LG02/OLG02 LoRa Gateway User Manual

Document Version: 1.0

Firmware Version: LG02_LG08—v5.0.0

Version	Description	Date
1.0	Release	2018-Aug-2

1. Introduction

1.1 What is LG02 & OLG02

LG02 & OLG02 are an open source dual channels LoRa Gateway. It lets you bridge LoRa wireless network to an IP network via WiFi, Ethernet, 3G or 4G cellular. The LoRa wireless allows users to send data and reach extremely long ranges at low data-rates. It provides ultra-long range spread spectrum communication and high interference immunity.

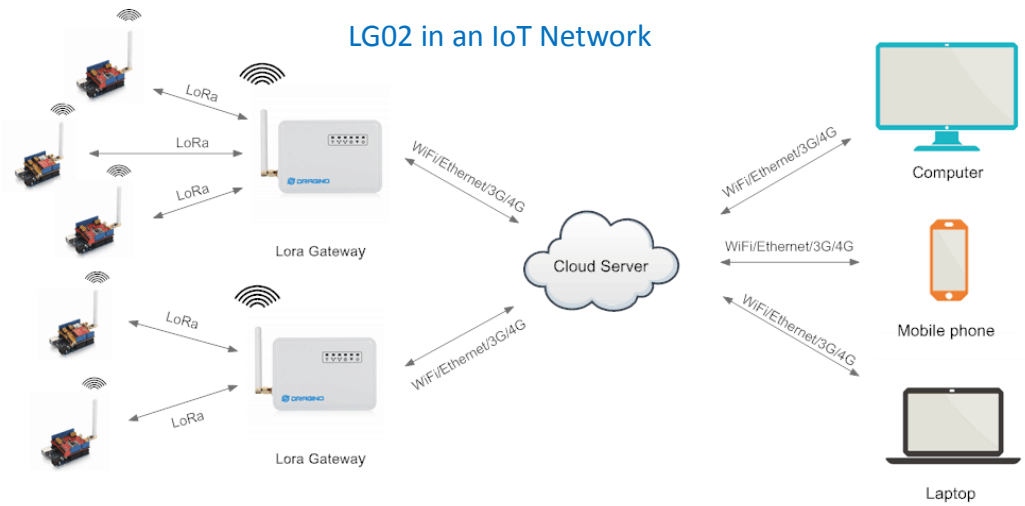
LG02 & OLG02 have rich internet connection method such as WiFi interface, Ethernet port and USB host port. These Interfaces provide flexible methods for users to connect their sensor networks to Internet.

LG02 & OLG02 can support the LoRaWAN protocol in single frequency and customized LoRa transmit protocol. The design of LG02 is use the Linux to directly control two sx1276/sx1278 LoRa modules which lets the LoRa can works in full duplex LoRa mode and increase the communication efficiency.

LG02 can be used to provide a low cost IoT wireless solution to support 50~300 sensor nodes.

Except LoRaWAN mode, LG02 can support multiply working mode such as: LoRa repeater mode, MQTT mode, TCP/IP Client mode, TCP/IP Server mode to fit different requirement for IoT connection. Click this link for more info about the modes.

LG02 & OLG02 provide a low cost for your IoT network connection. Compare to the cost with normal SX1301 LoRaWAN solution. LG02 & OLG02 is only of its 1/4 or less cost. This makes the LG02 very suitable to set up small scale LoRa network or use it to extend the coverage of current LoRaWAN network.



1.2 Specifications

Hardware System:

Linux Part:

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

Interface:

- 10M/100M RJ45 Ports x 2
- WiFi : 802.11 b/g/n
- LoRa Wireless
- Power Input: 12V DC
- USB 2.0 host connector x 1
- USB 2.0 host internal interface x 1
- 2 x LoRa Interfaces

WiFi Spec:

- IEEE 802.11 b/g/n
- Frenquency 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:

- Frequency Range:
  - ✓ Band 1 (HF): 862 ~ 1020 Mhz
  - ✓ Band 2 (LF): 410 ~ 528 Mhz
- 168 dB maximum link budget.
- +20 dBm - 100 mW constant RF output vs.
- +14 dBm high efficiency PA.
- Programmable bit rate up to 300 kbps.
- High sensitivity: down to -148 dBm.
- Bullet-proof front end: IIP3 = -12.5 dBm.
- Excellent blocking immunity.
- Low RX current of 10.3 mA, 200 nA register retention.
- Fully integrated synthesizer with a resolution of 61 Hz.
- FSK, GFSK, MSK, GMSK, LoRaTM and OOK modulation.
- Built-in bit synchronizer for clock recovery.

- Preamble detection.
- 127 dB Dynamic Range RSSI.
- Automatic RF Sense and CAD with ultra-fast AFC.
- Packet engine up to 256 bytes with CRC.
- Built-in temperature sensor and low battery indicator.

Cellular 4G LTE (optional):

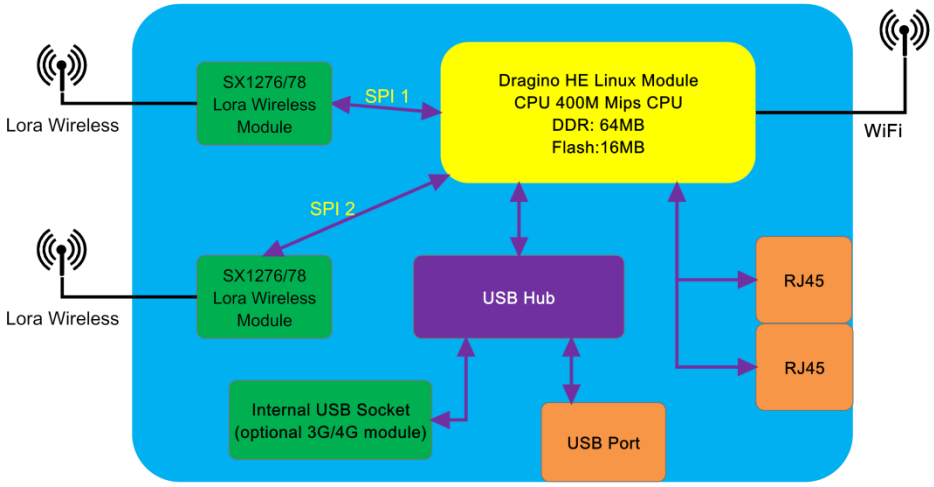
- Quectel **EC25 LTE module**
- Micro SIM Slot
- Internal 4G Antenna + External 4G Sticker Antenna.
- Up to 150Mbps downlink and 50Mbps uplink data rates
- Worldwide LTE,UMTS/HSPA+ and GSM/GPRS/EDGE coverage
- MIMO technology meets demands for data rate and link reliability in modem wireless communication systems

1.3 Features

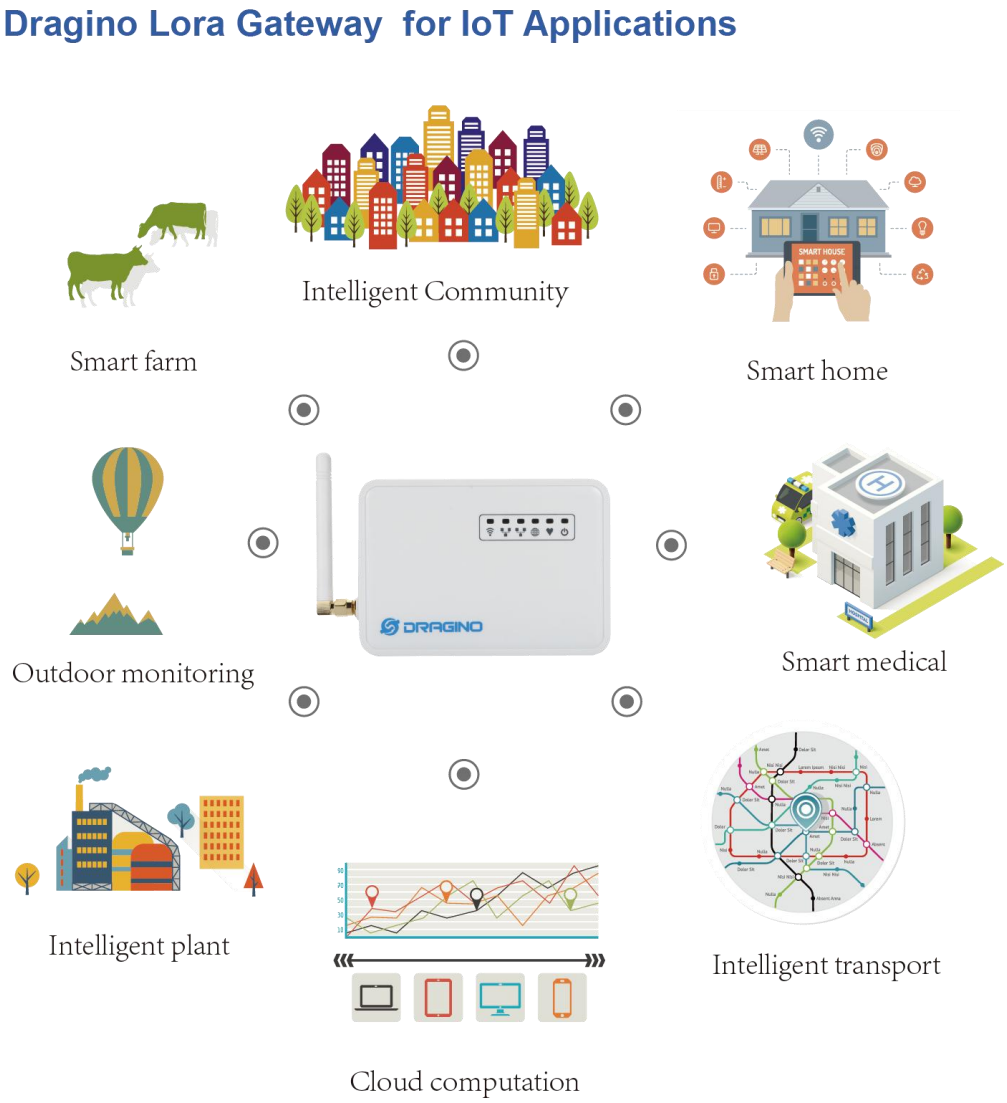
- ✓ Open Source OpenWrt LEDE system
- ✓ Low power consumption
- ✓ Firmware upgrade via Web
- ✓ Software upgradable via network
- ✓ Flexible protocol to connect to IoT servers
- ✓ Auto-Provisioning
- ✓ Built-in web server
- ✓ Managed by Web GUI, SSH via LAN or WiFi
- ✓ Internet connection via LAN, WiFi, 3G or 4G
- ✓ Failsafe design provides robustly system
- ✓ 2 x SX1276/SX1278 LoRa modules
- ✓ Full – duplex LoRa transceiver
- ✓ Two receive channels, and one transmit channel
- ✓ Limited support in LoRaWAN/ Support Private LoRa protocol
- ✓ Support upto 300 nodes
- ✓ LoRa band available at 433/868/915/920 Mhz
- ✓ Max range in LoRa: 5~10 km. Density Area:>500m

1.4 System Structure

LG02 System Overview:



1.5 Applications



1.6 Hardware Variants

The LG02 and OLG02 use the same firmware and have the same feature in the software side. In this document, we will use LG02 as the model number to explain the feature.

Model	Photo	Description
LG02		Indoor version for dual channel LoRa Gateway, without 4G module
LG02		Indoor version for dual channel LoRa Gateway, include 4G module.
OLG02		Outdoor version for dual channel LoRa Gateway

1.7 Install SIM card in 4G module

For LG02 & OLG02 4G version, the 4G module is inside the box, please open the box and use below direction to install the SIM card

2. Access LG02

2.1 Access and configure LG02

The LG02 is configured as a WiFi AP by factory default. User can access and configure the LG02 after connect to its WiFi network.

At the first boot of LG02, it will auto generate an unsecure WiFi network call ***dragino-xxxxxx***

User can use the laptop to connect to this WiFi network. The laptop will get an IP address 10.130.1.xxx and the LG01 has the default IP 10.130.1.1

Open a browser in the laptop and type

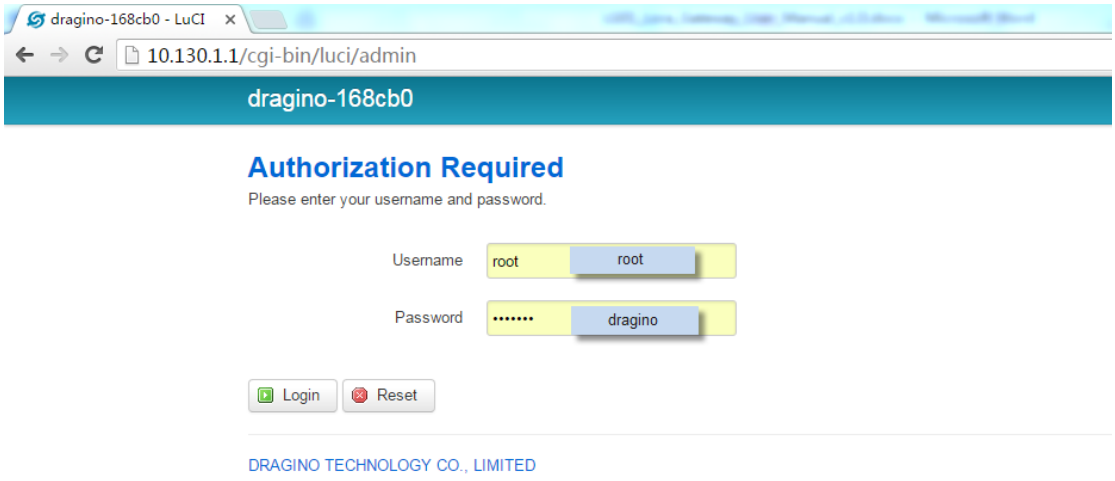
http://10.130.1.1/cgi-bin/luci/admin

User will see the login interface of LG02.

The account for Web Login is:

User Name: **root**

Password: **dragino**



Notice: In case the WiFi network is disabled, user can connect PC to LG02's LAN port, the PC will get DHCP from LG02, and be able to access it.

3. Typical Network Setup

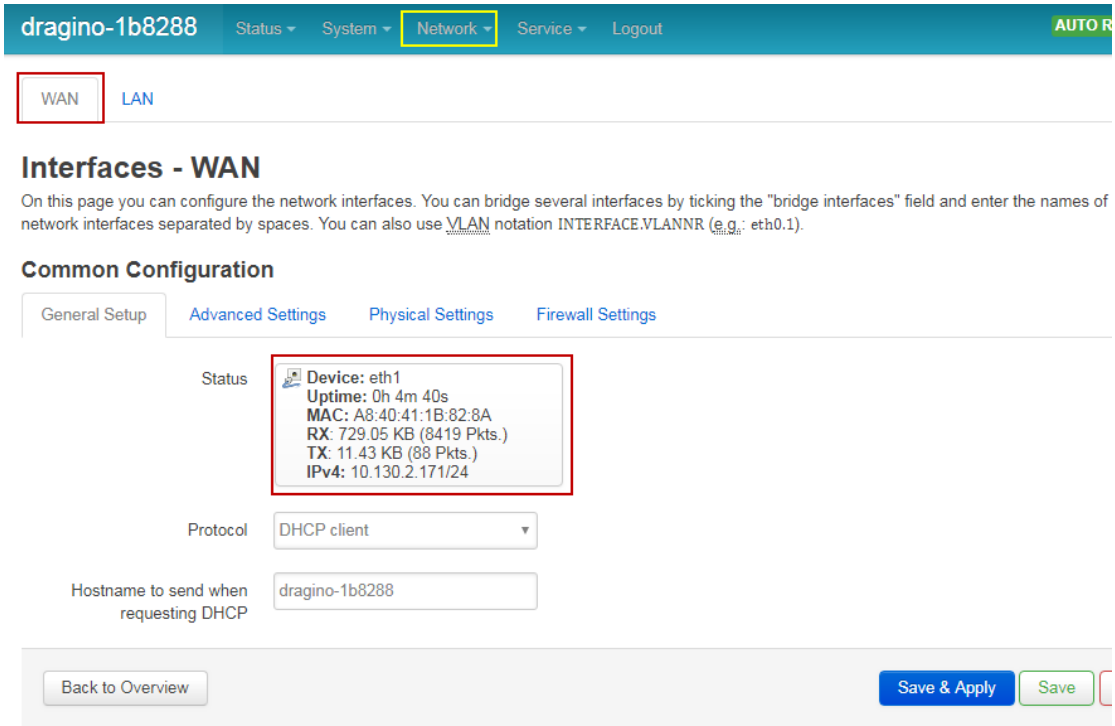
3.1 Overview

LG02 supports flexible network set up for different environment. This section describes the typical network topology can be set in LG02. The typical network set up includes:

- ✓ **WAN Port Internet Mode**
- ✓ **WiFi Client Mode**
- ✓ **WiFi AP Mode**
- ✓ **USB Dial Up Mode**

3.2 Use WAN port to access Internet

By default, the LG02 set to use WAN port as network connection. When connect LG02's WAN port to router, LG02 will get IP from router and have internet access. The network status can be checked as below:

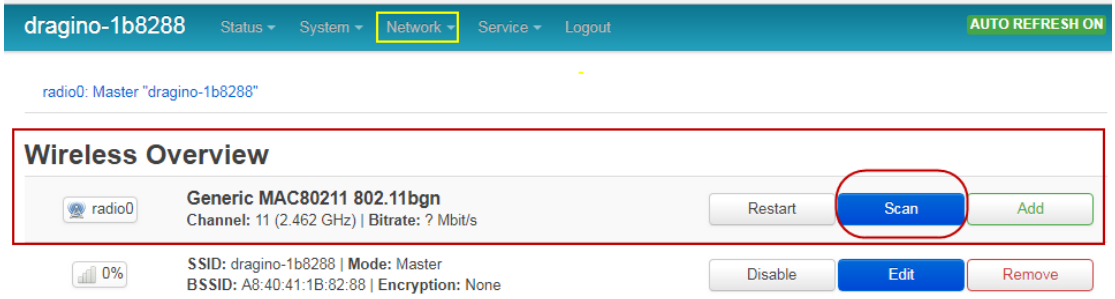


3.3 Access Internet as a WiFi Client.

In the WiFi Client Mode, Dragino acts as a WiFi client and gets DHCP from uplink router via WiFi. The step to set is as below:

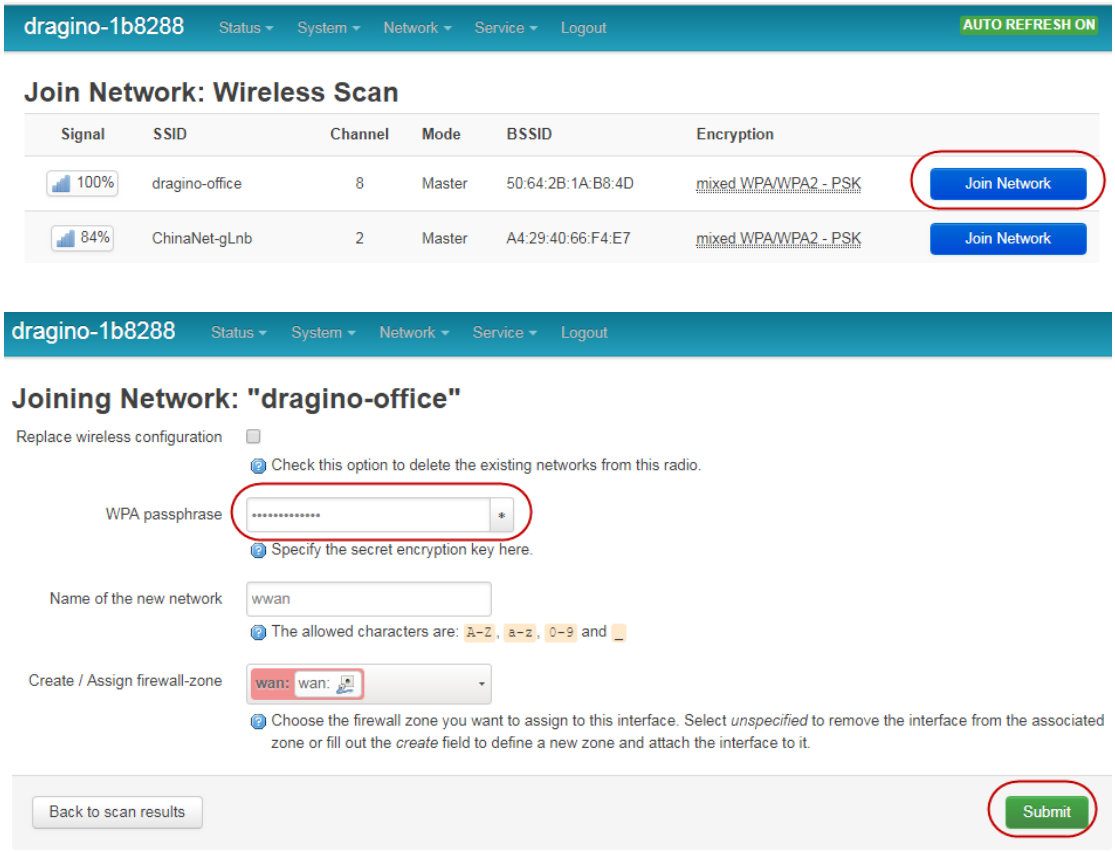
Step1:

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



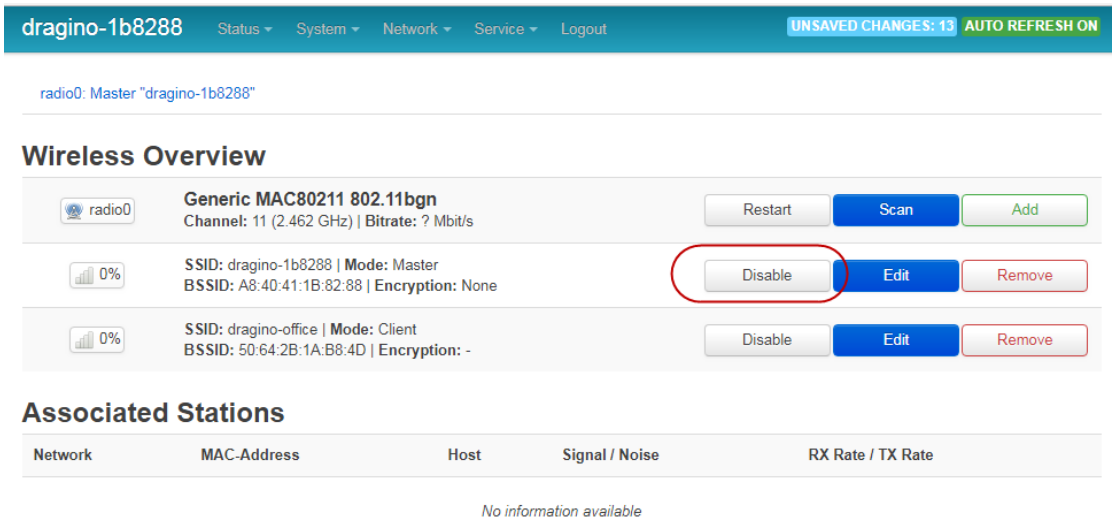
Step2:

Select the wireless AP and join:

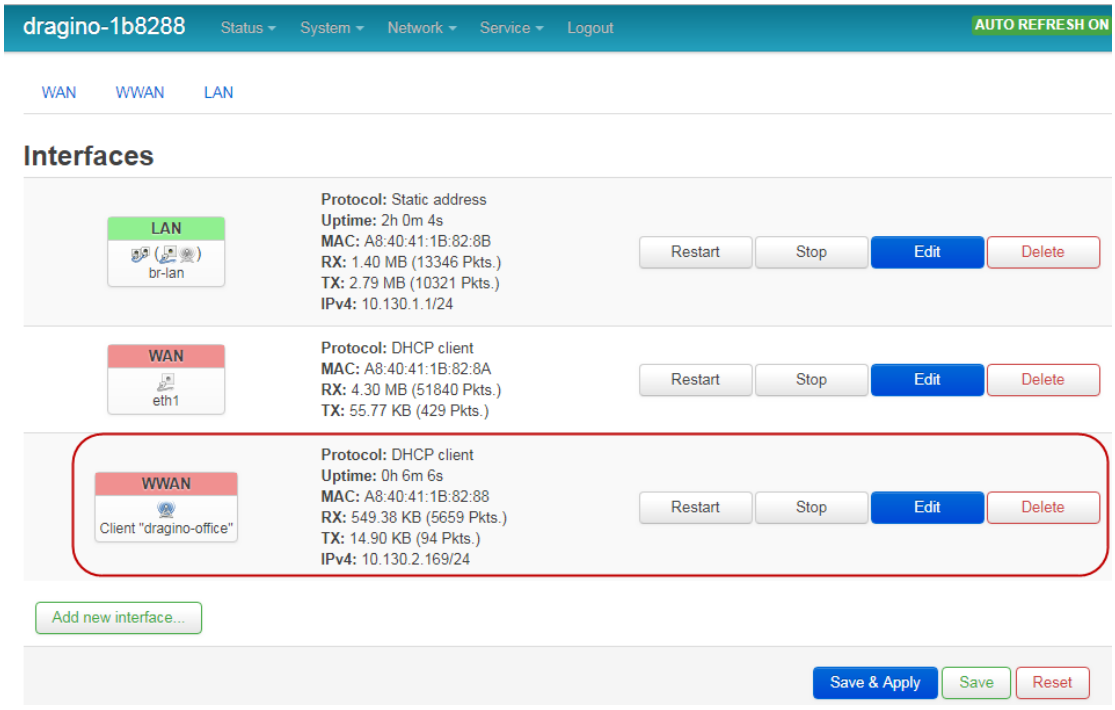


Step3:

In network->wireless page, disable WiFi AP network. Notice: After doing that, you will lose connection if your computer connect to the LG02 via LG02's wifi network.



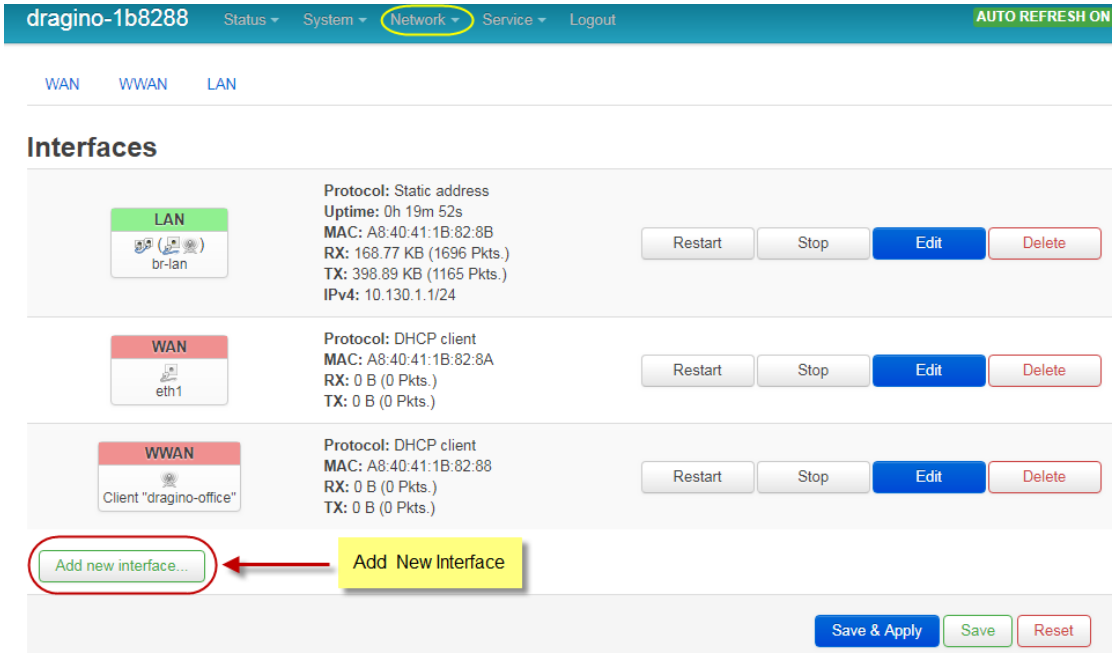
After successful associate, the WiFi network interface can be seen in the same page:

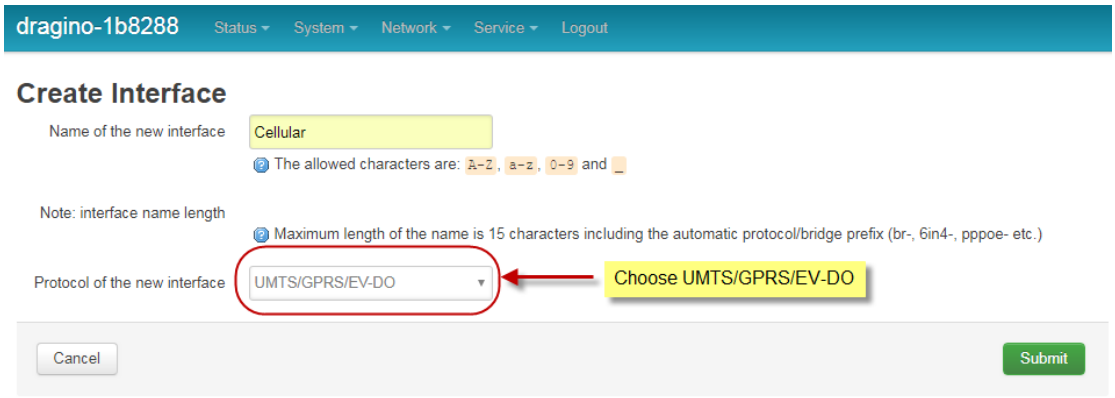


3.4 Use built-in 4G modem for internet access

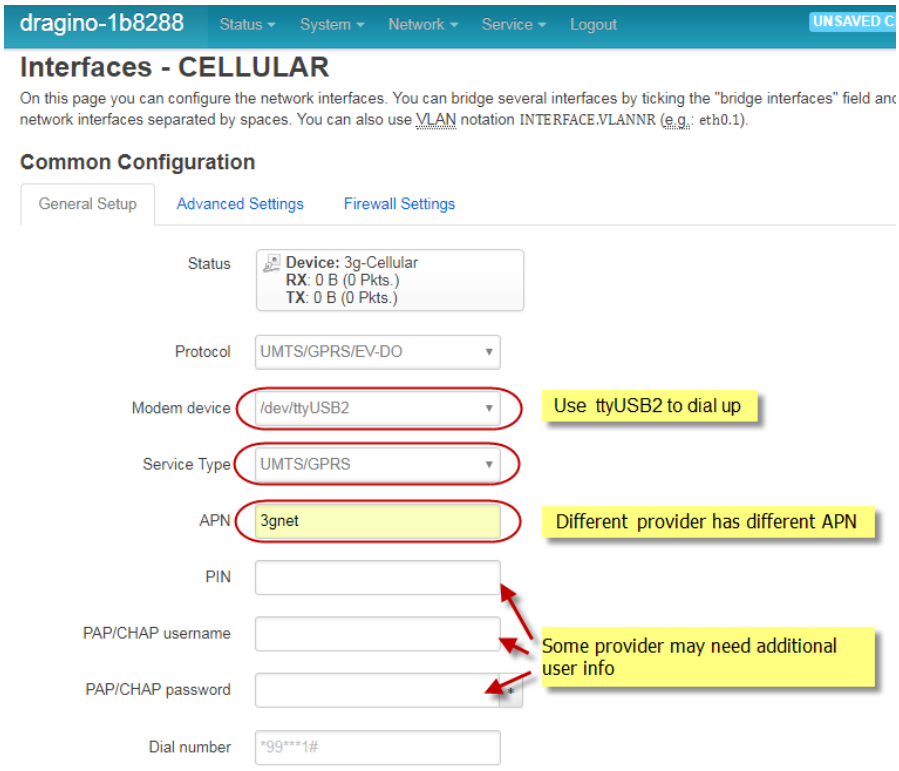
For the LG02 model with 4G version, user can configure the modem for internet access.

Step 1: Add New Interface

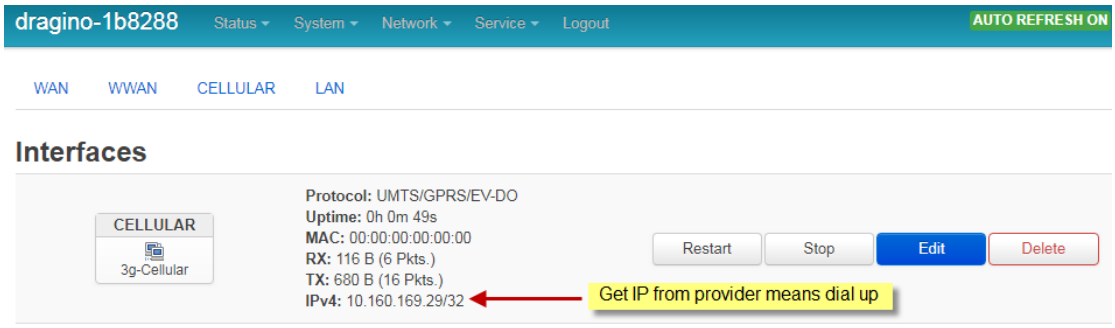




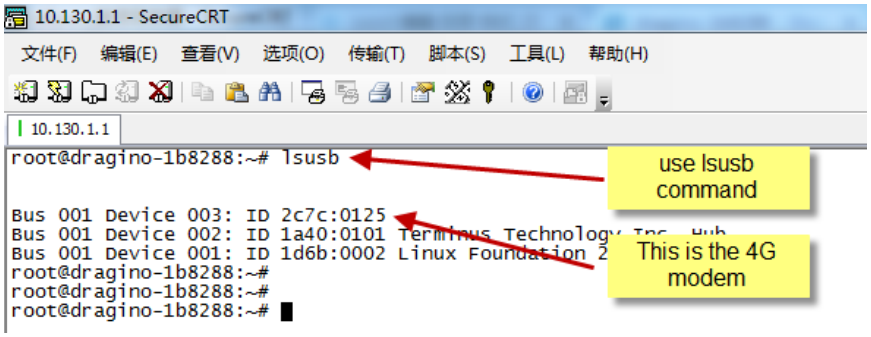
Step 2: Configure cellular interface



Step 3: Check Result

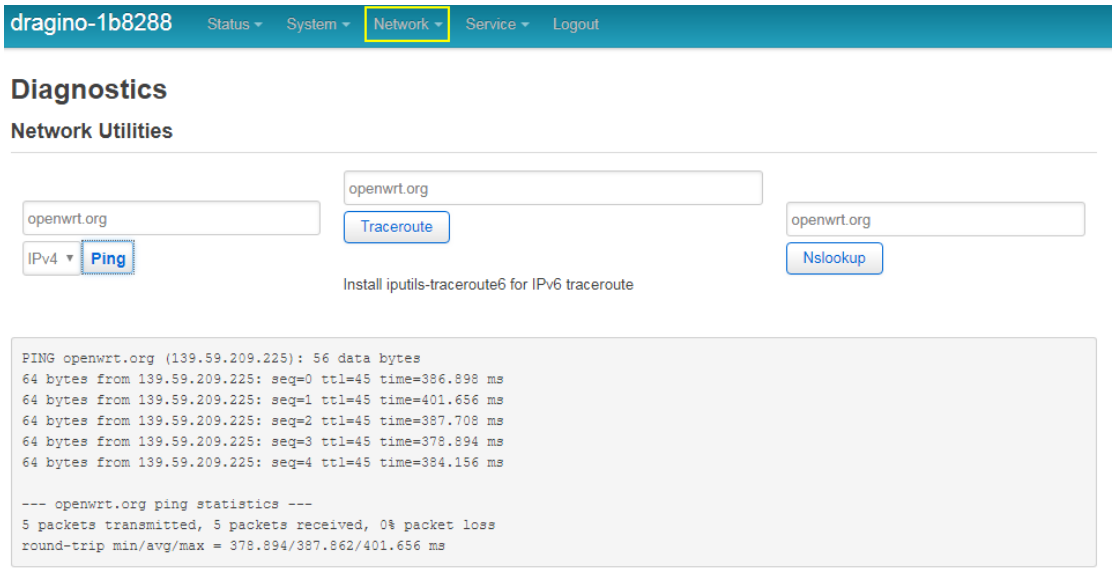


Note: In case you don't know if your device has 4G modem, you can run lsusb command in SSH access to check, as below:



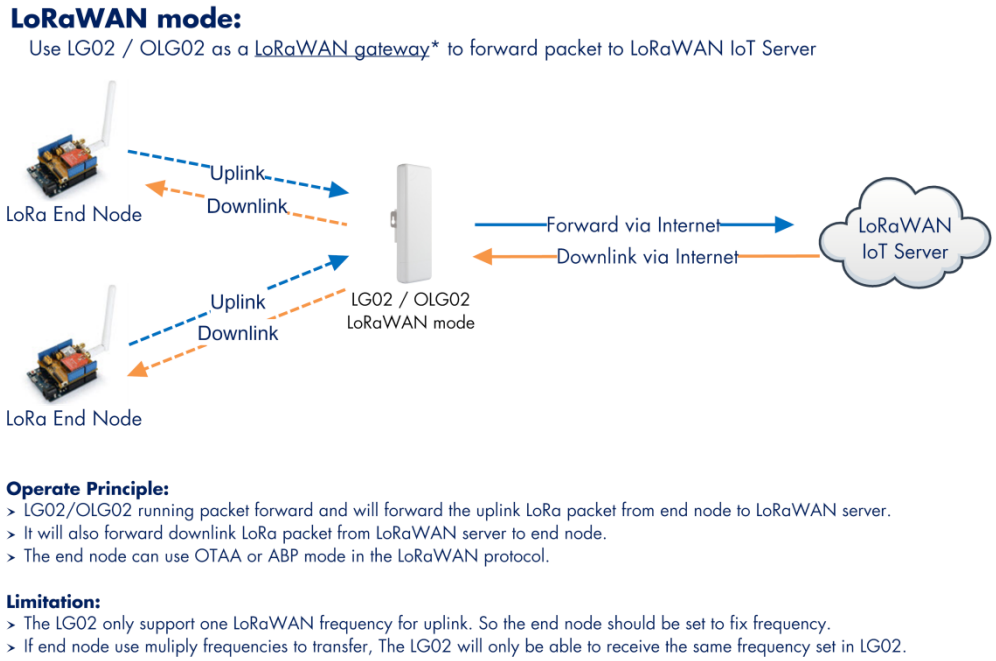
3.5 Check Internet connection

User can use the diagnostics page to check and analyze Internet connection.



4. Example 1: Configure as a LoRaWAN gateway

LG02 has two LoRa channels and can be configured as a Dual Channel LoRaWAN gateway. LG02 is pre-configured to support one uplink channel and one downlink channel in the LoRaWAN mode. This mode is works as below diagram:

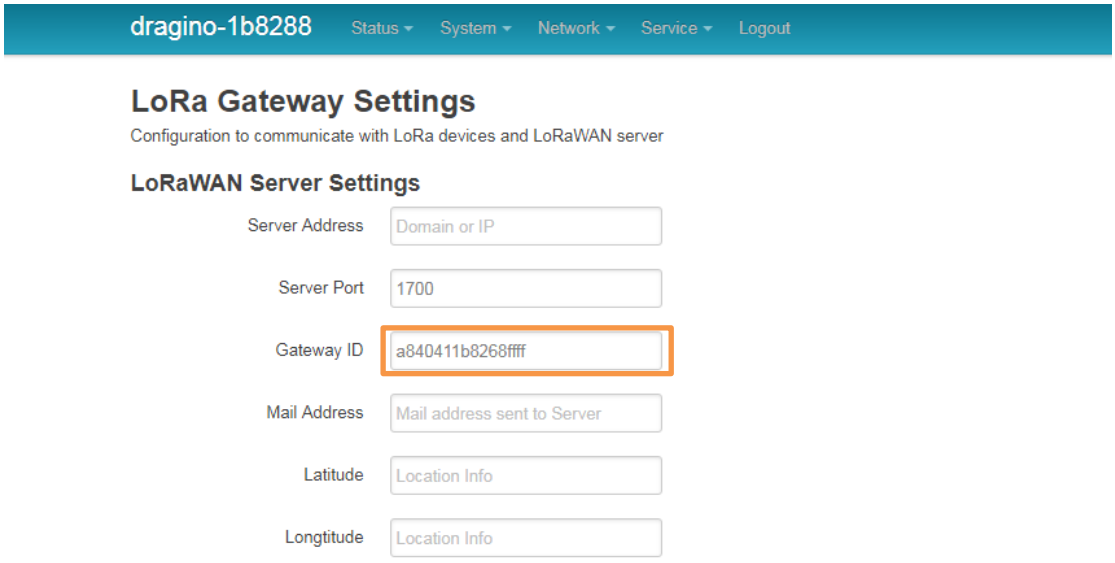


This chapter describes how to use LG02 to work with TTN LoRaWAN Server. The method to work with other LoRaWAN is similar.

4.1 Create a gateway in TTN Server

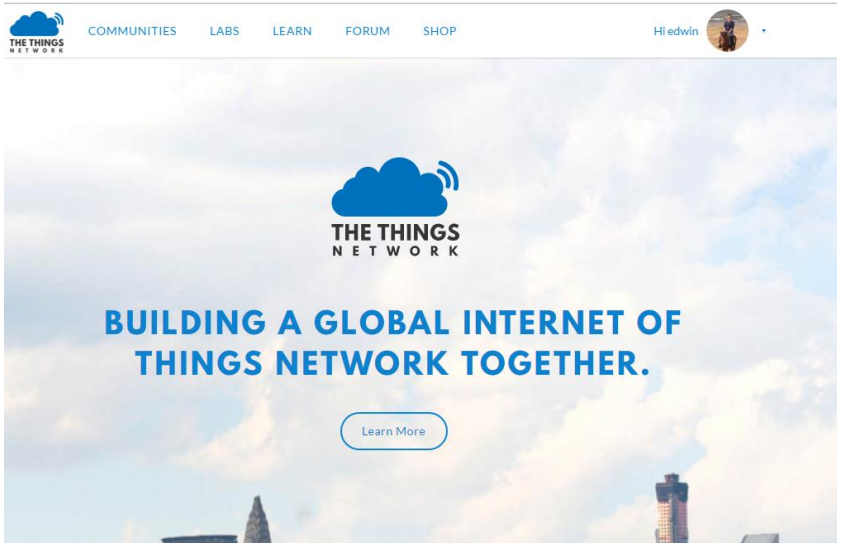
Step 1: Get a Unique gateway ID.

Every LG02 has a unique gateway id. The id can be found at LoRaWAN page:

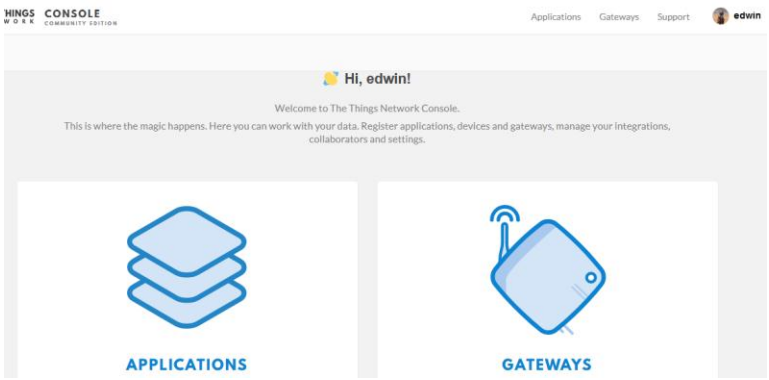


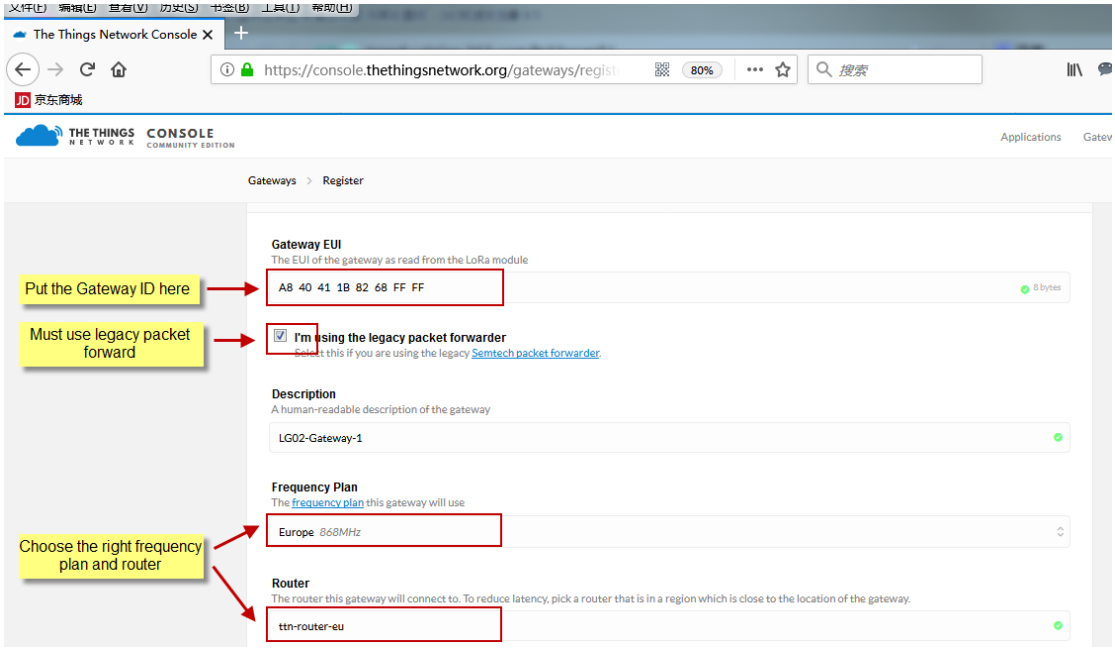
The gateway id is: **a840411b8268ffff**

Step 2: Sign up a user account in TTN server

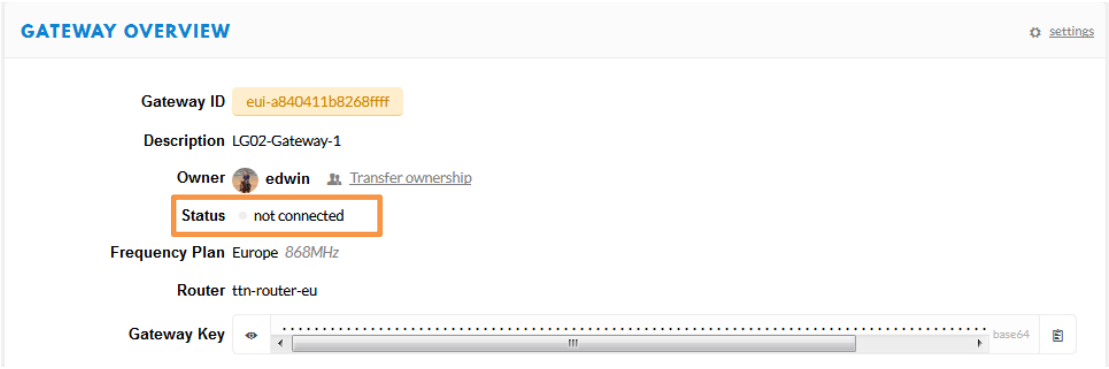


Step 3: Create a Gateway





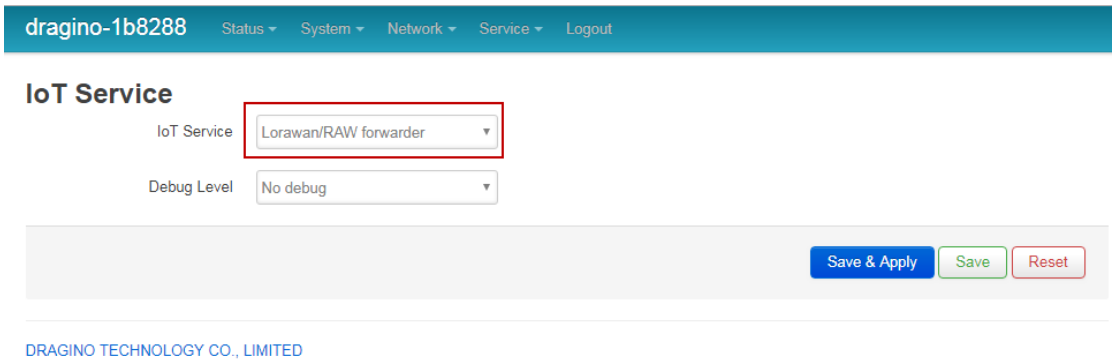
After create the gateway, we can see the gateway info, as below



4.2 Configure LG02 to connect to TTN

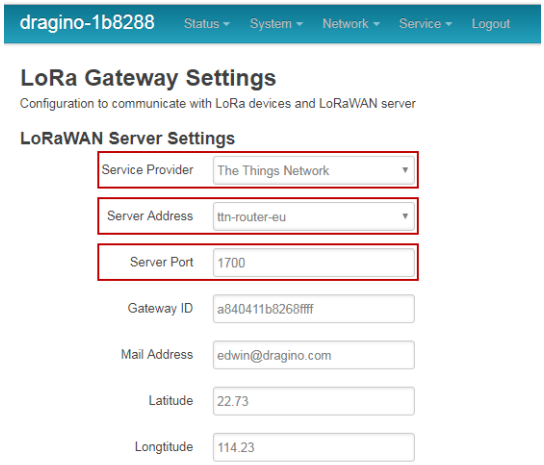
We should configure the LG02 now to let it connect to TTN network. Make sure your LG02 has Internet Connection first.

Step1: Configure LG02 to act as raw forwarder



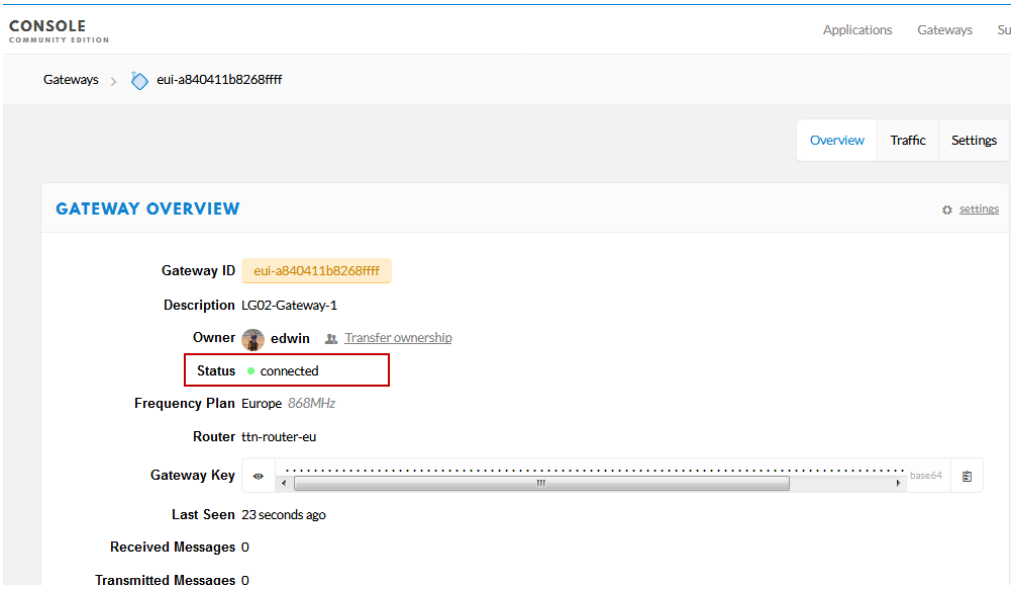
Step2: Input server info and gateway id

Choose the correct the server address and gateway ID.

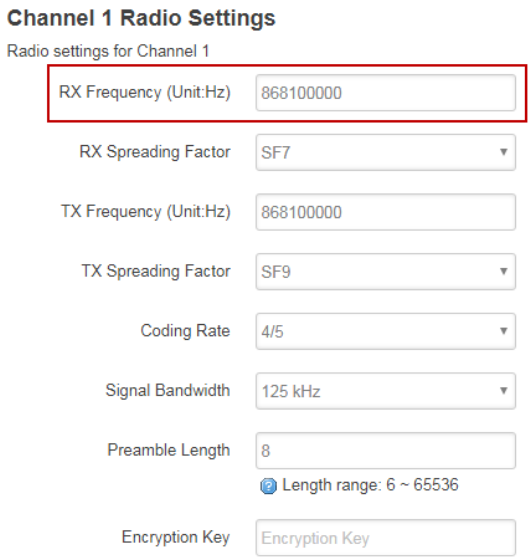


Check Result

After above settings, the LG02 should be able to connect to TTN, below is the result seen from TTN:



4.3 Configure frequency



Users only need to configure the RX Radio settings. In LoRaWAN protocol, the downlink packet will specify the downlink frequency and SF, the gateway will send out LoRa packet base on that.

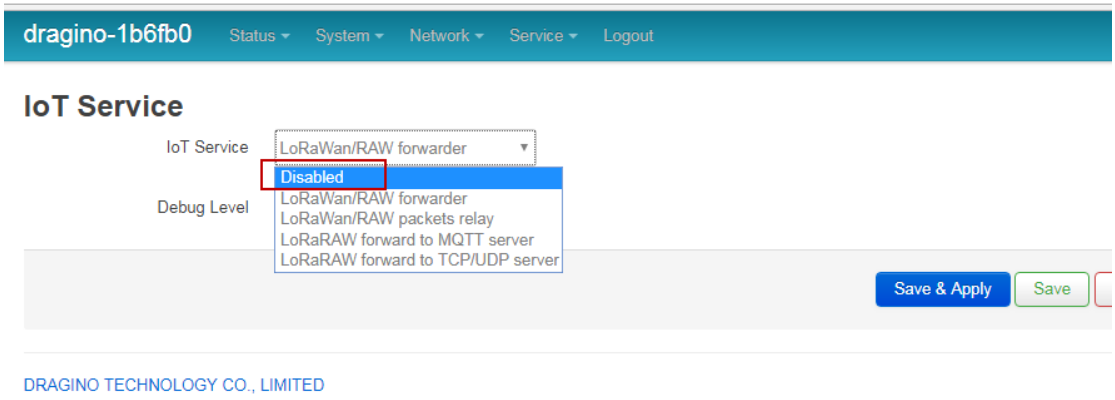
4.4 Create LoRa End Node

LG02 supports LoRaWAN End Node, in LoRaWAN protocol, it requires LoRaWAN node to send data in a hopping frequency. Since LG02 only support one single frequency, it will only able to receive the packet which is of the same Radio Frequency set up in LG02 Radio 1.

5. Example 2: Control the two radio to do transmit and receive in raw LoRa mode

Step 1: Disable All IoT service

/cgi-bin/luci/admin/gateway/iotserver



Step 2: Use lg02_single_rx_tx to transmit and receive

Usage: lg02_single_rx_tx [-d radio_dev] select radio 1 or 2 (default:1)

[-t] set as tx

[-r] set as rx

[-f frequence] (default:868500000)

[-s spreadingFactor] (default: 7)

[-b bandwidth] default: 125k

[-p payload]

[-v] show version

[-h] show this help and exit

Use Radio 1 to transmit:

```
root@dragino-1b6fb0:~# lg02_single_rx_tx -d 1 -t -f 868100000 -p hello
Radio struct: spi_dev=/dev/spidev1.0, spiport=3, freq=868100000, sf=7, bw=125000, cr=5
Setup RXRF Channel: freq = 868100000, sf = 7, spi = 3

Transmit at SF7BW125 on 868.100000.
INFO: Exiting lg02_single_rx_tx
root@dragino-1b6fb0:~#
```

Use Radio2 to receive:

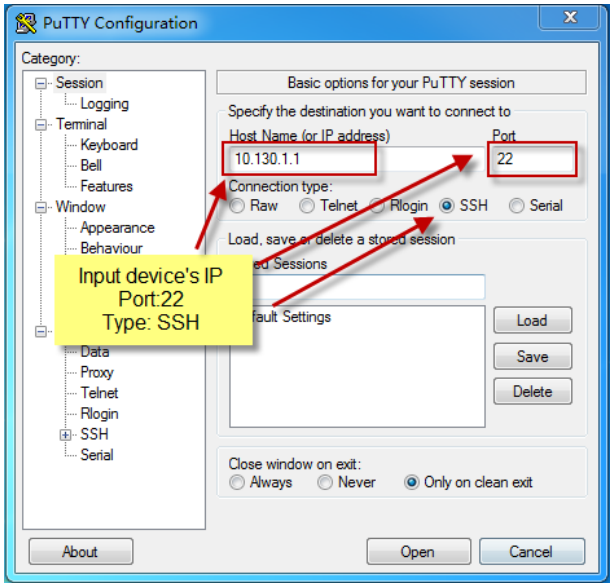
```
root@dragino-1b6fb0:~# lg02_single_rx_tx -d 2 -r -f 868100000
Radio struct: spi_dev=/dev/spidev2.0, spiport=3, freq=868100000, sf=7, bw=125000, cr=5
Spawn threads to manage fifo payload...
Setup RXRF Channel: freq = 868100000, sf = 7, spi = 3

Listening at SF7 on 868.100000 Mhz. port3

Receive(HEX):68656c6c6f

Receive(HEX):00184600f07ed5b37090785634124140a83456fc3efbd7
```

6. Linux System

The LG02 bases on OpenWrt Linux System. It is open source, and user are free to configure and modify the inside Linux settings.

6.1 SSH Access for Linux console

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



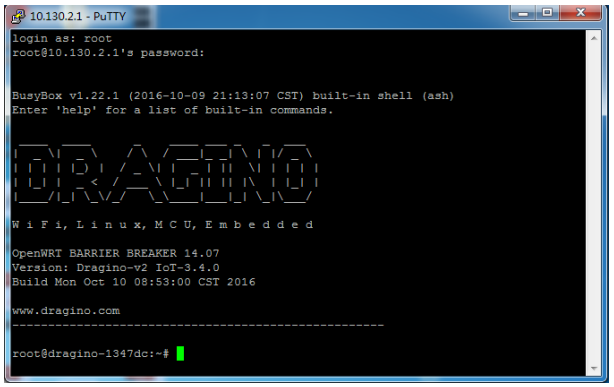
IP address: IP address of LG02

Port: 22

User Name: **root**

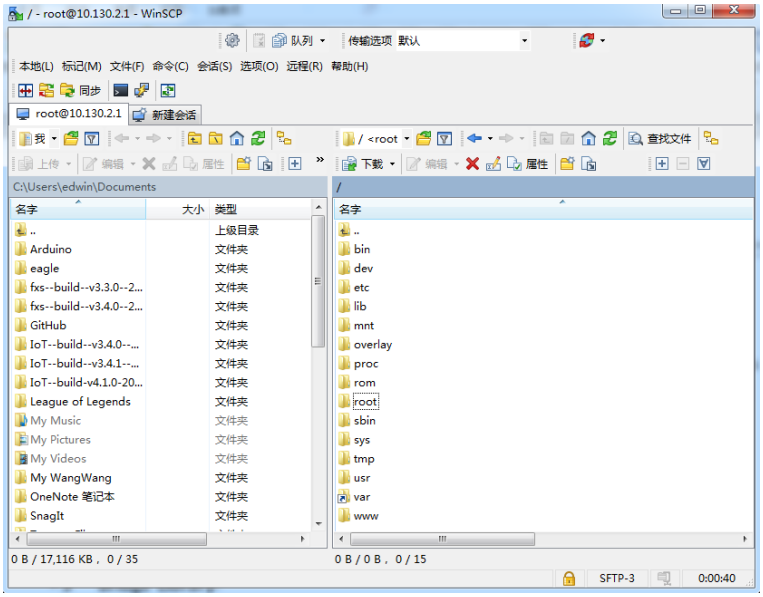
Password: **dragino** (default)

After log in, you will be in the Linux console and type command here.



6.2 Edit and Transfer files

The LG02 support **SCP protocol** and has a built **SFTP server**. There are many ways to edit and transfer files using these two protocols. One of the easiest is through WinSCP utility. After access via WinSCP to the device, use can use a FTP alike window to drag / drop files to the LG02 or Edit the files directly in the windows. Screenshot is as below:



6.3 File System

The LG02 has a 16MB flash and a 64MB RAM. The /var and /tmp directory are in the RAM, contents stored in /tmp and /var will be erased after reboot the device. Other directories are in the flash and will keep after reboot.

The Linux system use around 8MB ~10MB flash size which means there is not much room for user to store data in the LG02 flash. User can use an external USB flash to extend the size for storage.

6.4 Package maintain system

LG02 uses **OPKG package maintain system**. There are more than 3000+ packages available in our package server for user to install for their applications. For example, if user wants to add iperf tool, they can install the related packages and configure LG02 to use iperf

Below is some examples opkgs command, more please refer **OPKG package maintain system**

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, it will auto install the required packages.

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.

7. Upgrade Linux Firmware

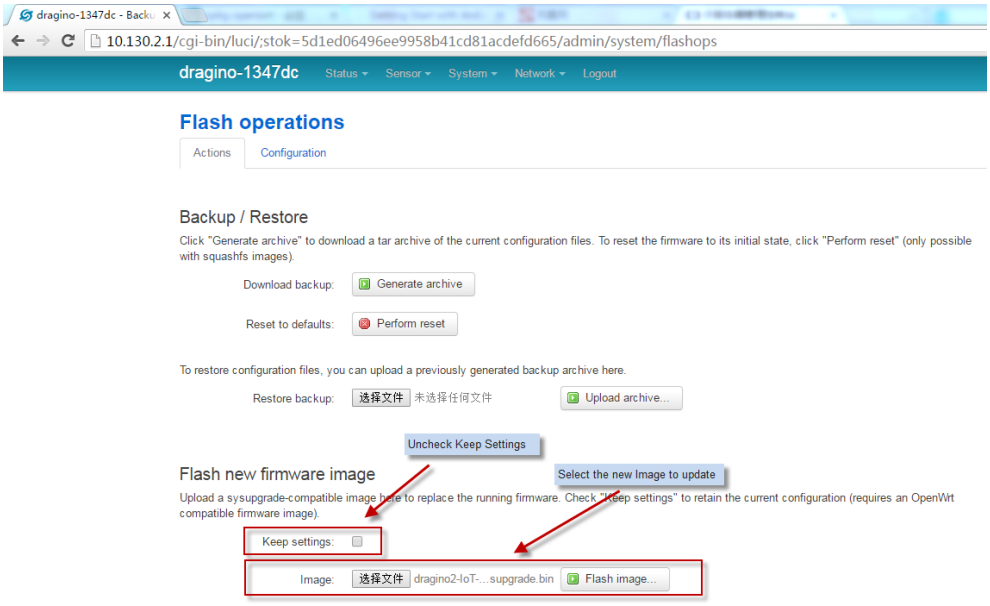
We keep improving the LG02 Linux side firmware for new features, bug fixes. The latest firmware can be found on IoT Mesh Firmware, and the Change Log can be found here: Firmware Change Log.

The file named as **dragino2-IoT--xxxxx-squashfs-sysupgrade.bin** is the upgrade Image. There are different methods to upgrade, as below:

7.1 Upgrade via Web UI

Go to the page: **Web --> System --> Back Up and flash firmware,** Select the image and click Flash Image, the image will be uploaded to the device and then click Process Update to upgrade.

System will auto boot to the new firmware after upgrade.



7.2 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 flash size.

8. FAQ

8.1 Why there is 433/868/915 version LoRa part?

Different country has different rules for the ISM band for using the LoRa. Although the LoRa chip can support a wide range of Frequency, we provide different version for best tune in the LoRa part. That is why we provide different version of LoRa.

8.2 What is the frequency range of LG02 LoRa part?

The chip used in the LoRa part is:

Version	LoRa IC	Support Frequency	Best Tune Frequency
433	Semtech SX1278	Band2(LF): 410 ~525Mhz Band3(LF): 137 ~175Mhz	433Mhz
868	Semtech SX1276	Band1(HF): 862 ~1020Mhz	868Mhz
915	Semtech SX1276	Band1(HF): 862 ~1020Mhz	915Mhz

User can set the LoRa within above frequency range in the software.

8.3 Can I make my own firmware for LG02? Where can I find the source code of LG02?

Yes, User can make own firmware for LG02 for branding purpose or add customized application.

The LG012source code and compile instruction can be found at:

https://github.com/dragino/openwrt_lede-18.06

8.4 More FAQs about general LoRa questions

We keep updating more FAQs in our WiKi about some general questions. The link is here:

http://wiki.dragino.com/index.php?title=LoRa_Questions

9. Trouble Shooting

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

In some case, when install package, it will generate kernel error such as below:

```
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, user can use the –force-depends option to install such package.

```
opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk --force-depends
```

9.2 How to recover the LG02 if firmware crash

LG012provide user a full control on its Linux system, it is possible that the device will brick and can't boot after improper modification in some booting files.

In this case, user can recover the whole Linux system by uploading a new firmware via Web Failsafe mode.

Procedure is as below:

- Use a RJ45 cable to connect the PC to LG02's port directly.
- Set the PC to ip 192.168.255.x, netmask 255.255.255.0
- Pressing 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 device detect a network connection and enter into the web-failsafe mode. Your PC should be able to ping 192.168.255.1 after device enter this mode.
- Open 192.168.255.1 in web broswer
- Select a squashfs-sysupgrade type firmware and update firmware.

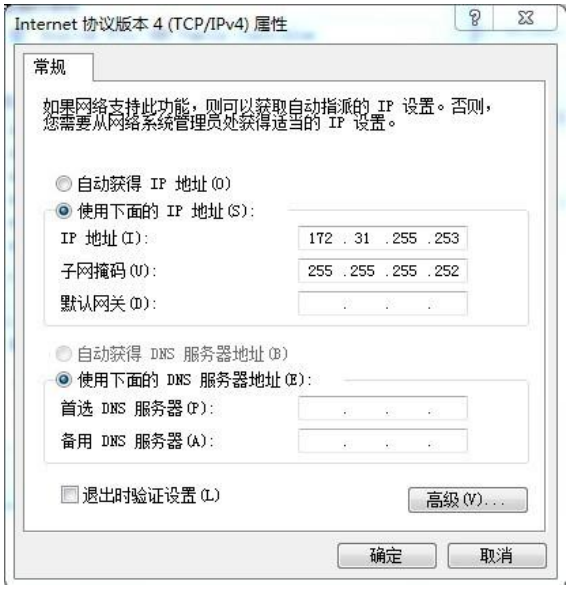
9.3 I configured LG02 for WiFi access and lost its IP. What to do now?

The LG01 has a fall-back ip in its LAN port. This IP is always enabled so user can use fall back ip to access LG01 no matter what the WiFi IP is. The fall back ip is useful for connect and debug the unit.

(Note: fallback ip can be disabled in the LAN and DHCP page)

Steps to connect via fall back IP:

1. Connect PC's Ethernet port to LG01's LAN port
2. Configure PC's Ethernet port has IP: 172.31.255.253 and netmask: 255.255.255.252
   As below photo:



3. In PC, use 172.31.255.254 to access LG01 via Web or Console.

10. Order Info

General Version:

- **LG02-433**: LoRa Gateway best tune to 433 MHz.
- **LG02-868**: LoRa Gateway best tuned to 868 MHz.
- **LG02-915**: LoRa Gateway best tuned to 915 MHz
- **G01S-915**: LoRa Gateway best tuned to 915 MHz.

Outdoor Version:

- **OLG02-433**: LoRa Gateway best tune to 433 MHz.
- **OLG02-868**: LoRa Gateway best tuned to 868 MHz.
- **OLG02-915**: LoRa Gateway best tuned to 915 MHz.

11. Packing Info

Package Includes:

- ✓ LG02 or OLG02 LoRa Gateway x 1
- ✓ Stick Antenna for LoRa RF part. Frequency is one of 433 or 868 or 915Mhz depends the model ordered
- ✓ Power Adapter: EU/AU/US type power adapter depends on country to be used
- ✓ Packaging with environmental protection paper box

Dimension and weight:

- ✓ Device Size: 12 x 8.5 x 3 cm
- ✓ Device Weight: 150g
- ✓ Package Size / pcs : 21.5 x 10 x 5 cm
- ✓ Weight / pcs : 360g
- ✓ Carton dimension: 45 x 31 x 34 cm. 36pcs per carton
- ✓ Weight / carton : 12.5 kg

12. 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

13. Reference

- Source code for LG01 LoRa Gateway
  https://github.com/dragino/openwrt_lede-18.06

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