LPS8 LoRaWAN Gateway User Manual

Document Version: 1.0

Firmware Version: LG02_LG08--build-v5.3.1572062709-20191026-1206

Version	Description	Date
1.0	Release	2019-Aug-10
1.0.1	Add trouble shooting for wifi AP not access issue	2019-Sep-23
1.0.2	Change the HTTP Port and SSH port for firmware version > v5.3	2019-Oct-26

Table of Contents

1 Introduction

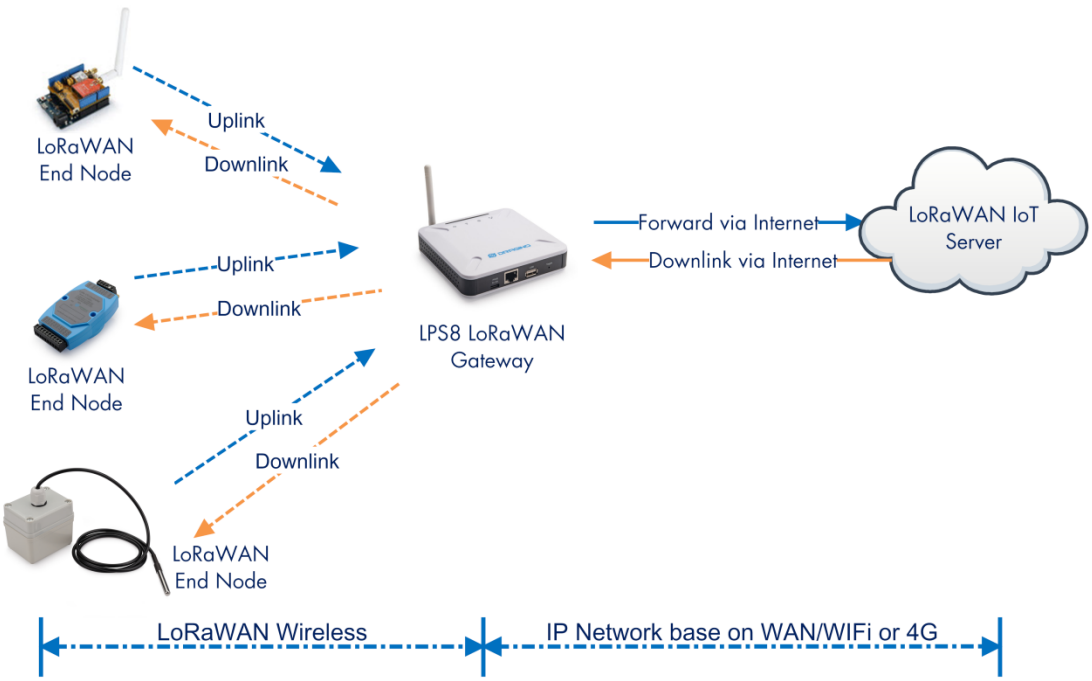
1.1 What is the LPS8

The LPS8 is an **open source** LoRaWAN 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 LPS8 uses **Semtech packet forwarder** and fully compatible with LoRaWAN protocol. It includes a **SX1308 LoRa concentrator**, which provides 10 programmable parallel demodulation paths.

LPS8 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.

LPS8 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
- USB 2.0 host connector x 1

WiFi Spec:

- IEEE 802.11 b/g/n
- Frequency Band: 2.4 ~ 2.462GHz
- Tx power:
  - ✓ 11n tx power : mcs7/15: 11db mcs0 : 17db
  - ✓ 11b tx power: 18db
  - ✓ 11g 54M tx power: 12db
  - ✓ 11g 6M tx power: 18db
- Wifi Sensitivity
  - ✓ 11g 54M : -71dbm
  - ✓ 11n 20M : -67dbm

LoRa Spec:

- Up to -140 dBm sensitivity with SX1257 Tx/Rx front-end
- 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

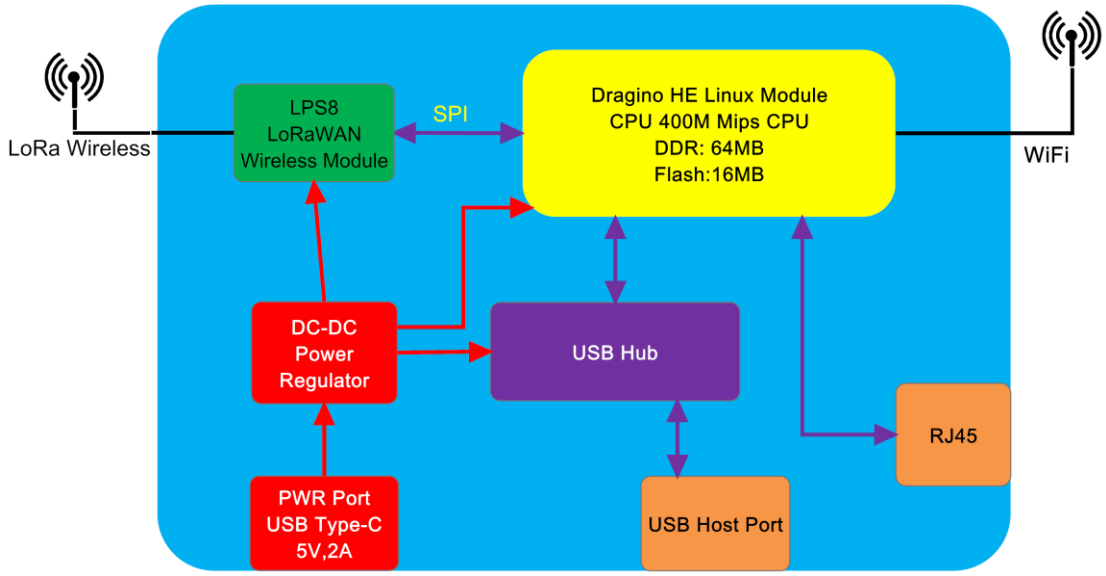
1.3 Features

- ✓ Open Source OpenWrt system
- ✓ Managed by Web GUI, SSH via WAN or WiFi

- ✓ Emulates 49x LoRa demodulators
- ✓ LoRaWAN Gateway
- ✓ 10 programmable parallel demodulation paths

1.4 Hardware System Structure

LPS8 System Overview:



1.5 LPS8 Applications

2 Access LPS8

2.1 Access and Configure the LPS8 via WiFi or Ethernet

The LPS8 is configured as a WiFi Access Point by factory default. You can access and configure the LPS8 after connecting to its WiFi network, or via its WAN Ethernet port.

WiFi

At the first boot of LPS8, it will auto generate an open WiFi network called ***dragino-xxxxxx***

You can use a PC to connect to this WiFi network. The PC will get an IP address 10.130.1.xxx and the LPS8 has the default IP 10.130.1.1

Ethernet

Alternatively, you can connect your PC to the LPS8 WAN port via Ethernet cable and obtain an IP address via DHCP. Assume the IP get from router is 192.168.1.3

Web Interface

Open a browser on the PC and type in the address:

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

or

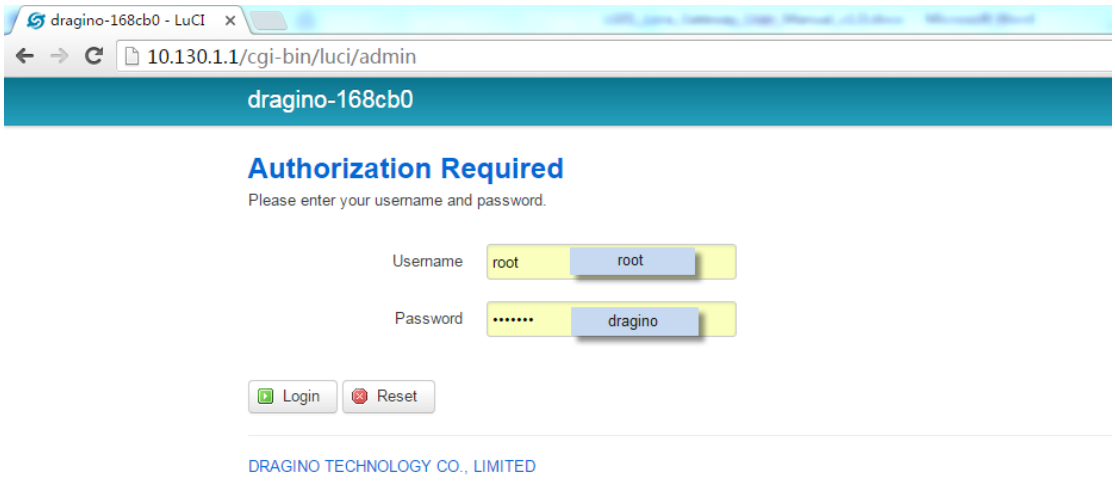
http://192.168.1.xx or http://192.168.1.xx:8000 (The web port has been changed to 8000 in WAN interface since firmware 5.3.xxx firmware)

You will see the login interface of LPS8 as shown below.

The account details for Web Login are:

User Name: root

Password: dragino



3 Typical Network Setup

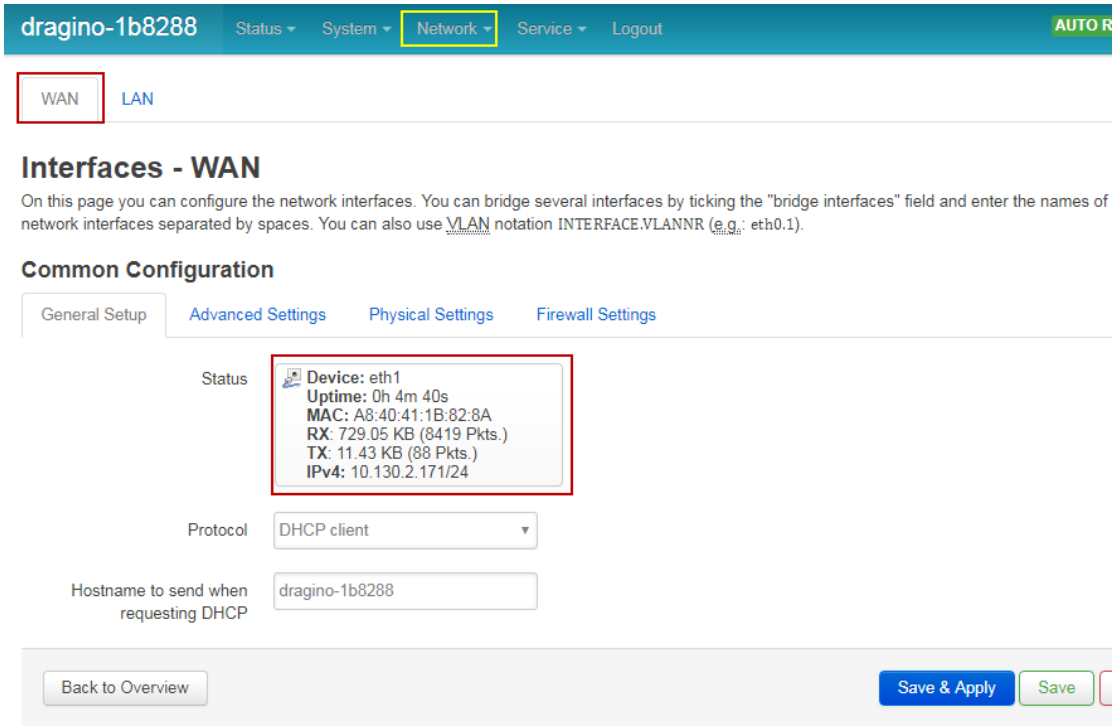
3.1 Overview

The LPS8 supports flexible network set up for different environments. This section describes the typical network topology can be set in LPS8. 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 LPS8 is set to use the WAN port to connect to an upstream network. When you connect the LPS8's WAN port to an upstream router, the LPS8 will get an IP address from the router and have Internet access via the upstream router. The network status can be checked as below:



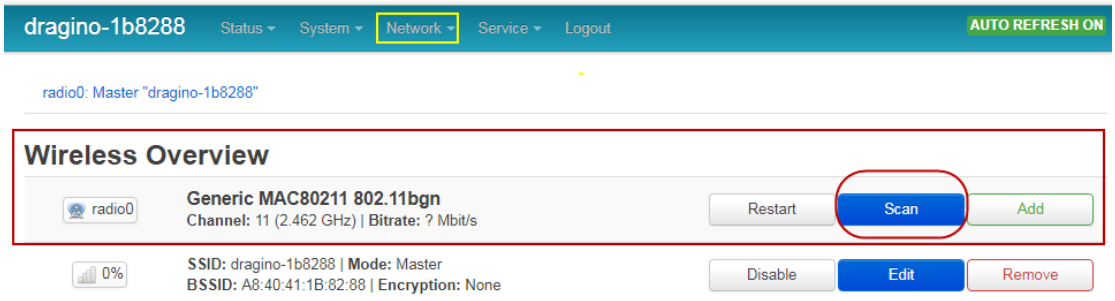
3.3 Access the Internet as a WiFi Client.

In the WiFi Client Mode, the LPS8 acts as a WiFi client and gets DHCP from an upstream router via WiFi.

The steps to set up as a WiFi Client are as below:

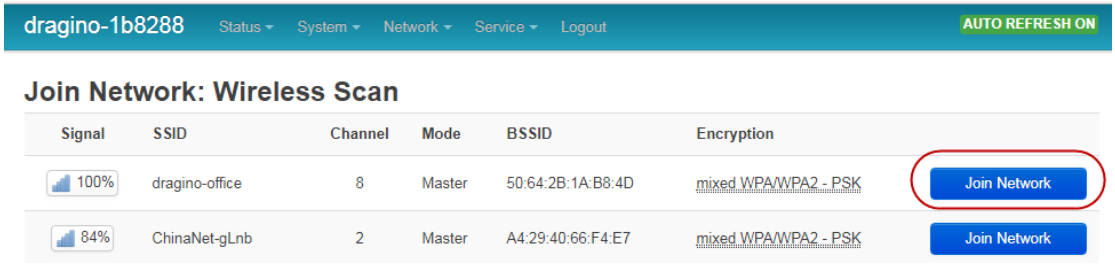
Step1:

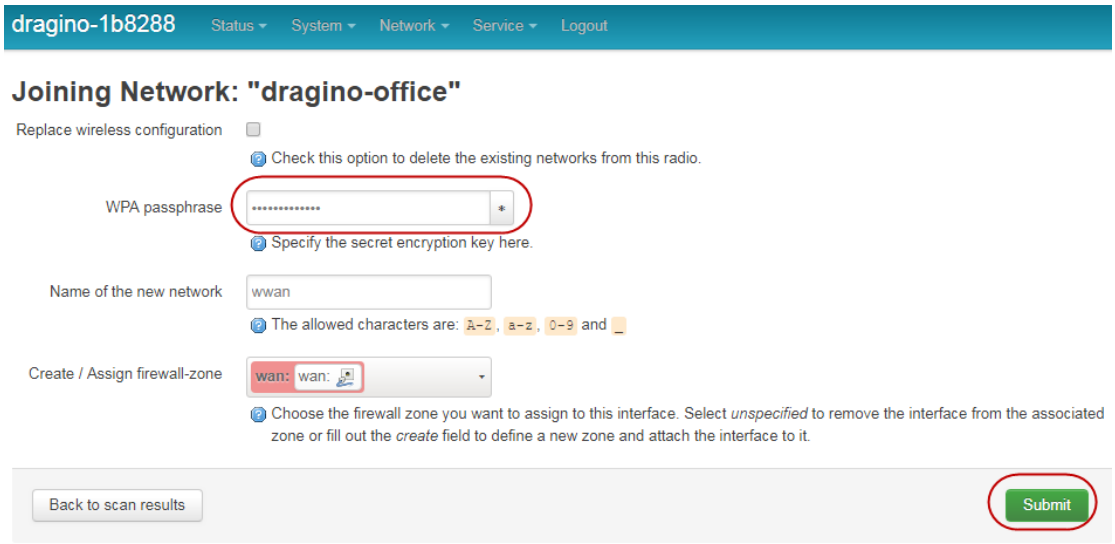
In Network -> Wireless, select Radio0 interface and scan.



Step2:

Select the Wireless AP and join:



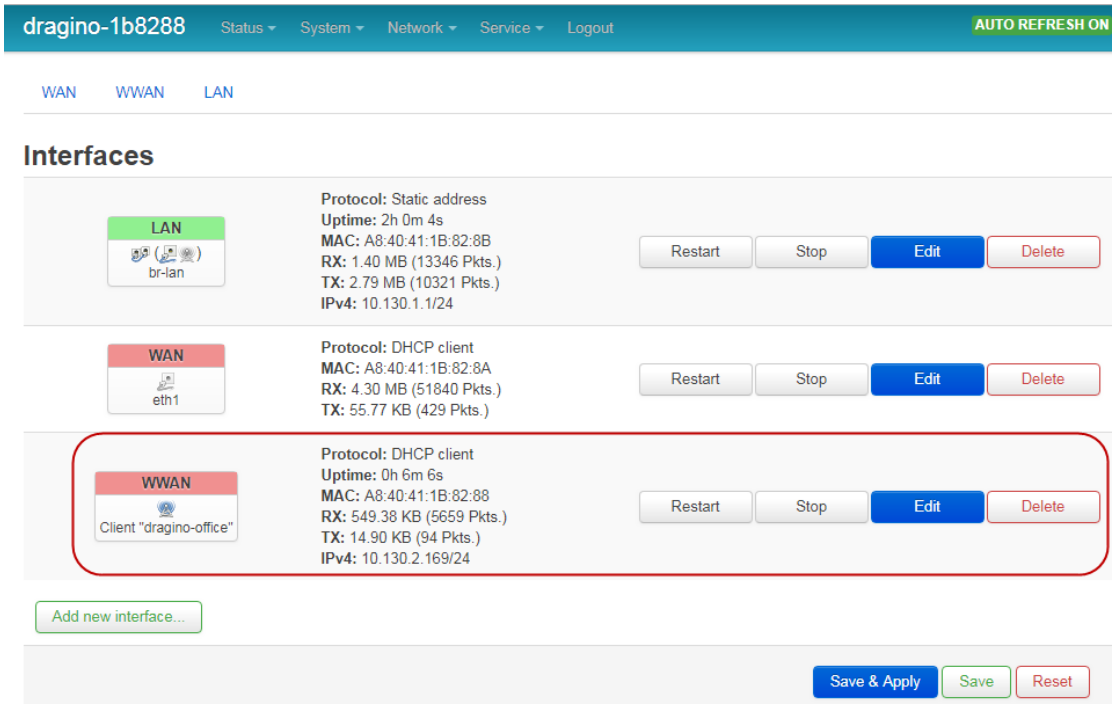


Step3:

In the Network->Wireless page, disable WiFi AP network. This step is important, the LPS WiFi interface can only WiFi AP or WiFi Client mode at a time.

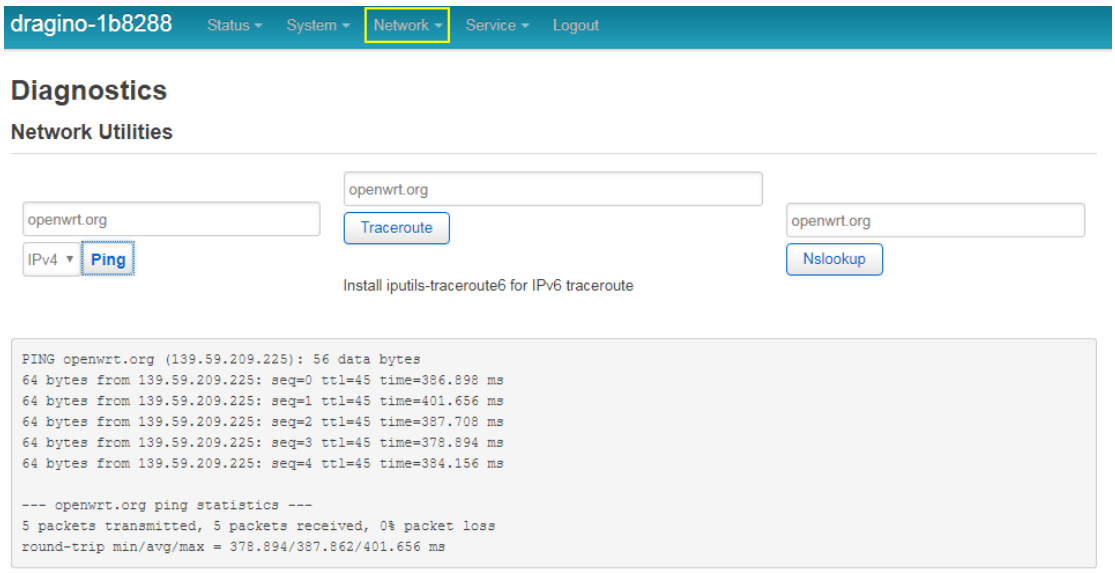
Note: After doing that, you will lose connection if your PC connects to the LPS8 via LPS8's WiFi network.

After successful association, the WiFi network interface can be seen in the same page:



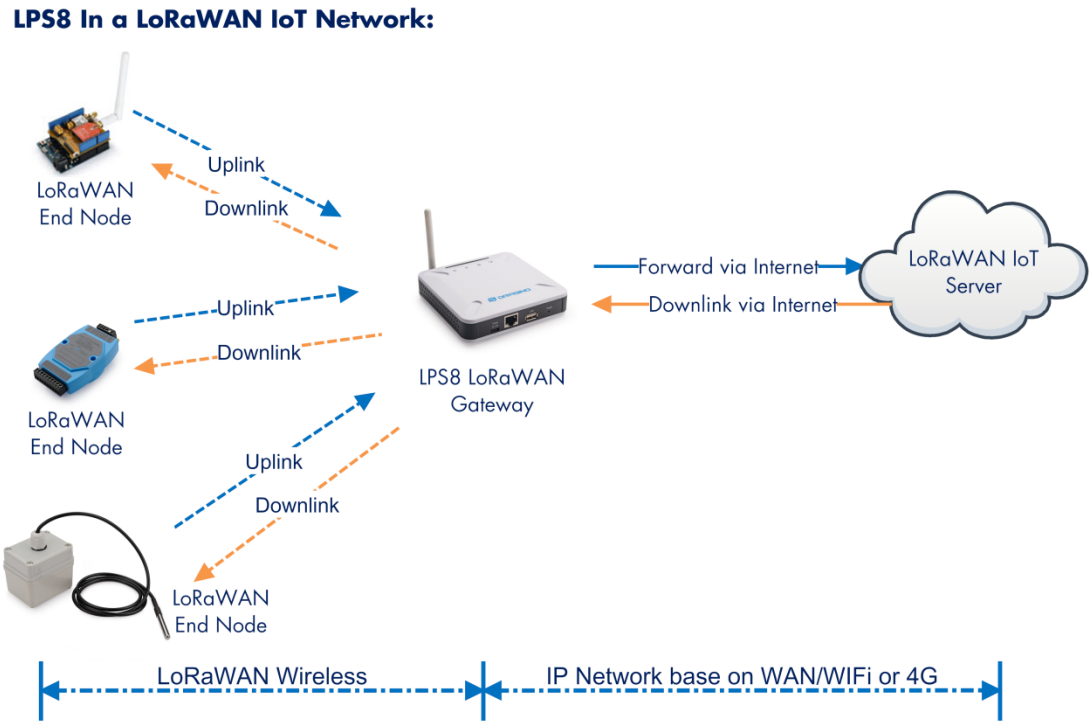
3.4 Check Internet connection

You can use the diagnostics page to check and analyze the Internet connection as shown below.



4 Example: Configure as a LoRaWAN gateway

LPS8 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.



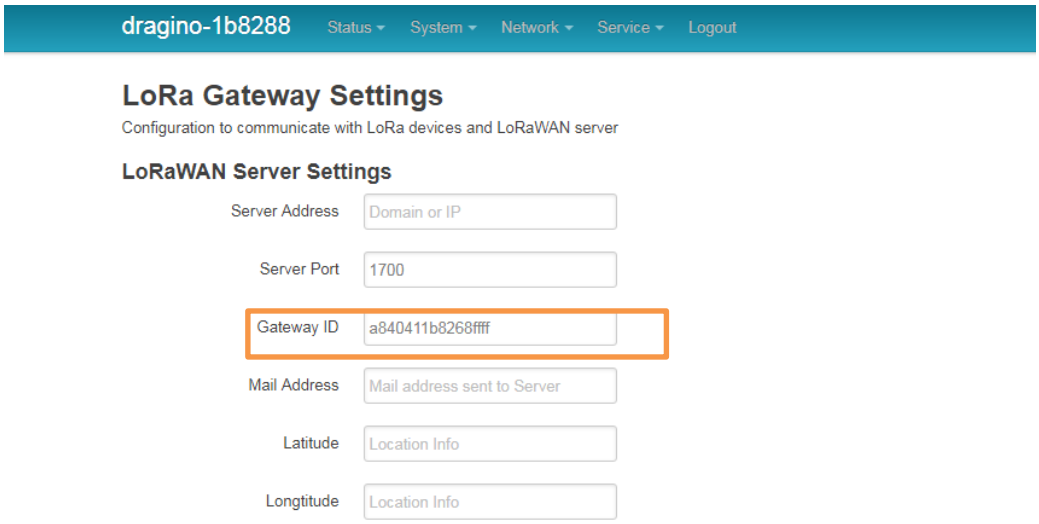
This chapter describes how to use the LPS8 to work with

TheThingsNetwork (TTN) LoRaWAN Server (www.thethingsnetwork.org)

4.1 Create a gateway in TTN Server

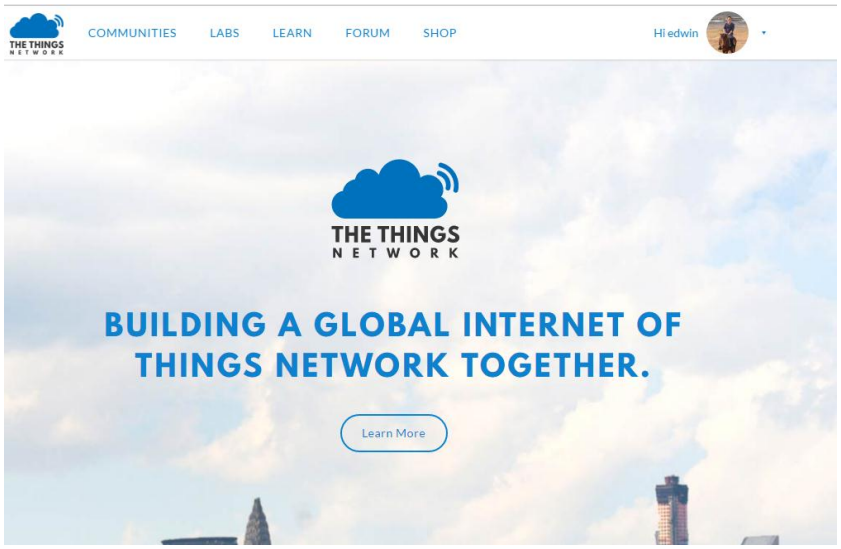
Step 1: Get a Unique gateway ID.

Every LPS8 has a unique gateway id. The ID can be found at LoRaWAN page:

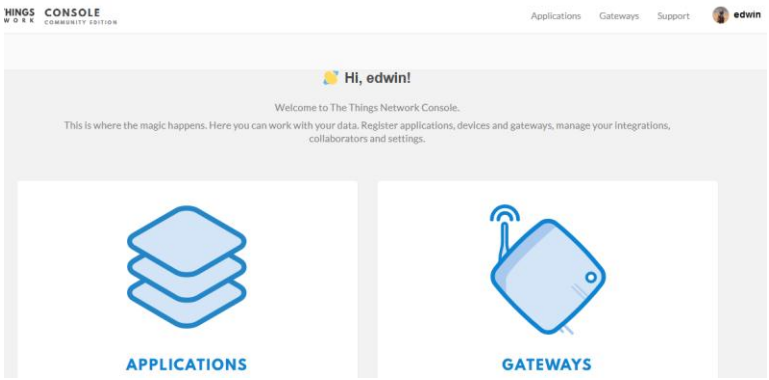


The example gateway id is: **a840411b8268ffff**

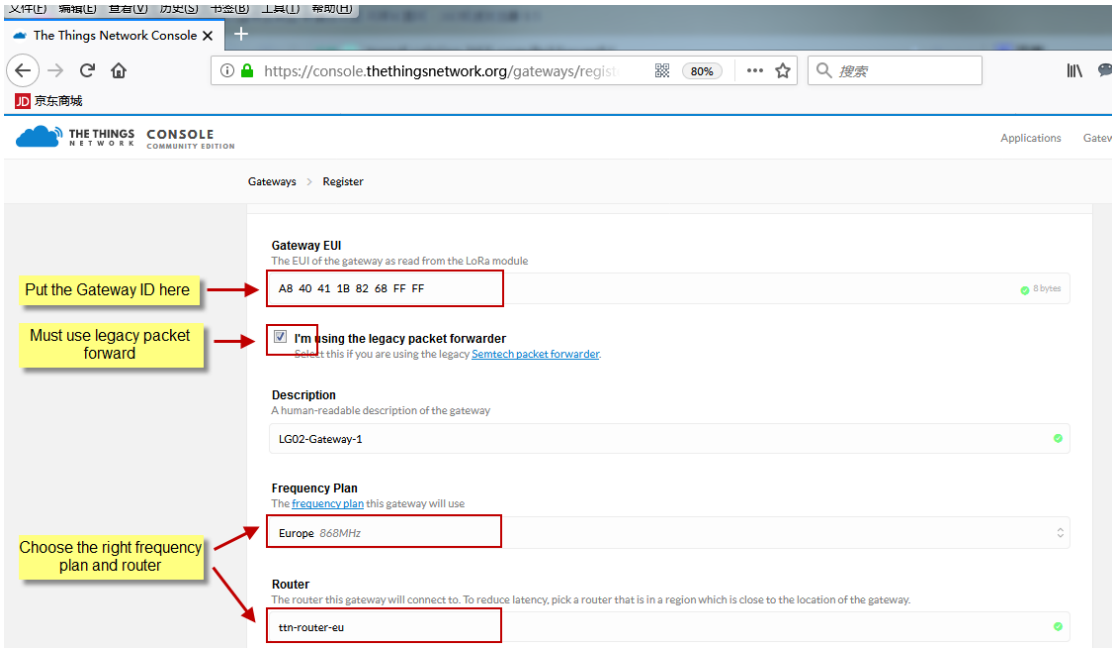
Step 2: Sign up a user account in TTN server



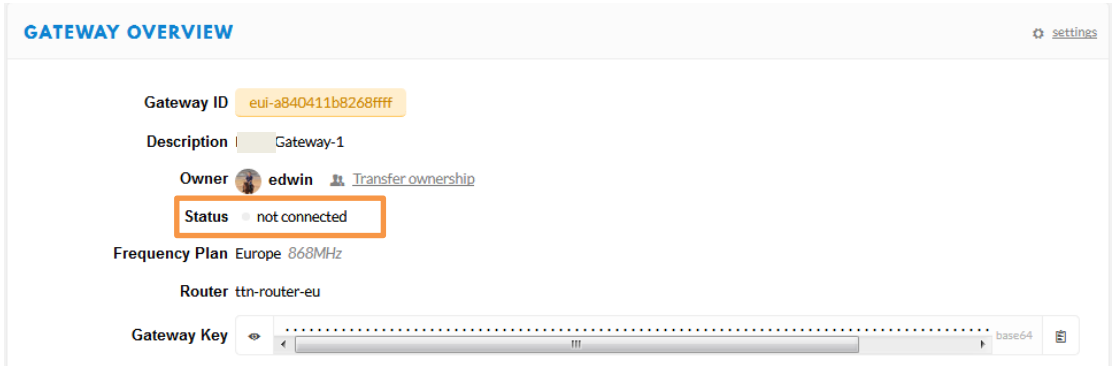
Step 3: Create a Gateway



Click on the Gateways icon to open the page below:



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

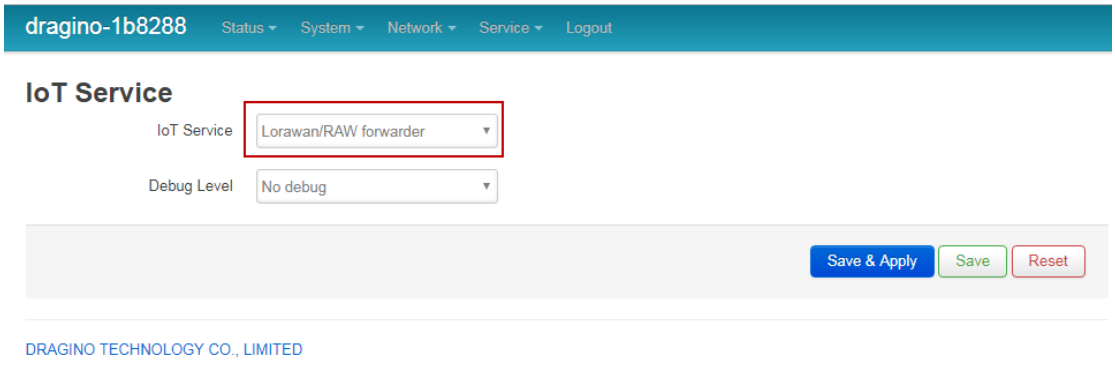


4.2 Configure LPS8 to connect to TTN

You can now configure the LPS8 to let it connect to TTN network.

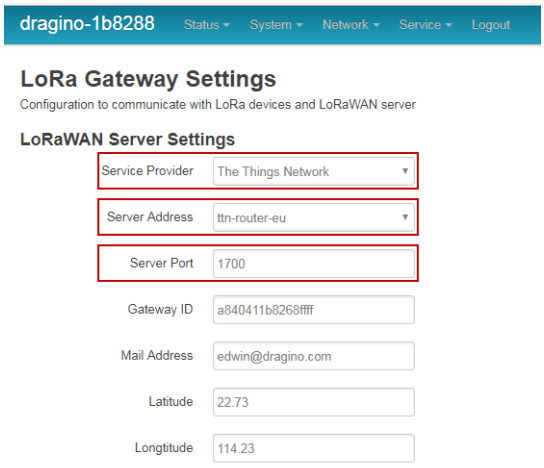
Make sure your LPS8 has a working Internet Connection first.

Step1: Configure LPS8 to act as raw forwarder



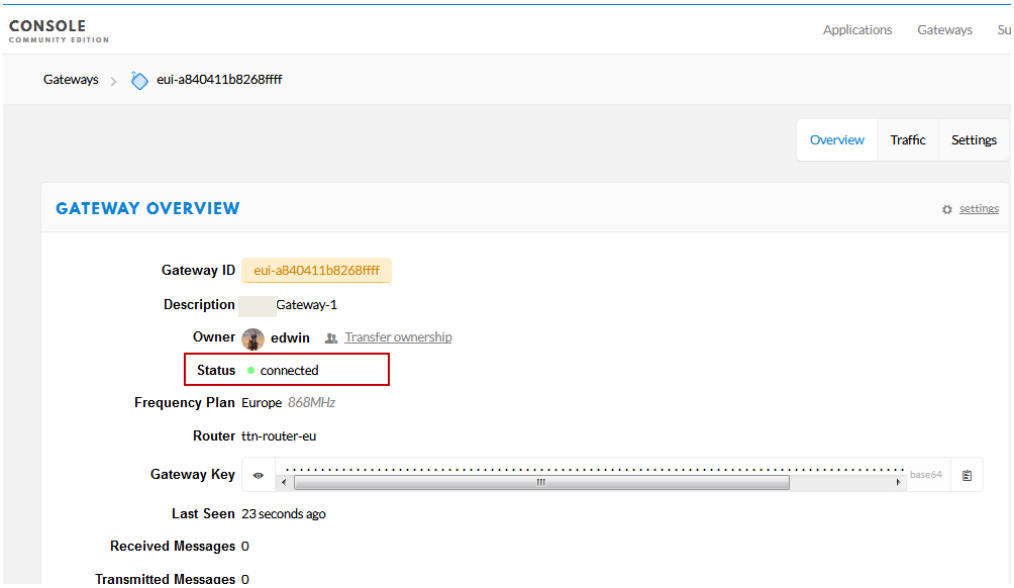
Step2: Input server info and gateway id

Choose the correct the server address and gateway ID.

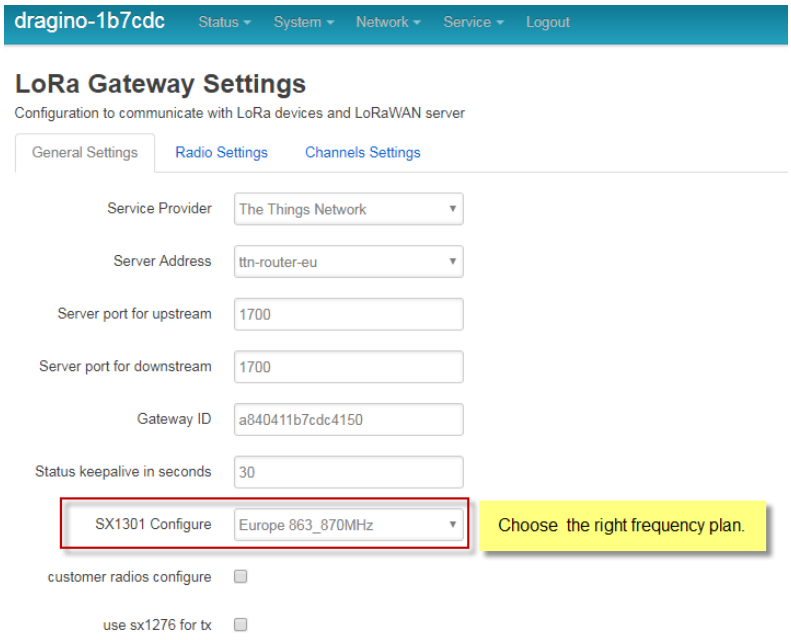


Check Result

After making the above settings, the LPS8 should be able to connect to TTN. Below is the result seen from TTN:



4.3 Configure frequency



After making the settings above, the LPS8 will be able to act as a LoRaWAN gateway.

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-33222-L IO Controller as a reference device - the setup for other LoRaWAN devices will be similar.

Step 1: Create a Device definition in TTN with the OTAA keys from the example LT-33222-L IO Controller device.

Three codes are required to define the device in TTN:

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

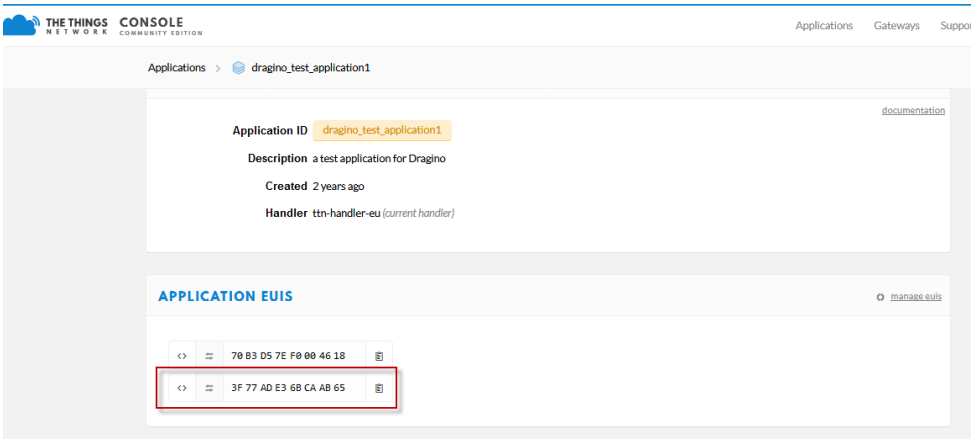
A set of these codes are stored in each device by the manufacturer as the default codes for that particular device. Each device is shipped with a sticker with the default Device EUI as shown below.

Note: You may be able to change these codes in a device by using a configuration facility on the device e.g. the LT-33222 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 server, you can use the codes set in the device as in the following example.

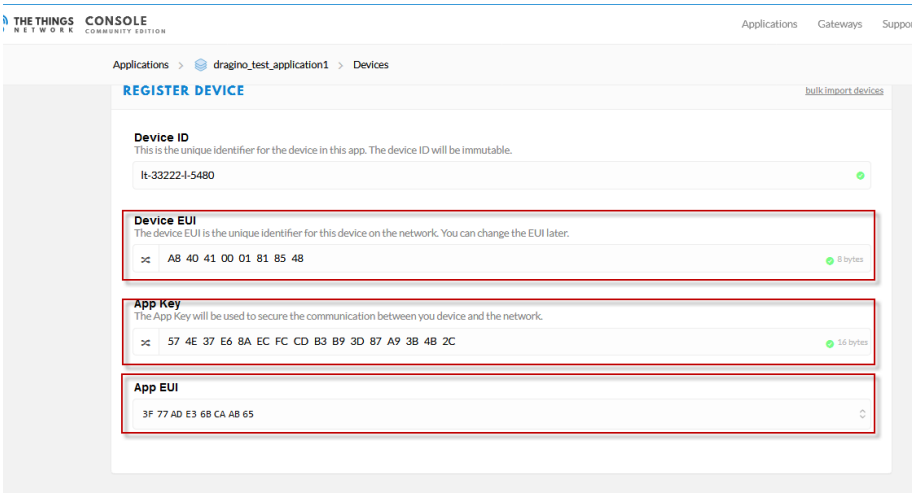
Select **Add Application** to open the screen below.

Note that there is an APP EUI already created by TTN, but this is not the one set in the device. To add the APP EUI for the LT33222 device, select **Manage EUIs** and **Add EUI**, then enter the required code.



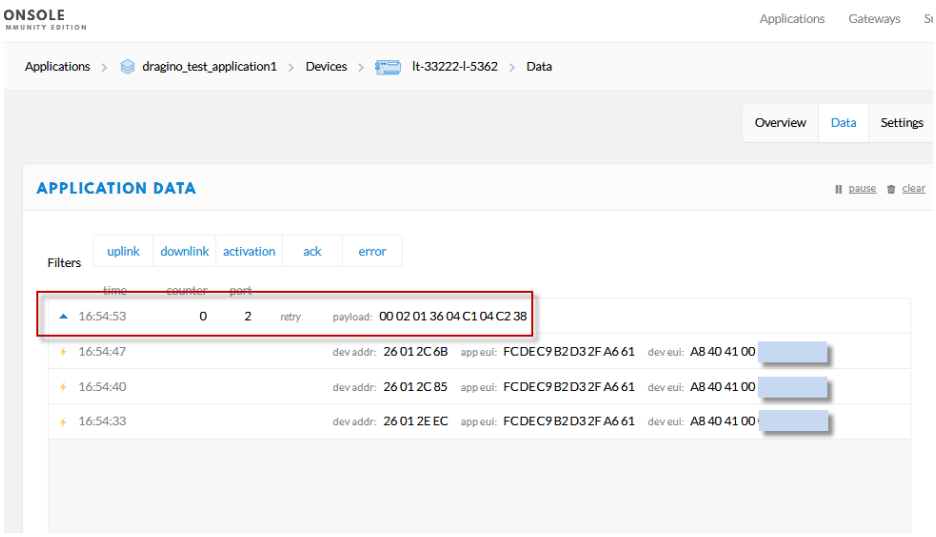
Select **Devices** and **Register Device** to open the screen below.

Enter the **Device EUI** and **APP KEY** codes, then select the App EUI from the list.
Check that all three codes match those shown on the device label before saving the configuration.



Step 2: Power on LT-33222 device and it will automatically join the TTN network. After joining successfully, it will start to upload messages to the TTN. Select the 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 display.


ONSOLE
Applications
Gateways
Applications
dragino_test_application1
Devices
lt-33222-l-5362
Data
Overview
Data
Settings
APPLICATION DATA
pause
clear
Filters
uplink
downlink
activation
ack
error
time
counter
port
16:54:53 0 2 retry payload: 00 02 01 36 04 C1 04 C2 38
16:54:47 dev addr: 26 01 2C 6B app eui: FC DE C9 B2 D3 2F A6 61 dev eui: A8 40 41 00
16:54:40 dev addr: 26 01 2C 85 app eui: FC DE C9 B2 D3 2F A6 61 dev eui: A8 40 41 00
16:54:33 dev addr: 26 01 2E EC app eui: FC DE C9 B2 D3 2F A6 61 dev eui: A8 40 41 00

5 Linux System

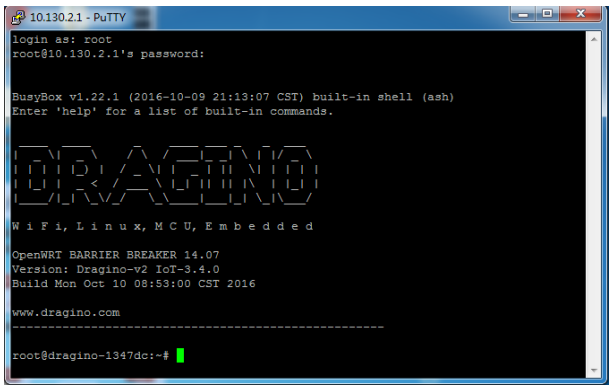
The LPS8 is based on the OpenWrt Linux system. It is open source, and users are free to configure and modify the Linux settings.

5.1 SSH Access for Linux console

You can access the Linux console via the SSH protocol. Make sure your PC and the LPS8 are connected to the same network, then use a SSH tool (such as putty in Windows) to access it.

IP address: IP address of LPS8
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.

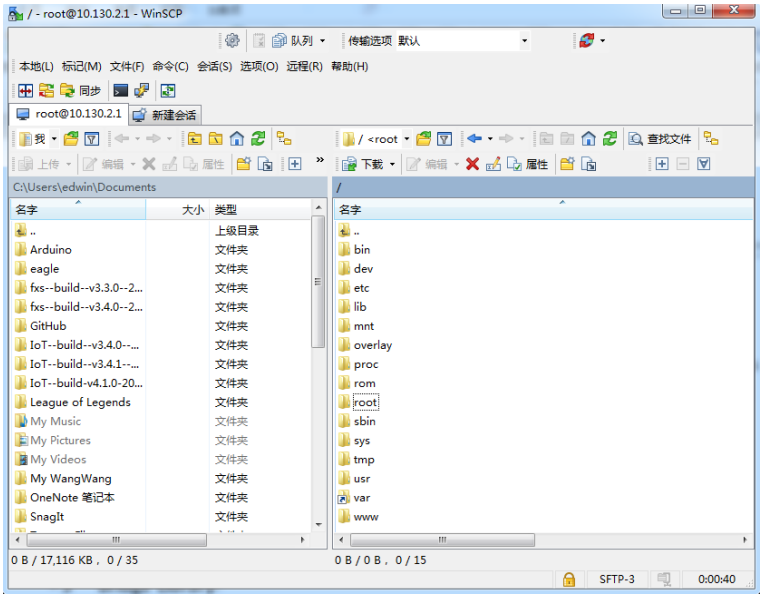


5.2 Edit and Transfer files

The LPS8 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 LPS8, or edit the files directly in the windows.

Screenshot is as below:



5.3 File System

The LPS8 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 LPS8 flash.
You can use an external USB flash memory device to extend the size of flash memory for storage.

5.4 Package maintenance system

LPS8 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 LPS8 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.

6 Upgrade Linux Firmware

We keep improving the LPS8 Linux side firmware for new features and bug fixes.
The latest firmware can be found on LoRa Gateway Firmware,
(http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LG02-OLG02/Firmware)
The Change Log can be found here: Firmware Change Log.
(http://www.dragino.com/downloads/downloads/LoRa_Gateway/LG02-OLG02/Firmware/ChangeLog)

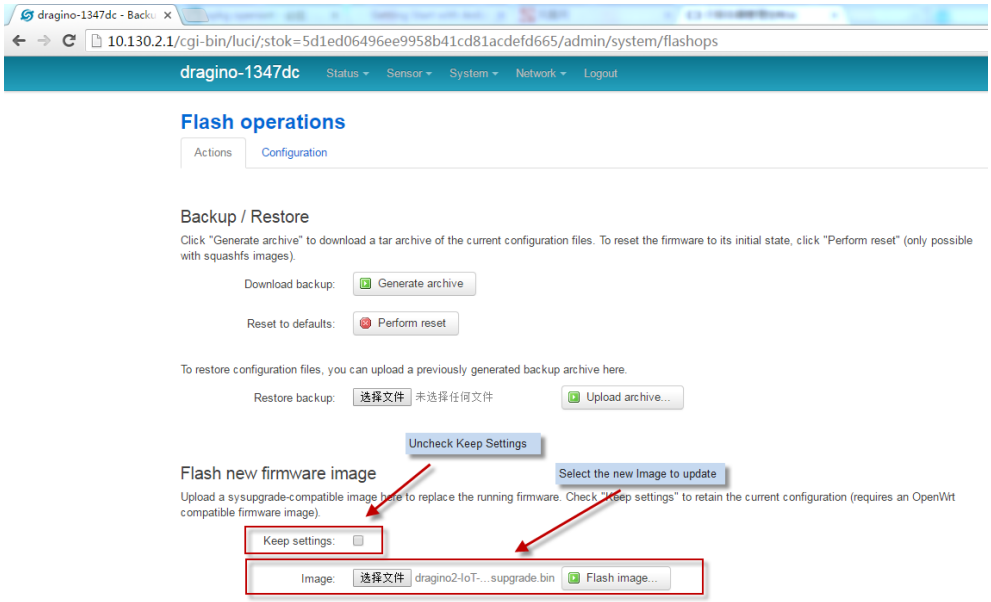
The file named as **xxxxx–xxxxx-squashfs-sysupgrade.bin** is the upgrade Image. There are different methods to upgrade, as below.

6.1 Upgrade via Web UI

Go to the page: **Web → System → Back Up and flash firmware**
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 **Keep 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.



6.2 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.

7 FAQ

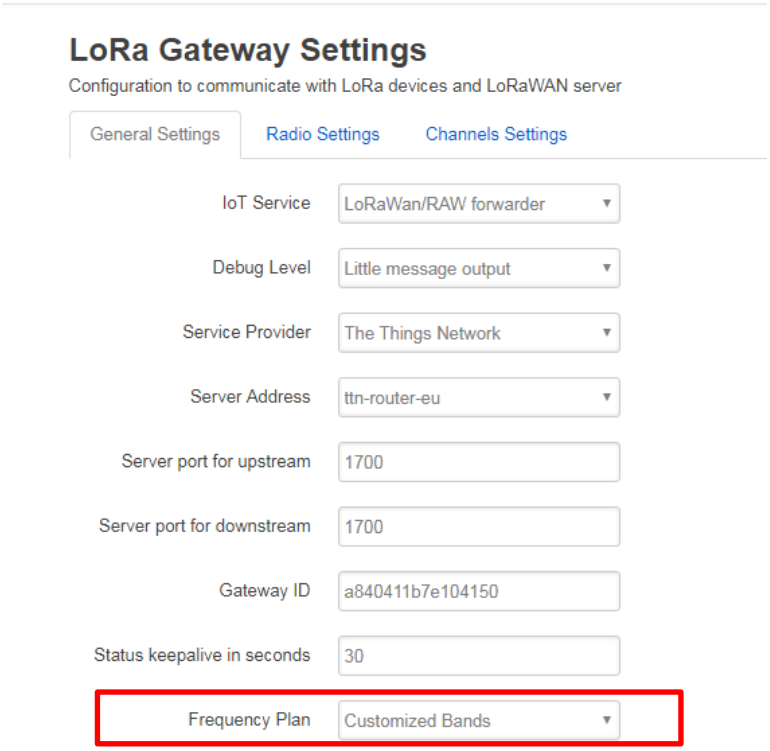
7.1 How can I configure for a customized frequency band?

You can customize your LoRaWAN channel on LPS8. For example if you want to set the gateway to meet the India LoROIT frequency band:

LoRoit Frequency plan for India

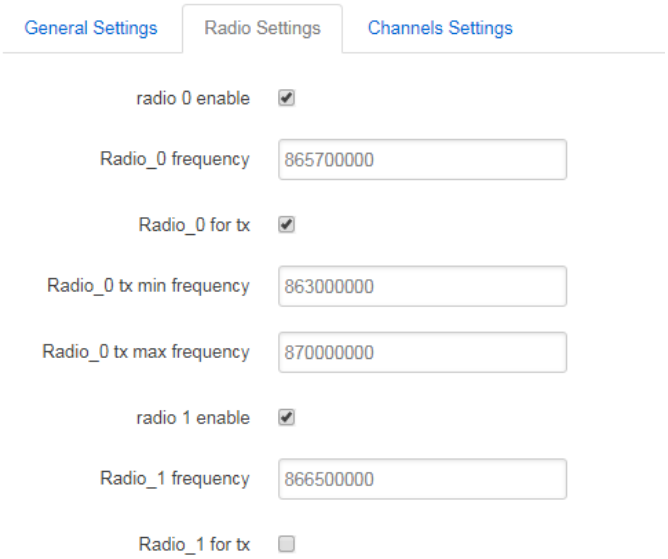
```
Channel    Frequency Modulation / BW
0             865.400 MHz     MultiSF    125 kHz
1             865.600 MHz     MultiSF    125 kHz
2             865.800 MHz     MultiSF    125 kHz
3             866.000 MHz     MultiSF    125 kHz
4             866.200 MHz     MultiSF    125 kHz
5             866.400 MHz     MultiSF    125 kHz
6             866.600 MHz     MultiSF    125 kHz
7             866.800 MHz     MultiSF    125 kHz
LoRa          865.700 MHz     SF7        250 kHz
FSK           865.700 MHz     FSK        250 kHz, 64 kbps

RX2 channel (downlink)
RX2          865.200 MHz      SF12       125 kHz
```

Step 1: Choose Frequency Band to use "Customized Bands"



Step 2: Configure Radio 0 & 1 Frequency

The LPS8 has two Radios from SX1308. You can configure these eight channels based on these two radios. Go to the Radio Settings page and enable Radio 0 to 865700000 and enable Radio 1 to 866500000.



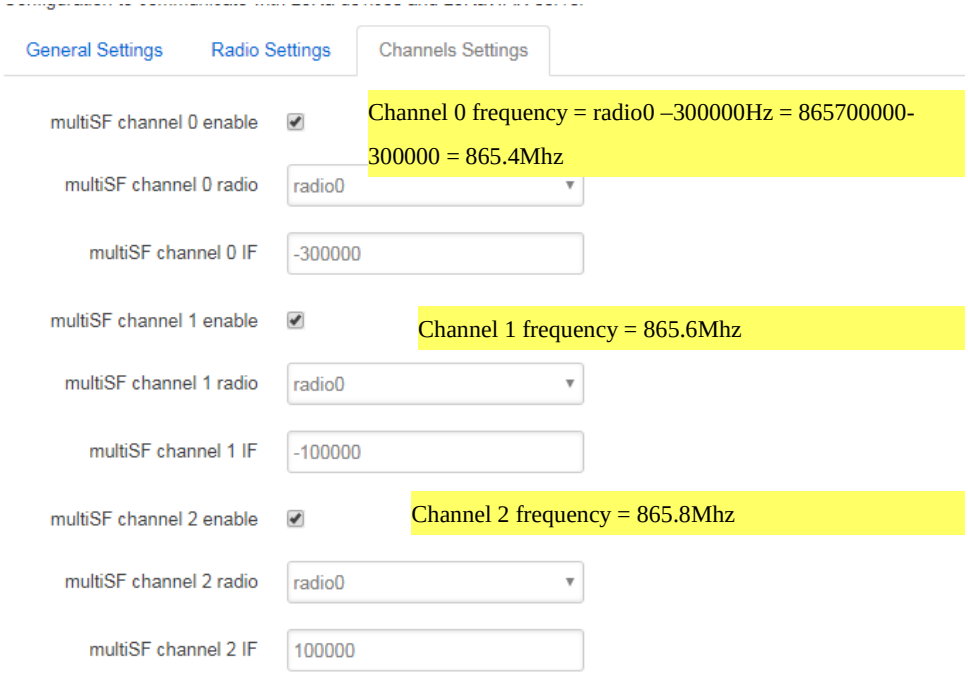
Step 3: Configure Channel Frequency.

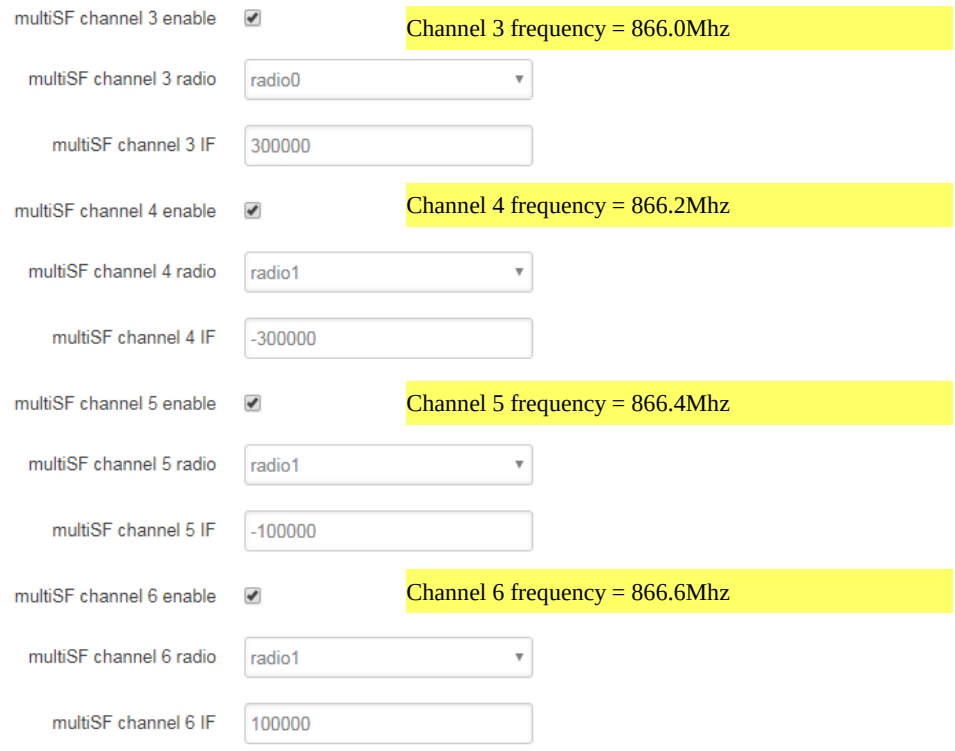
What we need to configure for LoRoit is 0~7 multiSF channel frequency and LoRa frequency as per LoRiot frequency plan.

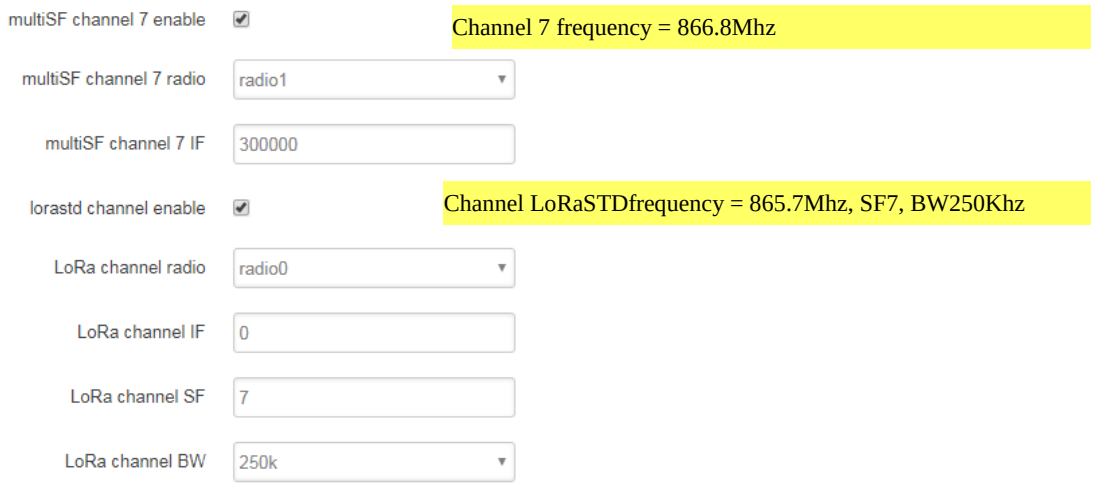
Each Channel Configure include below parameters:

- ✓ Radio used for this channel.
- ✓ Channel IF, frequency shift base on Radio Frequency.

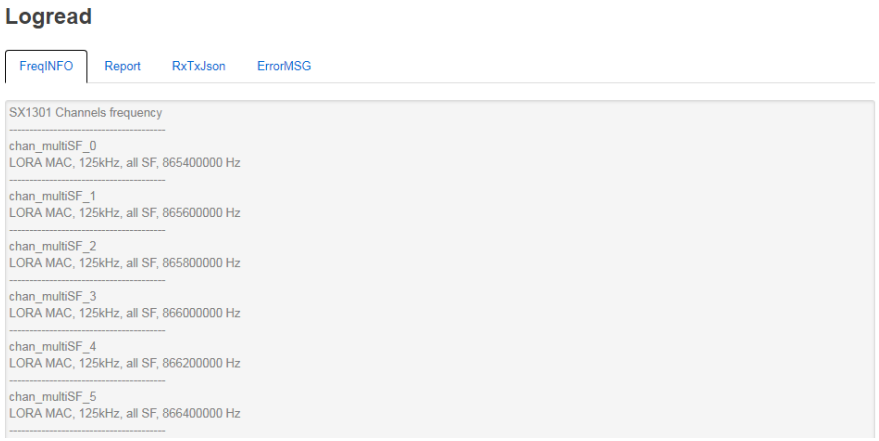
Below are the settings for the LoRiot frequency plan:




multiSF channel 3 enable
Channel 3 frequency = 866.0Mhz
multiSF channel 3 radio
radio0
multiSF channel 3 IF
300000
multiSF channel 4 enable
Channel 4 frequency = 866.2Mhz
multiSF channel 4 radio
radio1
multiSF channel 4 IF
-300000
multiSF channel 5 enable
Channel 5 frequency = 866.4Mhz
multiSF channel 5 radio
radio1
multiSF channel 5 IF
-100000
multiSF channel 6 enable
Channel 6 frequency = 866.6Mhz
multiSF channel 6 radio
radio1
multiSF channel 6 IF
100000


multiSF channel 7 enable
Channel 7 frequency = 866.8Mhz
multiSF channel 7 radio
radio1
multiSF channel 7 IF
300000
lorastd channel enable
Channel LoRaSTDfrequency = 865.7Mhz, SF7, BW250Khz
LoRa channel radio
radio0
LoRa channel IF
0
LoRa channel SF
7
LoRa channel BW
250k

Step 4: Save & Apply & check result in logread page.



7.2 Can I make my own firmware for LPS8?

Where can I find the source code of LPS8?

Yes, You can make your own firmware for the LPS8 for branding purposes or to add customized applications.
The LPS8 source code and compile instructions can be found at:
https://github.com/dragino/openwrt_lede-18.06

7.3 Can I use the 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, and all other frequencies will have high attenuation.

7.4 More FAQs about general LoRa questions

We keep updating more FAQs in our WiKi about general questions.
The Wiki link is here:
http://wiki.dragino.com/index.php?title=LoRa_Questions

8 Trouble Shooting

8.1 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

8.2 How to recover the LPS8 if the firmware crashes

LPS8 provides the user with full control on its Linux system, so it is possible that the device will brick and can't boot after an improper modification in some boot files. In this case, the user can recover the whole Linux system by uploading a new firmware via Web Failsafe mode.

Procedure is as below:

- Use an RJ45 cable to connect the PC to LPS8's WAN port directly.
- Set the PC to a static IP of 192.168.255.x, Netmask 255.255.255.0
- Press and hold the toggle button and power on the device.
- All LEDs of the device will blink, release the toggle button after ***four*** blinks
- All LEDs will then blink very fast once, this means that the device has detected a network connection and will enter into the Web-Failsafe mode. Your PC should be able to ping 192.168.255.1 after device enters this mode.
- Open 192.168.255.1 in web browser.
- Select a squashfs-sysupgrade type firmware and update firmware.

Note: If you see all LEDs blink very fast in Step 5, this means the network connection is established. If in this case, the PC is still not able to see the web page, you can debug as follows:

- ✓ Try different browser.
- ✓ Check if your PC is set to static IP address of 192.168.255.x
- ✓ Check if you have connected two RJ45 cables to device. If so, remove the unused one

8.3 I configured LPS8 for WiFi access and lost its IP. What to do now?

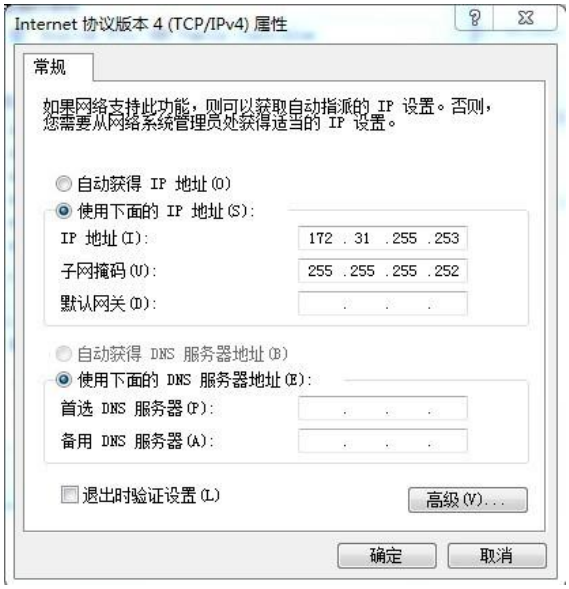
The LPS8 has a fall-back IP address on its WAN port. This IP is always enabled so you can use the fall-back IP to access LPS8 no matter what the WiFi IP is. The fall back IP is useful for connecting and debug the unit.

(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 LPS8 via Web or Console.

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

8.4 I connect to the LPS8's SSID but LPS8 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.

9 Order Info

***PART: LPS8-XXX-YYY*:**

XXX: Frequency Band

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

10 Packing Info

Package Includes:

- ✓ LPS8 LoRa 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 2.5 cm
- ✓ Device Weight:
- ✓ Package Size / pcs :
- ✓ Weight / pcs :
- ✓ Carton dimension:
- ✓ Weight / carton :

11 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

12 Reference

- ✧ Source code for LPS8 LoRa Gateway
  https://github.com/dragino/openwrt_lede-18.06

- ✧ OpenWrt official Wiki
  http://www.openwrt.org/

- ✧ Firmware
  http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LPS8-OLPS8/Firmware/