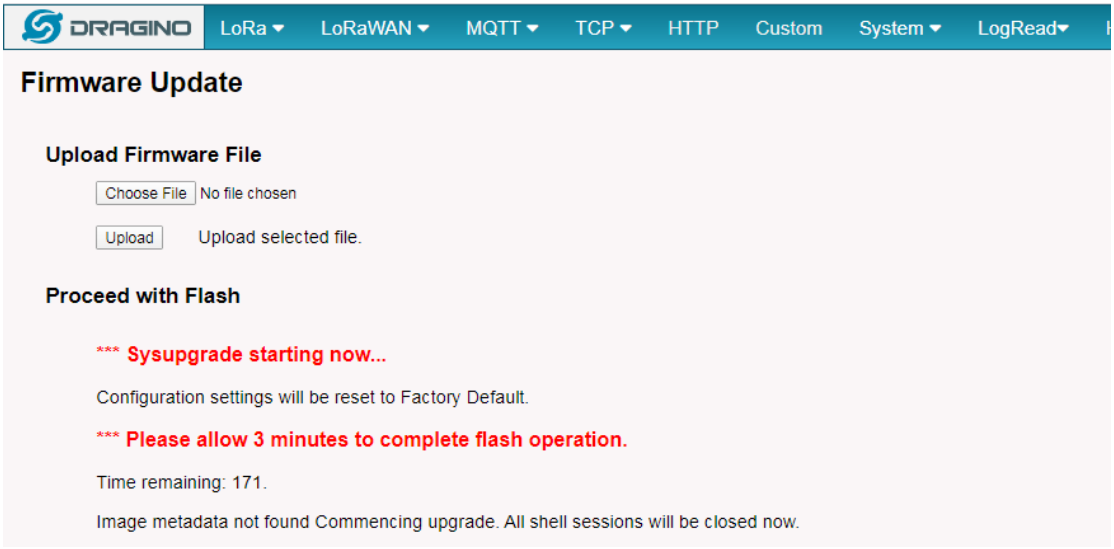
Web → System → Firmware Upgrade



Select the required image and click **Upload.** The image will be uploaded to the device, and then click **Process** to upgrade.

NOTE: You normally need to ***uncheck*** the **Preserve Settings** checkbox when doing an upgrade to ensure that there is no conflict between the old settings and the new firmware. The new firmware will start up with its default settings.

The system will automatically boot into the new firmware after upgrade.

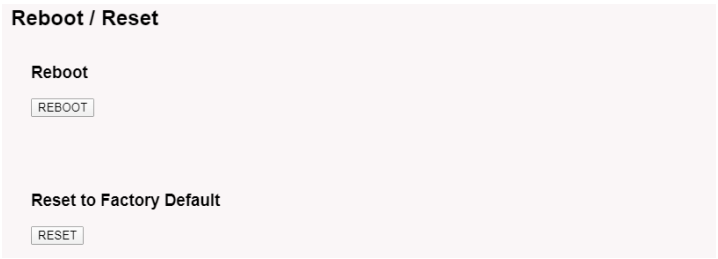


Note *: User can also upgrade firmware via Linux console
SCP the firmware to the system **/var** directory and then run

root@OpenWrt:~# /sbin/sysupgrade –n /var/Your_Image

NOTE: it is important to transfer the image in the /var directory, otherwise it may exceed the available flash size.

5.5.8 System --> Reboot/Reset



5.5.9 System --> Package Maintain

Place to show what packages have been installed and possible to upgrade packages.

5.6 LogRead

LogRead --> LoRa Log

Show the frequency for LoRa Radio and traffics.

5.6.1 LogRead --> System Log

Show the system log

6 More features

6.1 Packet Filtering

Drop unwanted packets:

See http://wiki.dragino.com/xwiki/bin/view/Main/Filter%20unwanted%20LoRaWAN%20packets/

6.2 Remote Access

Remote Access Devices for management:

Instruction http://wiki.dragino.com/xwiki/bin/view/Main/Remote%20Access%20Gateway/

6.3 How to decode ABP LoRaWAN node

Decode ABP

http://wiki.dragino.com/xwiki/bin/view/Main/Communicate%20with%20ABP%20End%20Node%20without%20LoRaWAN%20Network%20Server%20---%20LG308/

6.4 How to set data to MQTT broker

Only support ABP LoRaWAN End Node

Instruction:

http://wiki.dragino.com/xwiki/bin/view/Main/MQTT%20Forward%20Instruction/

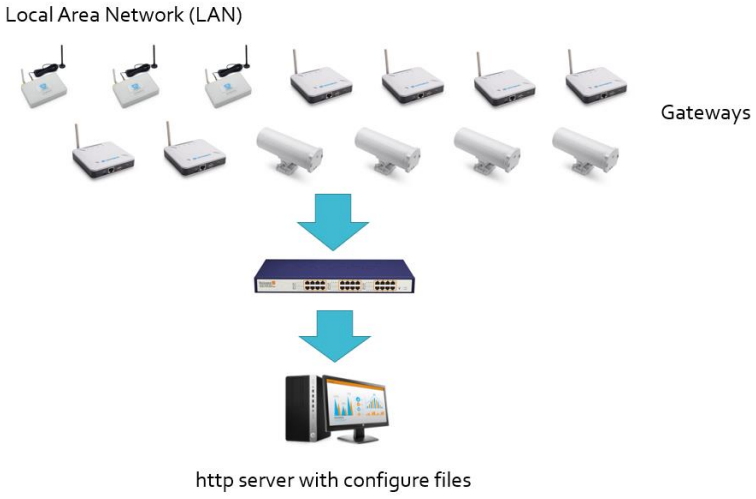
6.5 More instructions

http://wiki.dragino.com/xwiki/bin/view/Main/(LoRaWAN Gateway)

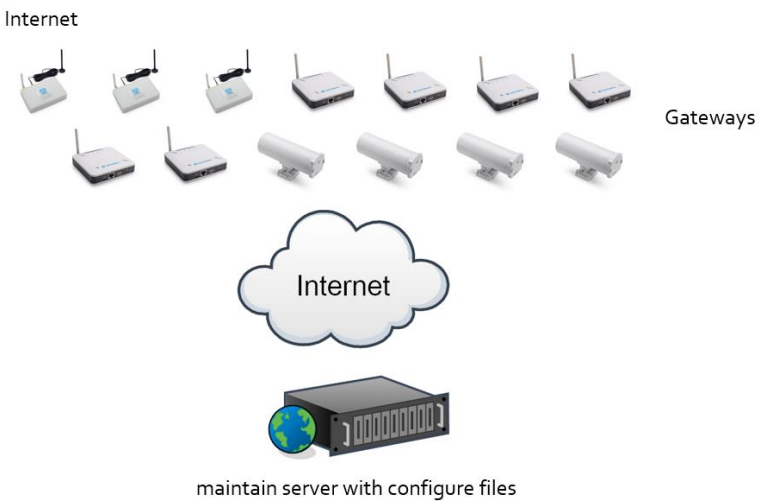
6.6 Auto-Provision

Auto Provision is the feature for batch configure and remote management. It can be used in below two cases:

Case 1: Batch configure gateways before deploy



Case 2: Maintain gateway configure from cloud



Please see this document for detail:
http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LPS8N/Firmware/Application_Note/&file=Auto-update-feature.pdf

7 Linux System

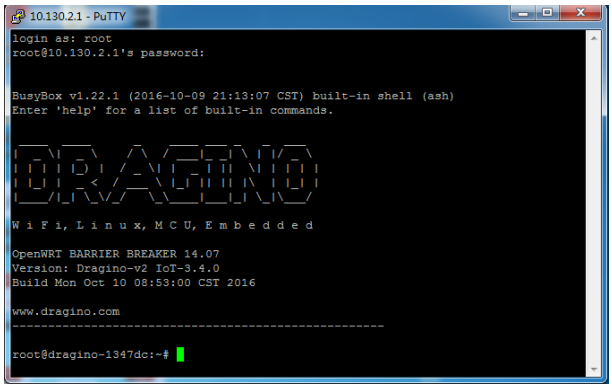
The LPS8N is based on the OpenWrt Linux system. It is open source, and users are free to configure and modify the Linux settings.

7.1 SSH Access for Linux console

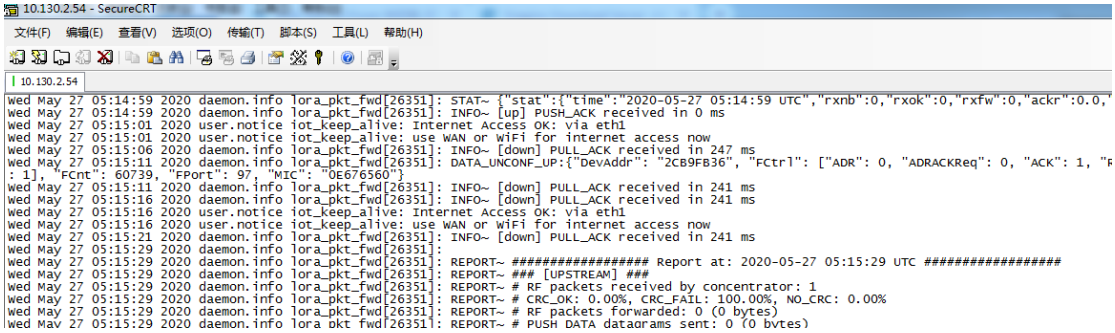
User can access the Linux console via the SSH protocol. Make sure your PC and the LPS8N are connected to the same network, then use a SSH tool (such as putty in Windows) to access it.

IP address: IP address of LPS8N
Port: 22 or 2222 (SSH port in WAN interface has been change to 2222 since firmware 5.3.xx, for security reason)
User Name: **root**
Password: **dragino** (default)

After logging in, you will be in the Linux console and can enter commands as shown below.



The "logread -f" command can be used to debug how system runs.

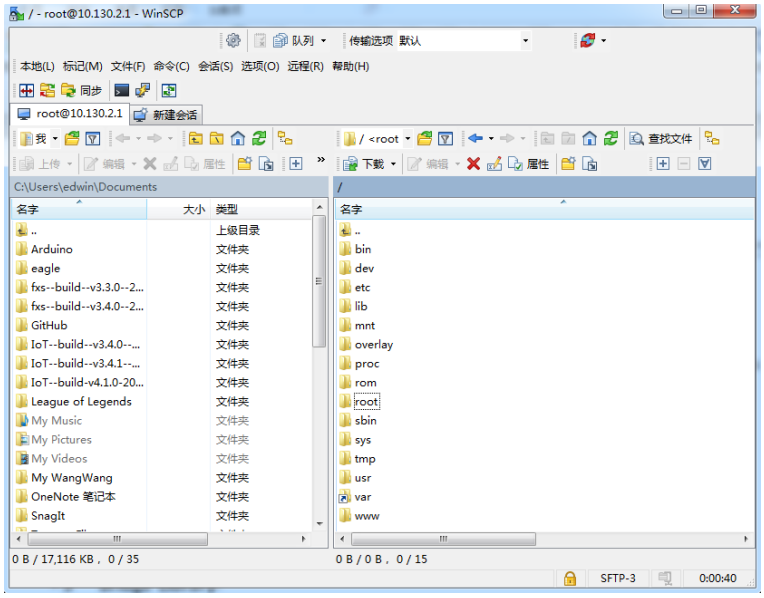


7.2 Edit and Transfer files

The LPS8N supports the **SCP protocol** and has a built-in **SFTP server**. There are many ways to edit and transfer files using these protocols.

In Windows, one of the easiest methods is using the WinSCP utility.
After establishing access via WinSCP to the device, you can use an FTP style window to drag / drop files to the LPS8N, or edit the files directly in the windows.

Screenshot is as below:



7.3 File System

The LPS8N has a 16MB flash and a 64MB RAM. The /var and /tmp directories are in the RAM, so contents stored in /tmp and /var will be erased after rebooting the device. Other directories are in the flash and will remain after reboot.

The Linux system uses around 8MB ~10MB flash size which means there is not much room for user to store data in the LPS8N flash.
You can use an external USB flash memory device to extend the size of flash memory for storage.

7.4 Package maintenance system

LPS8N uses the OpenWrt **OPKG package maintenance system**. There are more than 3000+ packages available in our package server for users to install for their applications. For example, if you want to add the ***iperf*** tool, you can install the related packages and configure LPS8N to use ***iperf*** .

Below are some example ***opkg*** commands. For more information please refer to the **OPKG package maintain system** (https://wiki.openwrt.org/doc/techref/opkg)

In Linux Console run:

root@dragino-169d30:~# opkg update // to get the latest packages list

root@dragino-169d30:~# opkg list //shows the available packages

root@dragino-169d30:~# opkg install iperf // install iperf

The system will automatically install the required packages as shown below.

root@dragino-169d30:/etc/opkg# opkg install iperf

Installing iperf (2.0.12-1) to root…

Downloading http://downloads.openwrt.org/snapshots/packages/mips_24kc/base/iperf_2.0.12-1_mips_24kc.ipk

Installing uclibcxx (0.2.4-3) to root…

Downloading http://downloads.openwrt.org/snapshots/packages/mips_24kc/base/uclibcxx_0.2.4-3_mips_24kc.ipk

Configuring uclibcxx.

Configuring iperf.

8 Upgrade Linux Firmware

We keep improving the LPS8N Linux side firmware for new features and bug fixes. Below are the links for reference.

- **Latest firmware**: LoRa Gateway Firmware,
(http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LPS8N/Firmware)
- **Change Log**: Firmware Change Log.
(http://www.dragino.com/downloads/downloads/LoRa_Gateway/LPS8N/Firmware/ChangeLog)

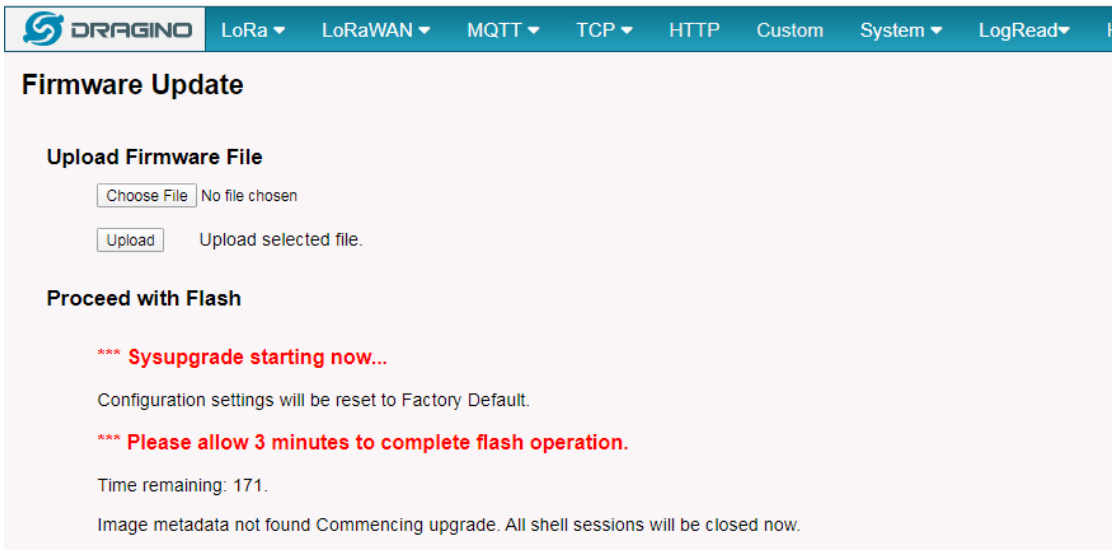
The file named as **xxxxx–xxxxx-squashfs-sysupgrade.bin** is the upgrade Image. There are different methods to upgrade, as below.

8.1 Upgrade via Web UI

Go to the page: **Web → System → Firmware Upgrade**
Select the required image and click **Flash Image.** The image will be uploaded to the device, and then click **Process Update** to upgrade.

NOTE: You normally need to ***uncheck*** the **Preserve Settings** checkbox when doing an upgrade to ensure that there is no conflict between the old settings and the new firmware. The new firmware will start up with its default settings.

The system will automatically boot into the new firmware after upgrade.



8.2 Upgrade via Linux console

SCP the firmware to the system **/var** directory and then run

root@OpenWrt:~# /sbin/sysupgrade –n /var/Your_Image

NOTE: it is important to transfer the image in the /var directory, otherwise it may exceed the available flash size.

9 FAQ

9.1 How can I configure for a customized frequency band?

See below link for how to customize frequency band:
http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20customized%20LoRaWAN%20frequency%20band/

9.2 Can I make my own firmware for the gateway, Where can I find the source code?

Yes, You can make your own firmware for the LPS8N for branding purposes or to add customized applications.
The source code and compile instructions can be found at:
https://github.com/dragino/openwrt_lede-18.06

9.3 Can I use 868Mhz version for 915Mhz bands?

It is possible but the distance will be very short, you can select US915 frequency band in 868Mhz version hardware. It will work but you will see the performance is greatly decreased because the 868Mhz version has an RF filter for band 863~870Mhz, all other frequencies will have high attenuation.

10 Trouble Shooting

10.1 I get kernel error when install new package, how to fix?

In some cases, when installing a package with ***opkg***, it will generate a kernel error such as below due to a mismatch I the kernel ID:

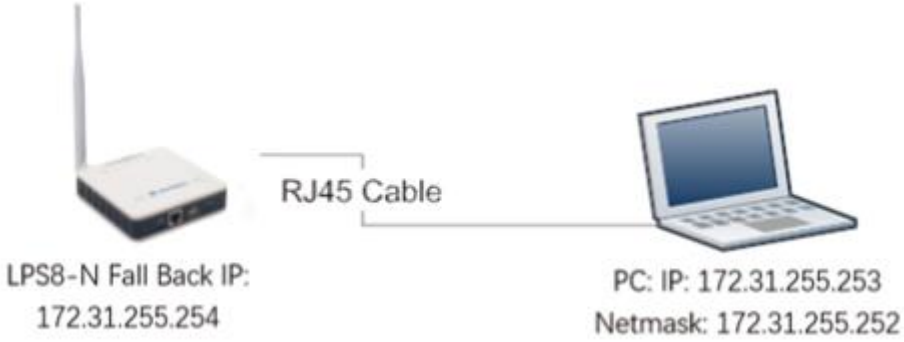
root@dragino-16c538:~# opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk
Installing kmod-dragino2-si3217x (3.10.49+0.2-1) to root…
Collected errors:
* satisfy_dependencies_for: Cannot satisfy the following dependencies for kmod-dragino2-si3217x:
* kernel (= 3.10.49-1-4917516478a753314254643facdf360a) *
 * opkg_install_cmd: Cannot install package kmod-dragino2-si3217x.

In this case, you can use the –force-depends option to install such package as long as the actual kernel version is the same.
Opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk –force-depends

10.2 How to recover the LPS8N if the firmware crashes

Please follow this instruction to recover your gateway:
http://wiki.dragino.com/xwiki/bin/view/Main/How%20to%20Recover%20Gateway%20if%20can%27t%20access%20it/

10.3 I configured LPS8N for WiFi access and lost its IP. What to do now?



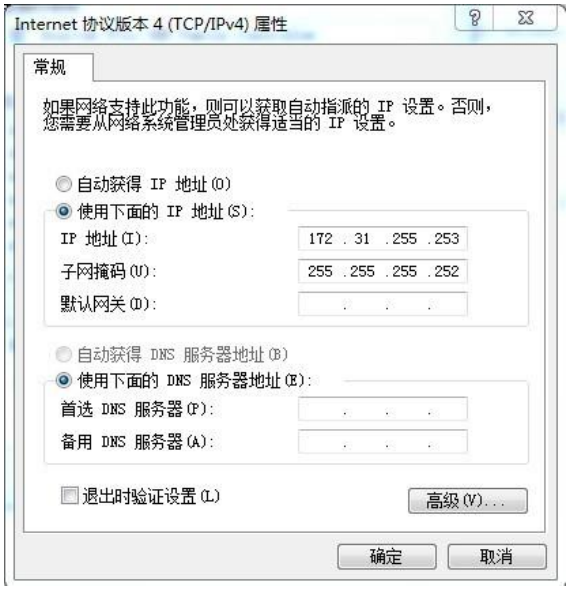
The LPS8N has a fall-back IP address on its WAN port. This IP is always enabled so you can use the fall-back IP to access LPS8N no matter what the WiFi IP is. The fall back IP is useful for connecting and debug the unit.

(Note: fallback IP can be disabled in the WAN and DHCP page)

Steps to connect via fall back IP:

1. Connect PC's Ethernet port to LG01's WAN port
2. Configure PC's Ethernet port has
   IP: 172.31.255.253 and
   Netmask: 255.255.255.252

   As below photo:



3. In the PC, use IP address 172.31.255.254 to access the LPS8N via Web or Console.

Please note the latest firmware uses port 8000 for http and 2222 for ssh access.

10.4 I connect to the LPS8N's SSID but LPS8N didn't assign DHCP IP to my laptop?

This is a known bug for the firmware version before 2019-09-23 for LPS, the issue was fixed since version: LG02_LG08--build-v5.2.1569218466-20190923-1402.

In the old version, user can use the fall back ip method to access and configure the device.

11 Order Info

***PART: LPS8N-XXX*:**

XXX: Frequency Band

- **868**: valid frequency: 863Mhz ~ 870Mhz. for bands EU868, RU864, IN865 or KZ865.
- **915**: valid frequency: 902Mhz ~ 928Mhz. for bands US915, AU915, AS923 or KR920

12 Packing Info

Package Includes:

- ✓ LPS8N LoRaWAN Gateway x 1
- ✓ Stick Antenna for LoRa RF part. Frequency is one of 470 or 868 or 915Mhz depends the model ordered
- ✓ Packaging with environmental protection paper box

Dimension and weight:

- ✓ Device Size: 12 x 12 x 3 cm
- ✓ Weight: 187g
- ✓ Package Size: 14.5 x 13.5 x 6 cm
- ✓ Weight: 300g

13 Support

- Try to see if your questions already answered in the wiki.
- 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

14 FCC Warning

This device complies with part 15 of the FCC Rules. Operation is subject to the following two
conditions: (1) this device may not cause harmful interference, and (2) this device must accept
any interference received, including interference that may cause undesired operation.
Any changes or modifications not expressly approved by the party responsible for compliance
could void the user's authority to operate the equipment.
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment
generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.
However, there is no guarantee that interference will not occur in a particular installation.
If this equipment does cause harmful interference to radio or television reception,
which can be determined by turning the equipment off and on, the user is encouraged to try to
correct the interference by one or more of the following measures:
-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different
from that to which the receiver is connected.
-- Consult the dealer or an experienced radio/TV technician for help.
To maintain compliance with FCC's RF Exposure guidelines, This equipment should be installed and operated with minimum distance between 20cm the radiator your body:
Use only the supplied antenna.