DLOS8 Outdoor LoRaWAN Gateway User Manual

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1.0	Release	2020-Jun-14

Table of Contents

1 Introduction 5

1.1 What is the DLOS8 5

1.2 Specifications 6

1.3 Features 7

1.4 Hardware System Structure 8

1.5 DLOS8 Applications 9

1.6 LED Indicators 9

2 Access and Configure DLOS8 10

2.1 Find IP address of DLOS8 10

2.1.1 Connect via WiFi 10

2.1.2 Connect via Ethernet with DHCP IP from router 11

2.1.3 Connect via WiFi with DHCP IP from router 11

2.1.4 Connect via Ethernet with fall back ip 11

2.2 Access Configure Web UI 12

3 Typical Network Setup 13

3.1 Overview 13

3.2 Use WAN port to access Internet 13

3.3 Access the Internet as a WiFi Client 14

3.4 Access the Internet via Cellular 14

3.5 Check Internet connection 15

4 Example: Configure as a LoRaWAN gateway 16

4.1 Create a gateway in TTN Server 17

4.2 Configure DLOS8 to connect to TTN 19

4.3 Configure frequency 21

4.4 Add a LoRaWAN End Device 22

5 Web Configure Pages 25

5.1 Home 25

5.2 LoRa Settings 26

5.2.1 LoRa --> LoRa 26

5.2.2 LoRa --> ABP Decryption 27

5.3 LoRaWAN Settings *28*
5.3.1 LoRaWAN --> LoRaWAN 28
5.3.2 LoRaWAN --> LORIOT 28
5.4 MQTT Settings *29*
5.5 System *29*
5.5.1 System --> System Overview 29
5.5.2 System --> General (login settings) 30
5.5.3 System --> Network 31
5.5.4 System --> WiFi 32
5.5.5 System --> Cellular 32
5.5.6 System --> Network Status 33
5.5.7 System --> Remote Mgnt 33
5.5.8 System --> Firmware Upgrade 34
5.5.9 System --> Reboot/Reset 35
5.5.10 System --> Package Maintain 36
5.6 LogRead *37*
5.6.1 LogRead --> LoRa Log 37
5.6.2 LogRead --> System Log 37
6 More features 38
6.1 More instructions *38*
7 Linux System 39
7.1 SSH Access for Linux console *39*
7.2 Edit and Transfer files *40*
7.3 File System *40*
7.4 Package maintenance system *41*
8 Upgrade Linux Firmware 42
9 FAQ 43
9.1 How can I configure for a customized frequency band? *43*
9.2 Can I connect DLOS8 to LORIOT? *43*
9.3 Can I make my own firmware for the gateway, where can I find the source code? *43*
9.4 Can I use 868Mhz version for 915Mhz bands? *43*
10 Trouble Shooting 44
10.1 I get kernel error when install new package, how to fix? *44*
10.2 How to recover the DLOS8 if the firmware crashes *44*

10.3 I configured DLOS8 for WiFi access and lost its IP. What to do now? 45

11 Order Info 46

12 Packing Info 47

13 Support 47

1 Introduction

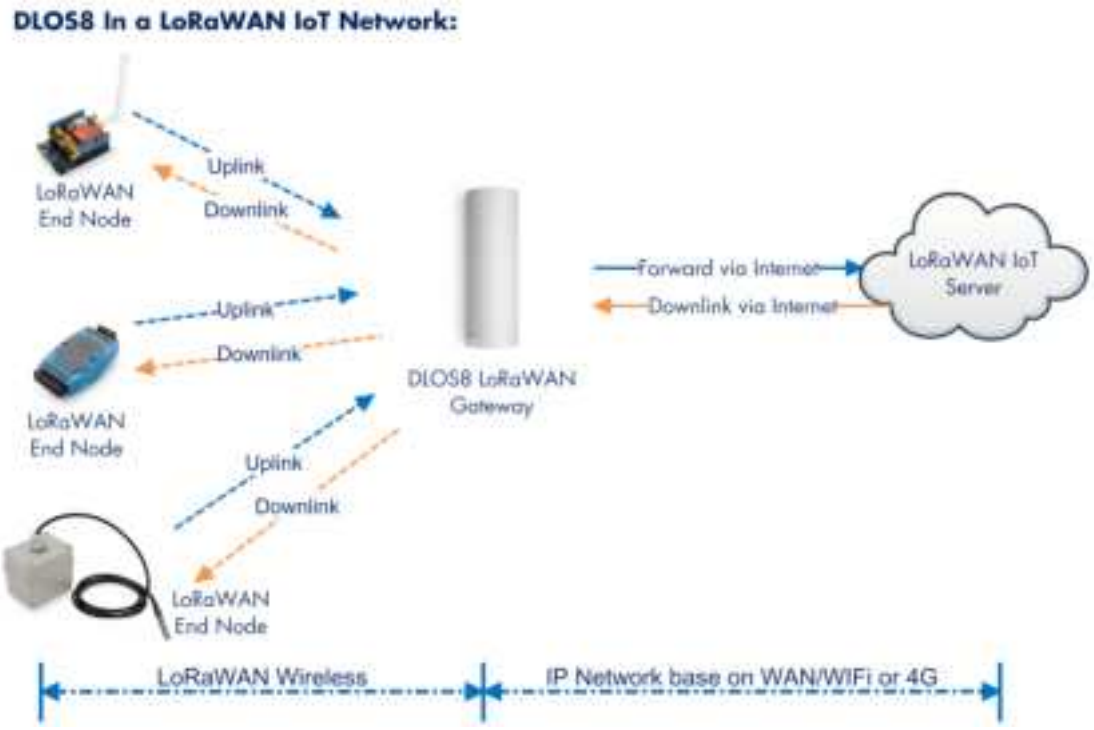
1.1 What is the DLOS8

The DLOS8 is an **open source outdoor** LoRaWAN 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.

The DLOS8 uses Semtech packet forwarder and fully compatible with LoRaWAN protocol. It includes a **SX1301 LoRaWAN concentrator**, which provide 10 programmable parallel demodulation paths.

DLOS8 has pre-configured standard LoRaWAN frequency bands to use for different countries. User can also customized the frequency bands to use in their own LoRaWAN network.

DLOS8 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.



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
- LoRaWAN Wireless
- Power Input: 12 ~ 24 V DC, 1 A
- IEEE 802.3 af compliant PoE port (DC 37 ~ 57 v)
- USB 2.0 host connector x 1
- Mini-PCI E connector x 1
- SX1301 + 2 x SX1257

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

Cellular 4G LTE (optional):

- Quectel **EC25 LTE module**
- Standard Size SIM Slot

- 2 x 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

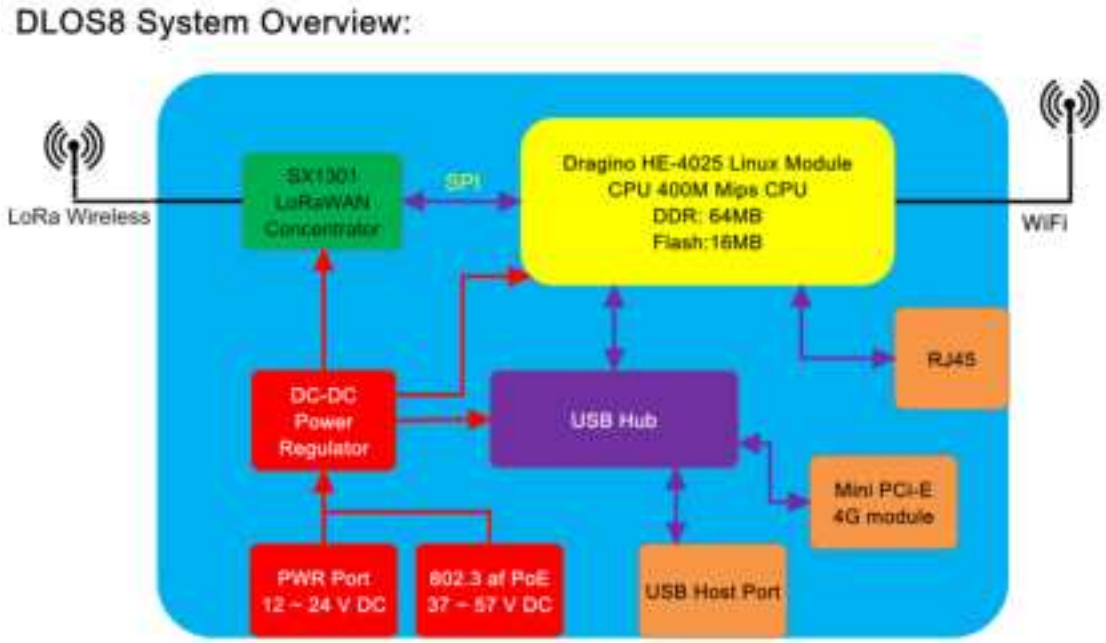
Power over Ethernet:

- IEEE 802.3af compliant.
- Support wide input voltage range 37Vdc to 57Vdc.
- Thermal cut off.
- Short circuit protection.
- Over current protection
- Isolation level 4 KVrms.
- Enhanced surge protection

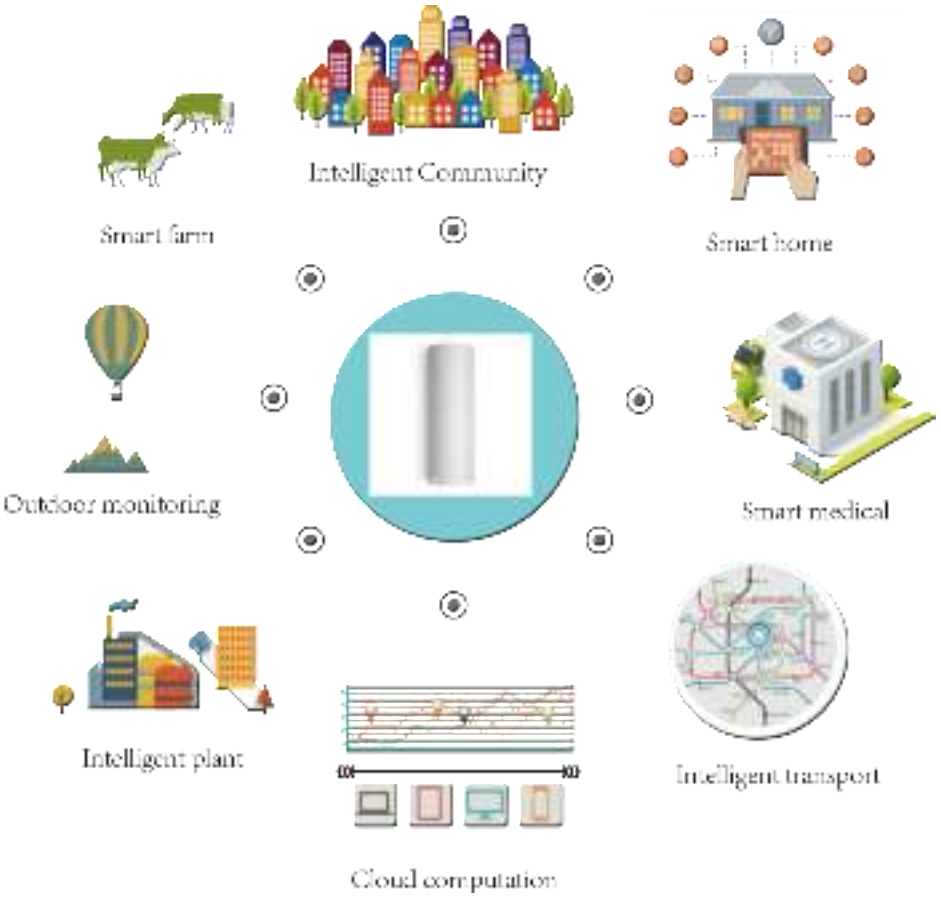
1.3 Features

- ✓ Open Source OpenWrt system
- ✓ Managed by Web GUI, SSH via LAN or WiFi
- ✓ Emulates 49x LoRa demodulators
- ✓ Outdoor LoRaWAN Gateway
- ✓ 10 programmable parallel demodulation paths
- ✓ LoRaWAN packet filtering
- ✓ Far seeing LED indicator
- ✓ Built-in GPS module for location & timing
- ✓ External fiber glass antenna
- ✓ 802.3af PoE
- ✓ IP65
- ✓ Lighting Protection
- ✓ Power Consumption:12v 300 ~500mA

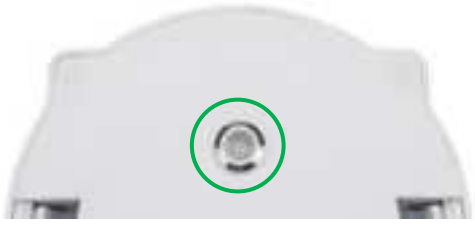
1.4 Hardware System Structure



1.5 DLOS8 Applications



1.6 LED Indicators



There is a waterproof triple color LED on DLOS8 enclosure, the meaning of the LED is:

- ✓ **SOLID GREEN**: DLOS8 is alive with LoRaWAN server connection.
- ✓ **BLINKING GREEN**: a) Device has internet connection but no LoRaWAN Connection. or b) Device is in booting stage, in this stage, it will **BLINKING GREEN** for several seconds and then **RED** and **YELLOW** will blink together.
- ✓ **SOLID RED**: Device doesn't have Internet connection.

2 Access and Configure DLOS8

The DLOS8 is configured as a WiFi Access Point by default. User can access and configure the DLOS8 after connecting to its WiFi network, or via its Ethernet port.

2.1 Find IP address of DLOS8

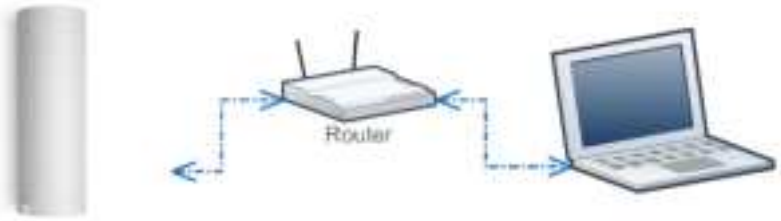
2.1.1 Connect via WiFi

At the first boot of DLOS8, it will auto generate a WiFi network called ***dragino-xxxxxx*** with password:

dragino+dragino

User can use a PC to connect to this WiFi network. The PC will get an IP address 10.130.1.xxx and the DLOS8 has the default IP 10.130.1.1

2.1.2 Connect via Ethernet with DHCP IP from router



Alternatively, connect the DLOS8 Ethernet port to your router and DLOS8 will 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 DLOS8. You can also use this IP to connect.

2.1.3 Connect via WiFi with DHCP IP from router

If the DLOS8 already connect to the router via WiFi, use can use the WiFi IP to connect to DLOS8.

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 the DLOS8 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

You will see the login interface of DLOS8 as shown below.

The account details for Web Login are:

User Name: root

Password: dragino

3 Typical Network Setup

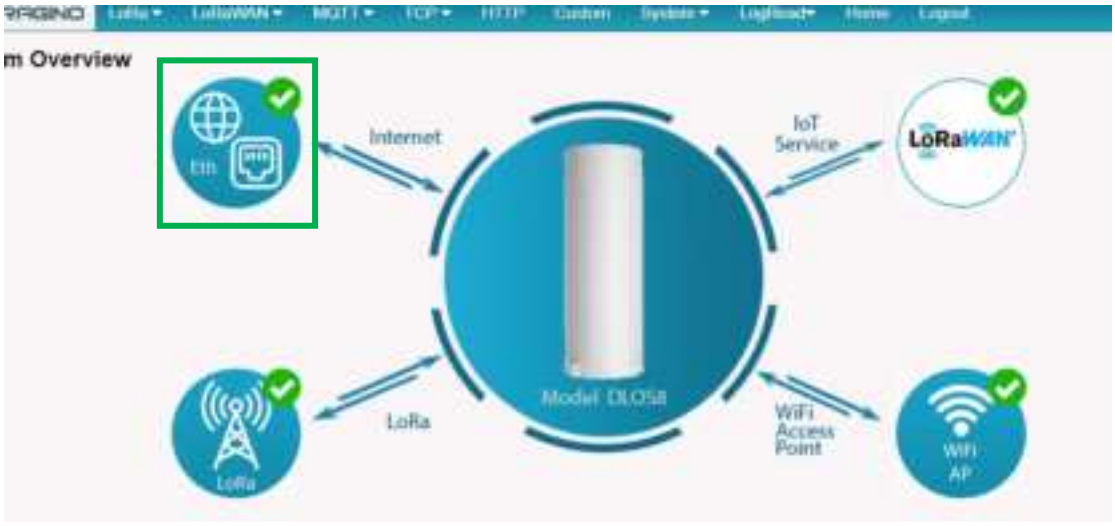
3.1 Overview

The DLOS8 supports flexible network set up for different environments. This section describes the typical network topology. The network set up includes:

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

3.2 Use WAN port to access Internet

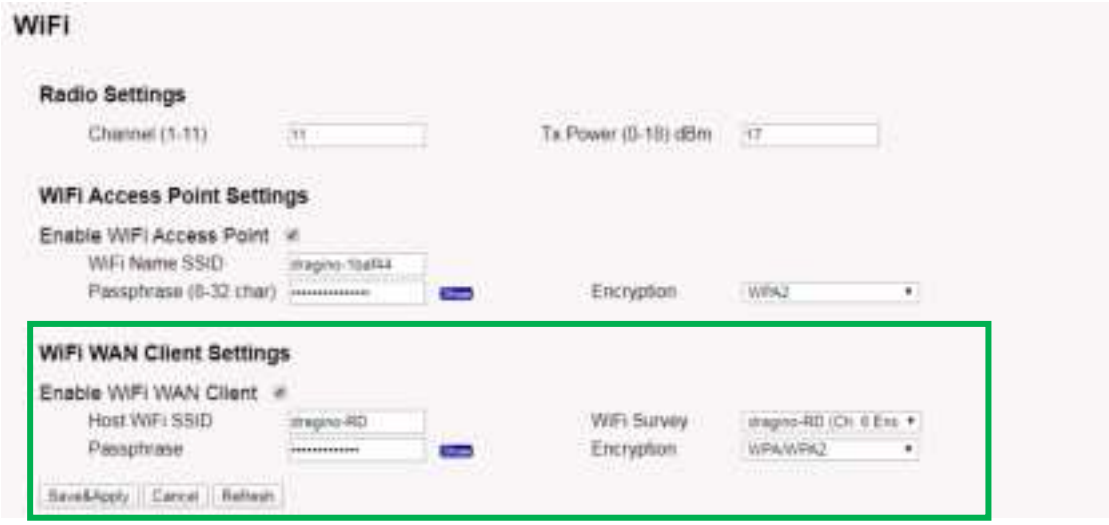
By default, the DLOS8 is set to use the WAN port to connect to an upstream network. When you connect the DLOS8's WAN port to an upstream router, DLOS8 will get an IP address from the router and have Internet access via the upstream router. The network status can be checked in the **home page**:



3.3 Access the Internet as a WiFi Client.

In the WiFi Client Mode, DLOS8 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**

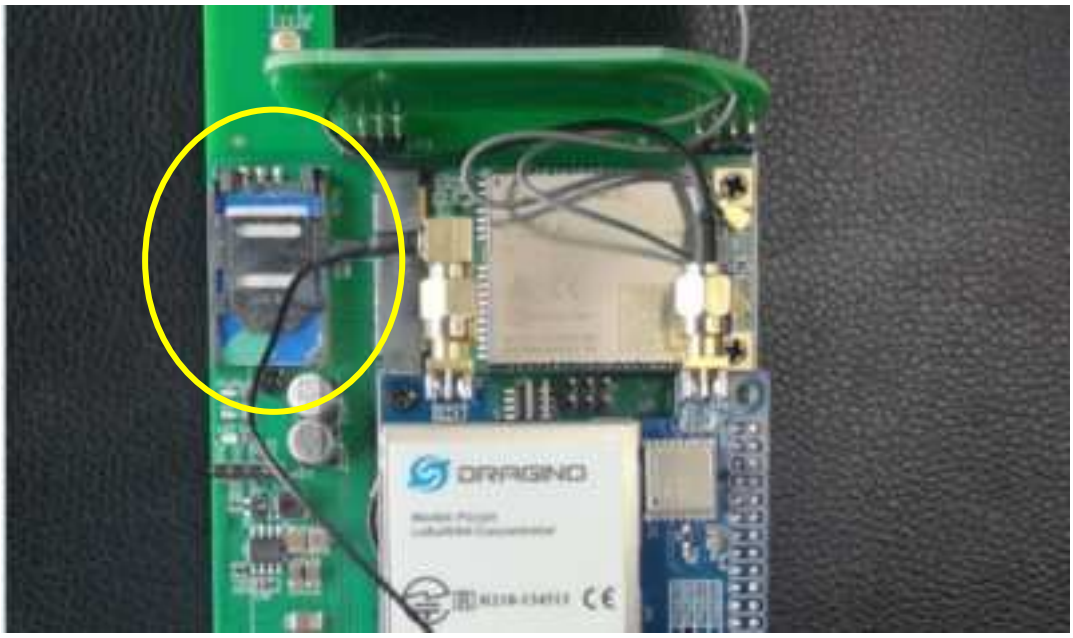


In the WiFi Survey Choose the WiFi AP, and input the Passphrase then click Save & Apply to connect.

3.4 Access the Internet via Cellular

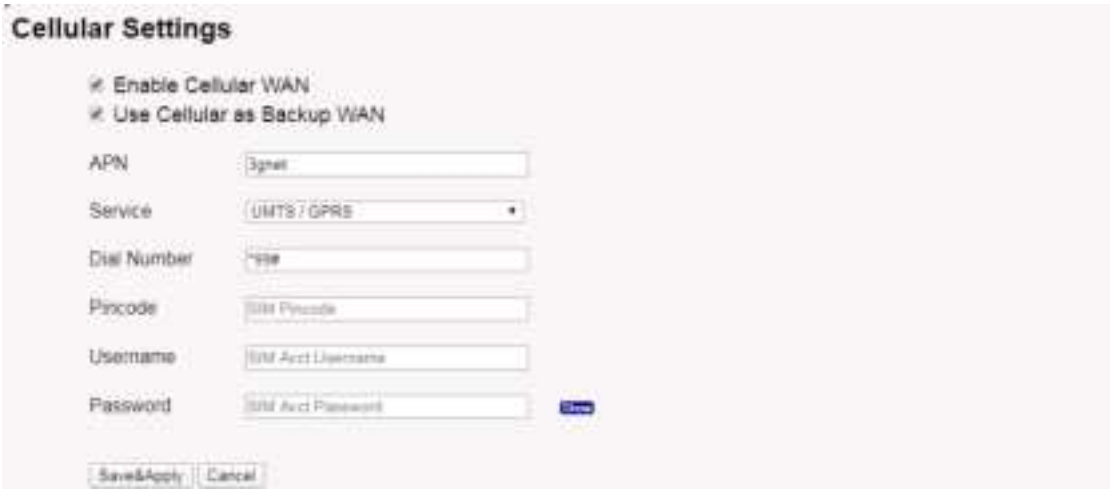
If the DLOS8 support 3G/4G Cellular modem option, user can use it as main internet connection or back up.

First, install the SIM card as below:



The set up page is **System → Cellular**

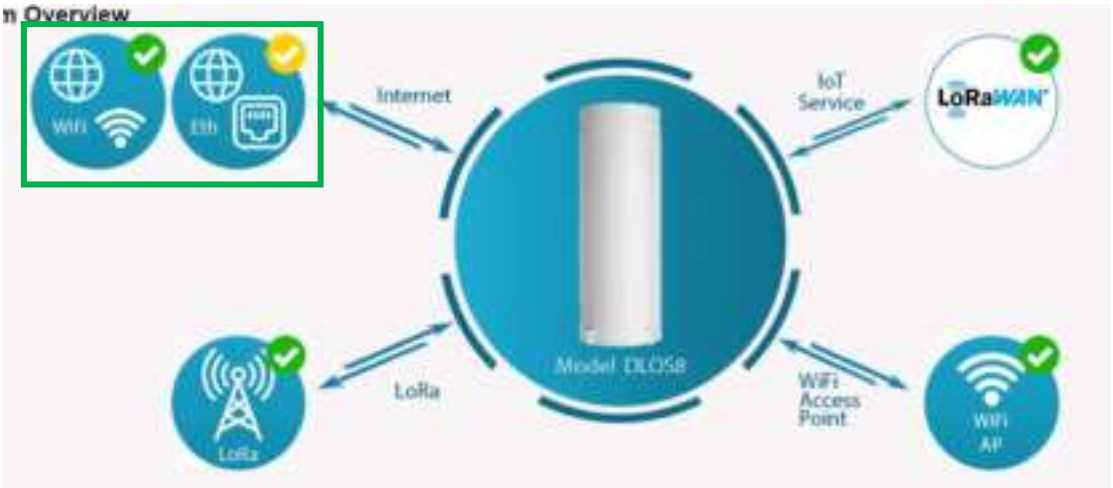
While use the cellular as Backup WAN, device will use Cellular for internet connection while WAN port or WiFi is not valid and switch back to WAN port or WiFi after they recover.



3.5 Check Internet connection

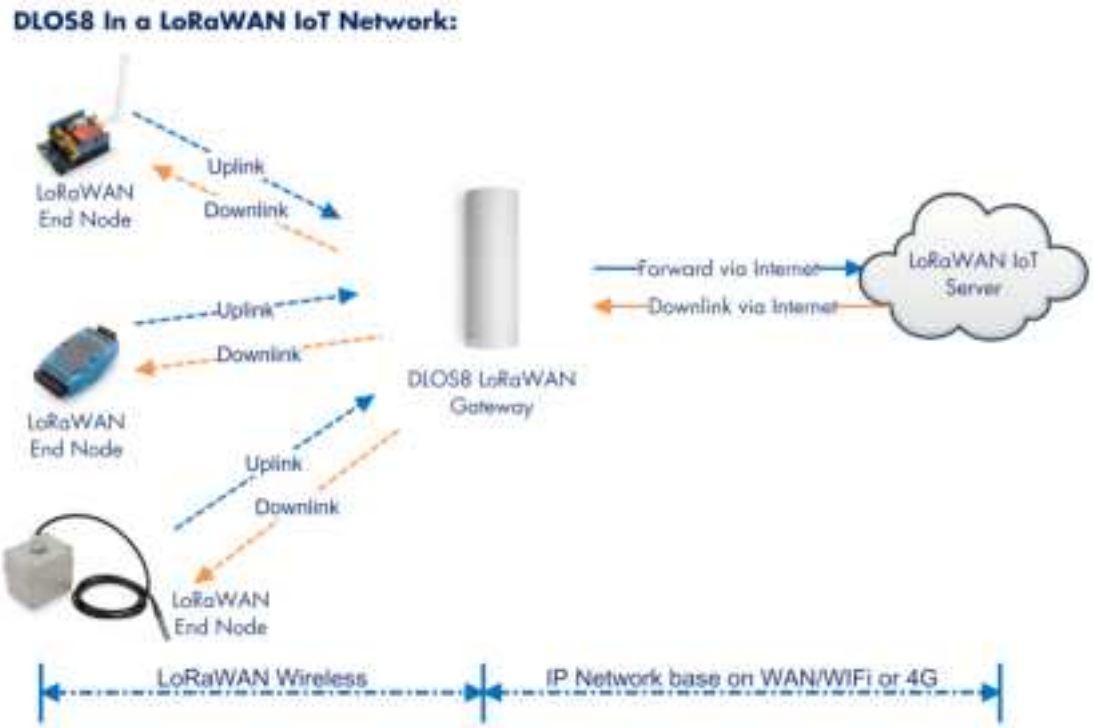
In the **Home** page, we can check the Internet connection.

- 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

DLOS8 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.

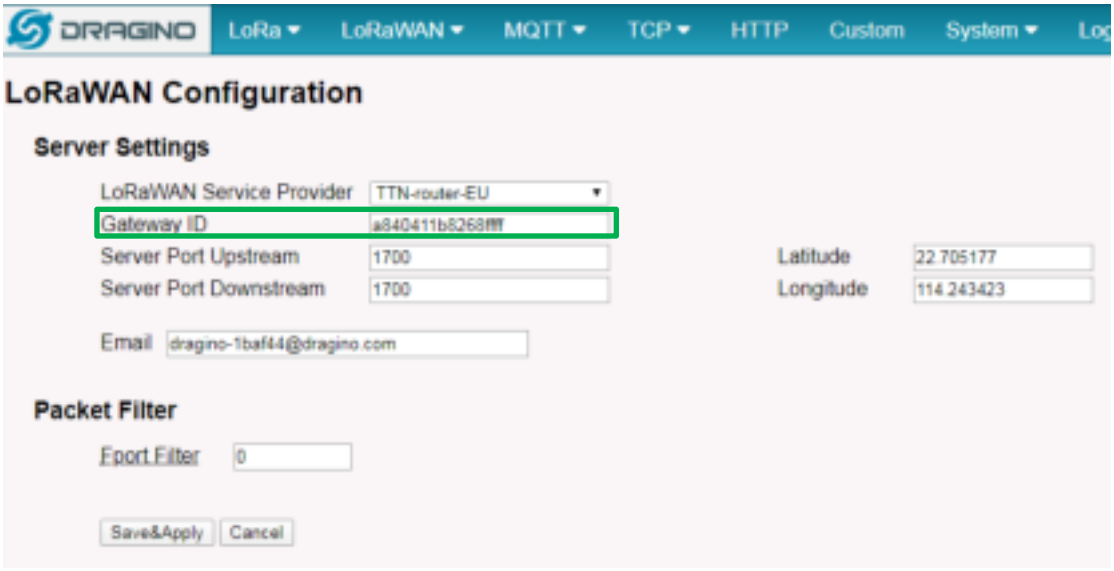


This chapter describes how to use the DLOS8 to work with TheThingsNetwork (TTN) LoRaWAN Server (www.thethingsnetwork.org)

4.1 Create a gateway in TTN Server

Step 1: Get a Unique gateway ID.

Every DLOS8 has a unique gateway id. The ID can be found at LoRaWAN page:

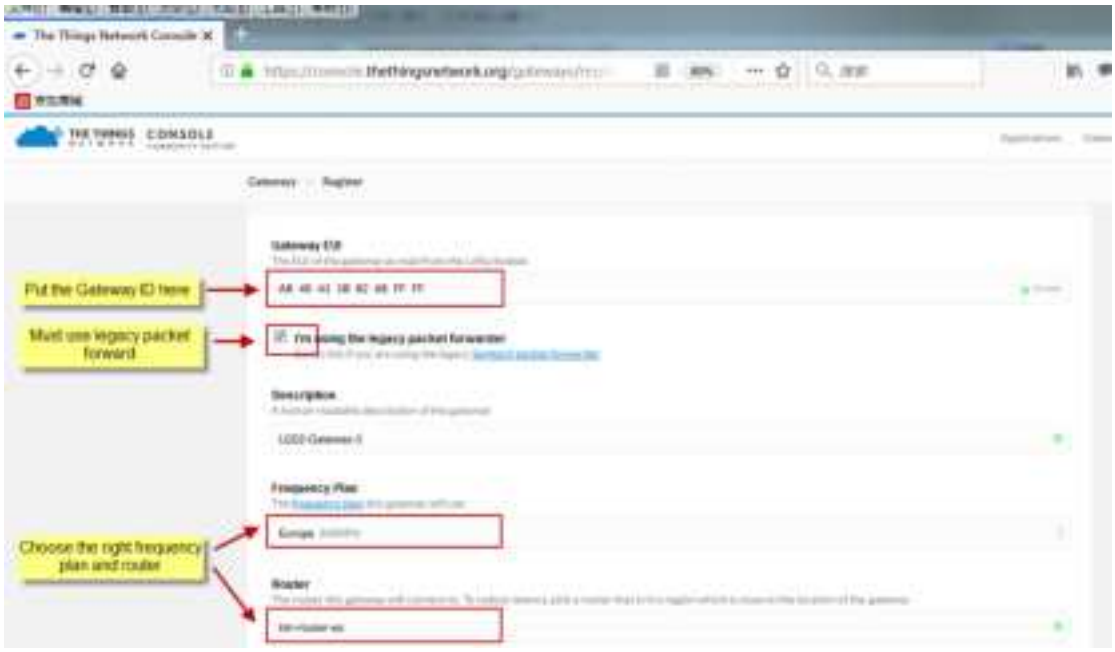


The example gateway id is: **a840411b8268ffff**

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:



Notice: The TTN router should match the Frequency Plan you choose, otherwise you will have problem for End Node to join the network. If you don't know which router you need to select, please check: https://www.thethingsnetwork.org/docs/gateways/packet-forwarder/semtech-udp.html#connect-a-gateway_server-addresses

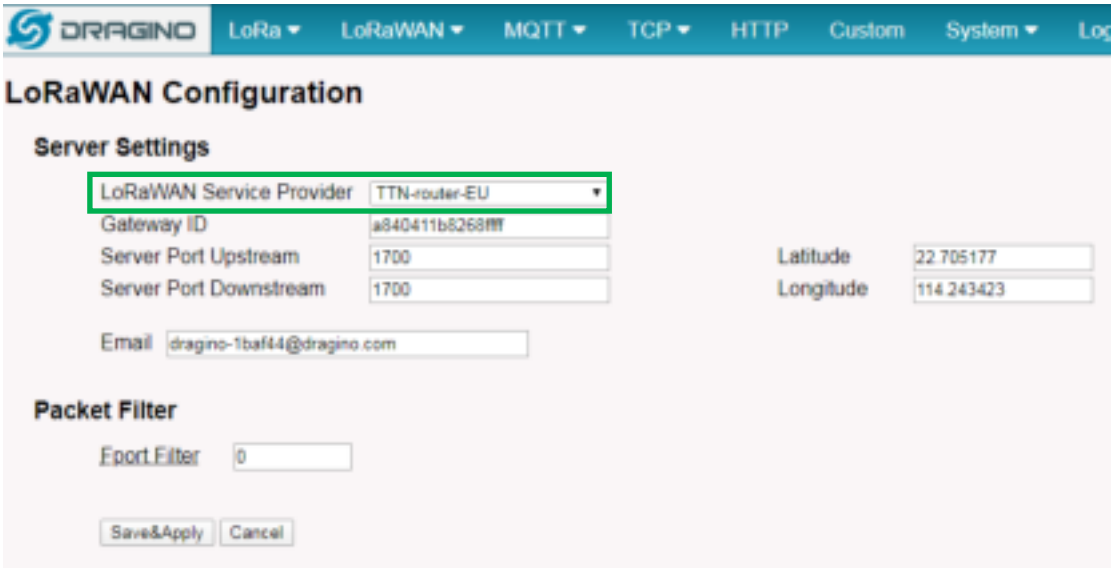
After creating the gateway, you can see the gateway info, as below.

4.2 Configure DLOS8 to connect to TTN

You can now configure the DLOS8 to let it connect to TTN network.

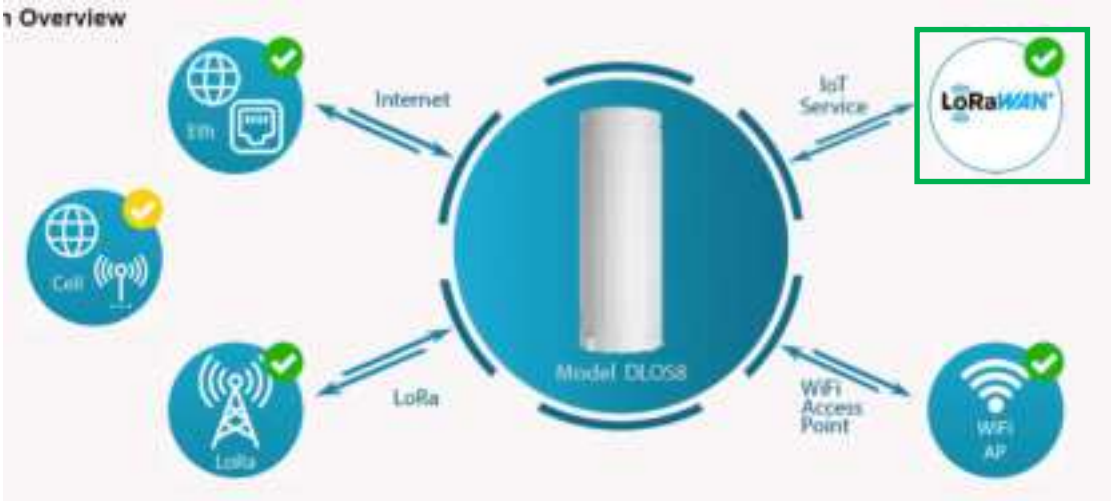
Make sure your DLOS8 has a working Internet Connection first.

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



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

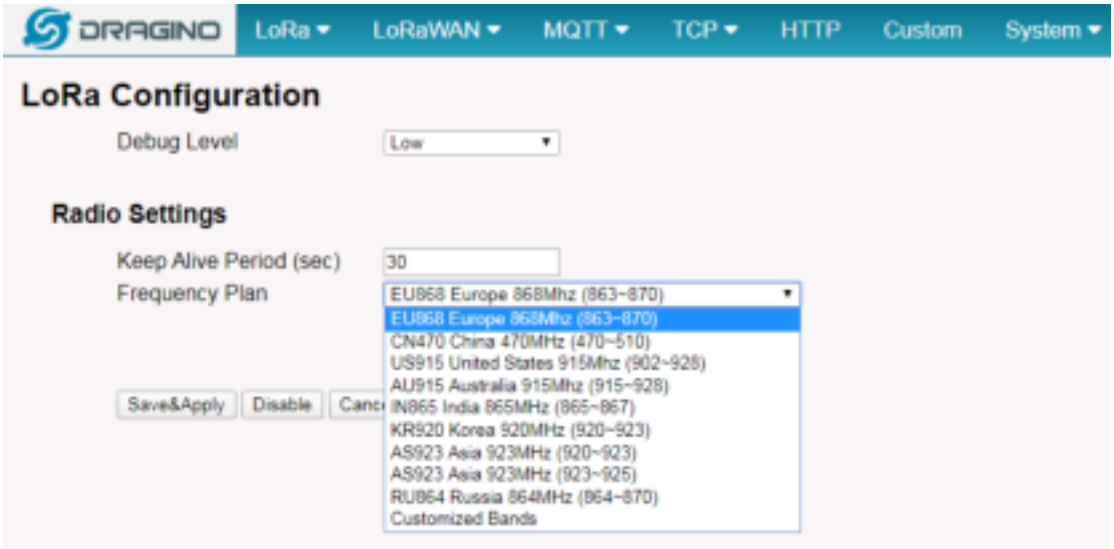
In the home page, we can see the LoRaWAN connection is ready now.



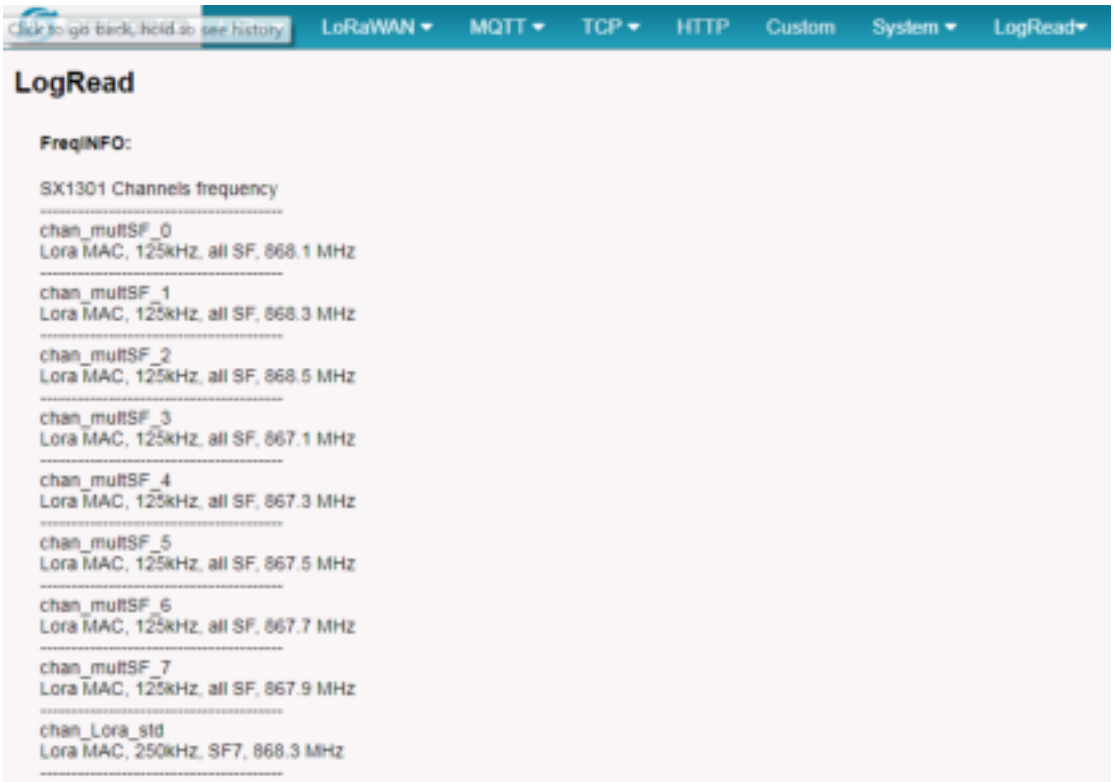
In TTN portal, we can also see the gateway is connected.

4.3 Configure frequency

We also need to set the frequency plan in DLOS8 to match the LoRaWAN 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 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.

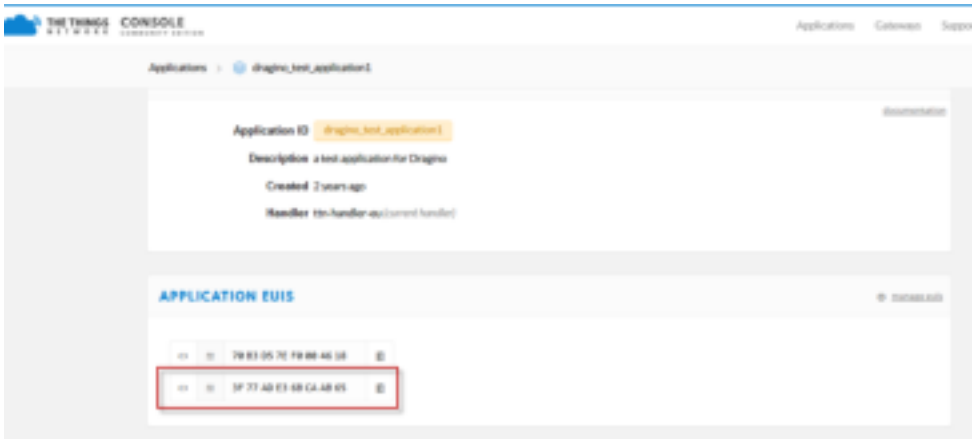
A set of these codes are stored in each device by the manufacturer as the default codes for that particular device. Each device is shipped with a sticker with the default Device EUI as shown below.

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

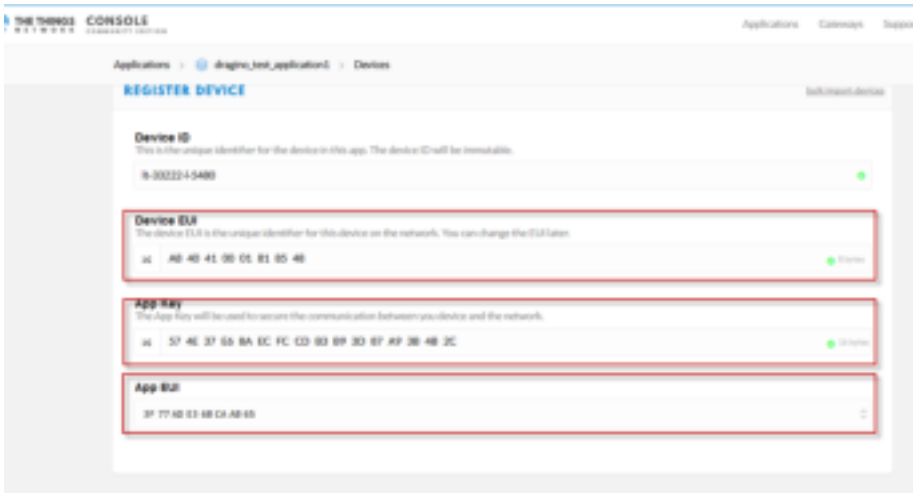
Select **Add Application** to open the screen below.

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 LT-22222-L device, select **Manage EUIs** and **Add EUI**, then enter the required code.



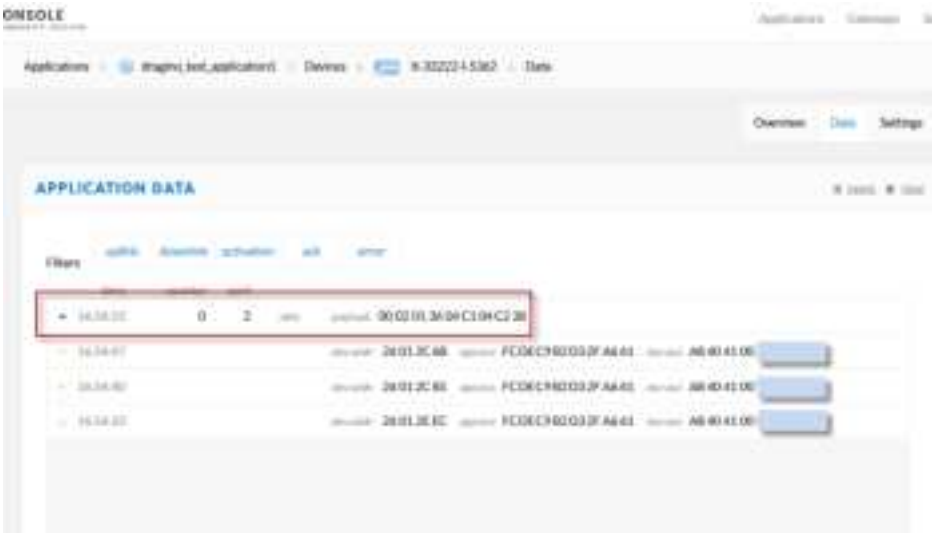
Select **Devices** and **Register Device** to open the screen below.

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-22222-L 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.

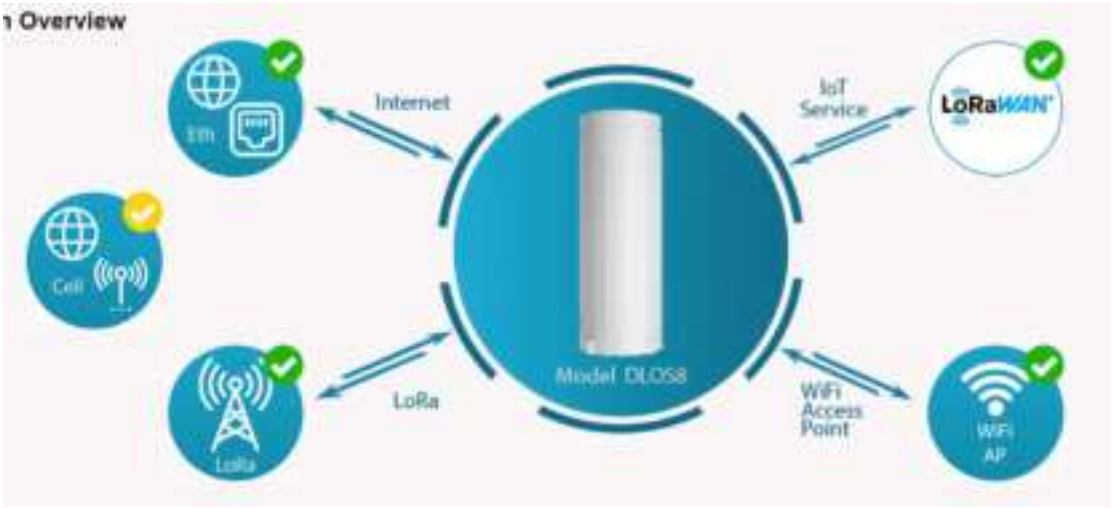
Note that it may take some time for the device data to appear in the TTN display.


ONEOLE
APPLICATION DATA

5 Web Configure Pages

5.1 Home

Shows the system running status.



5.2 LoRa Settings

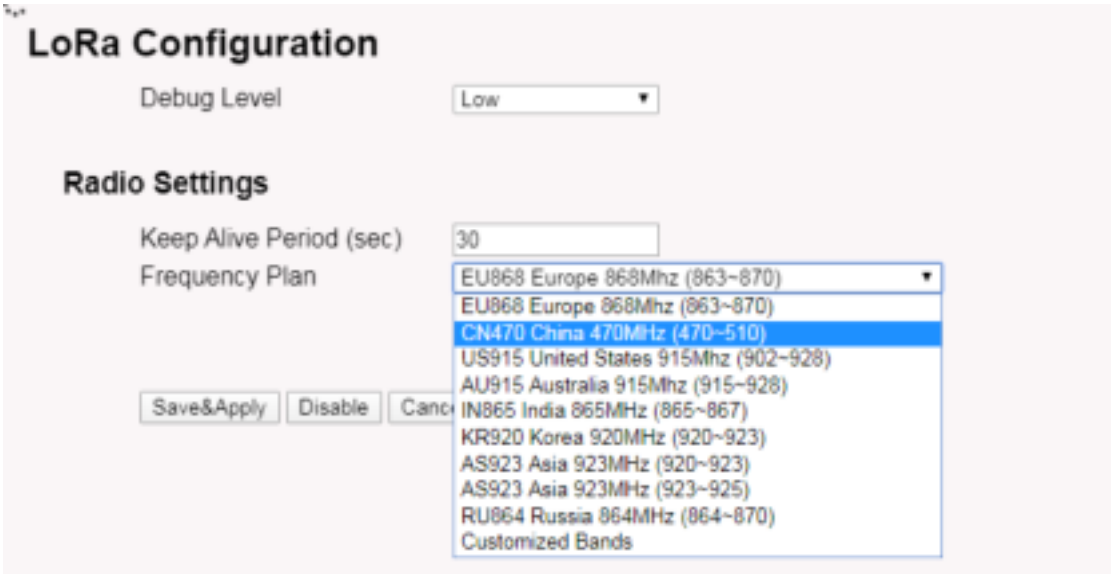
5.2.1 LoRa --> LoRa

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

Different DLOS8 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/index.php?title=Customized_Frequency_Band_for_Gateway

5.2.2 LoRa --> ABP Decryption

The DLOS8 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/index.php?title=Communication_with_ABP_End_Node

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

*: User can ignore the latitude and longitude settings here, DLOS8 will use the actually value from GPS module.

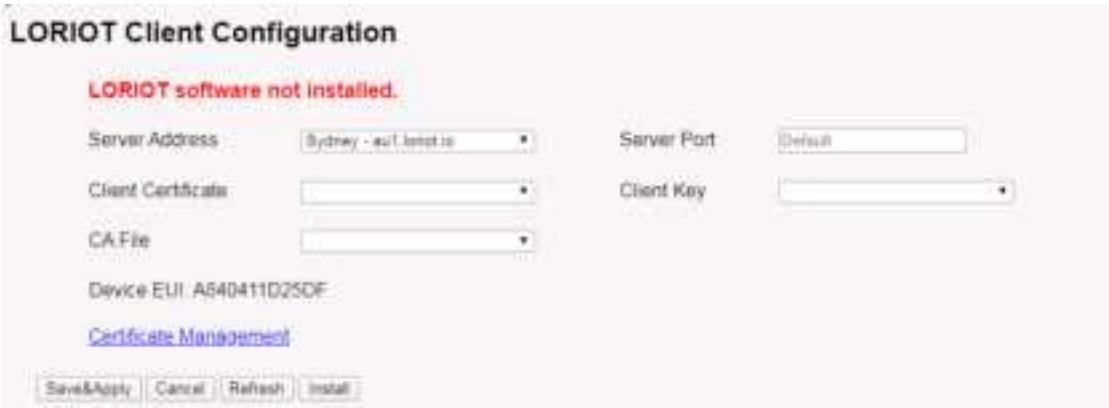
**: Packet filter is to drop the unwanted LoRaWAN packet, instruction see here:

See http://wiki.dragino.com/index.php?title=Main_Page#Filter_unwanted_LoRaWAN_packets

5.3.2 LoRaWAN --> LORIOT

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

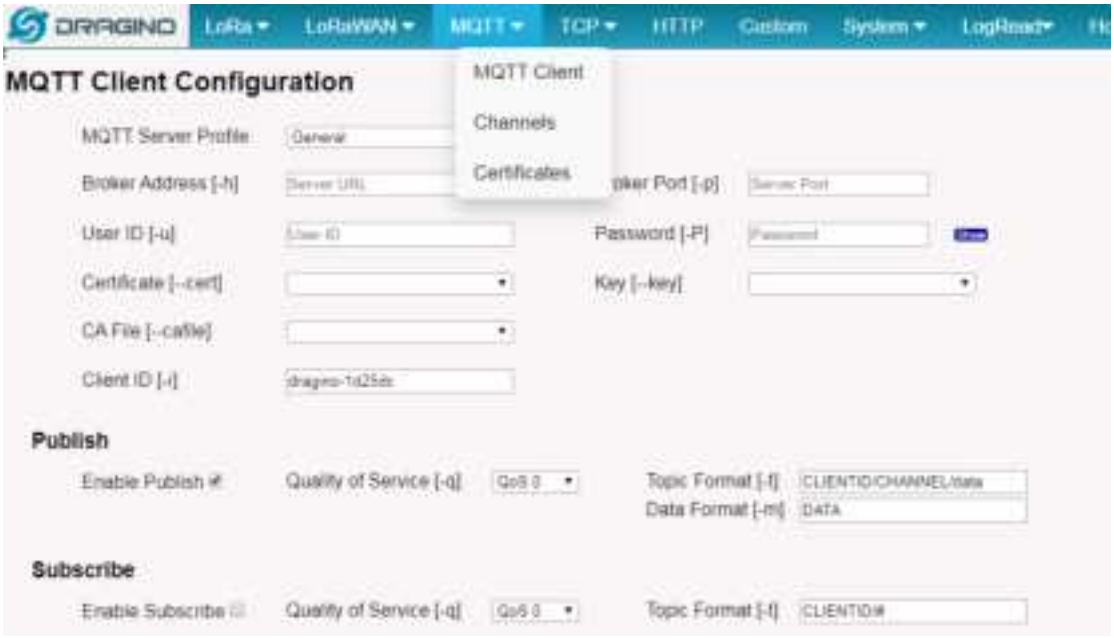
Instruction: http://wiki.dragino.com/index.php?title=Notes_for_LORIOT



5.4 MQTT Settings

If end nodes works in ABP mode, user can configure DLOS8 to transfer the data to MQTT broker, Instruction:

http://wiki.dragino.com/index.php?title=Main_Page#MQTT_Forward_Instruction



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 login for DLOS8: **root /dragino** or **admin /dragino**. Both root and admin has 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 DLOS8 has the AP enable, LAN settings specify the network info for DLOS8's own network.

WAN Settings:

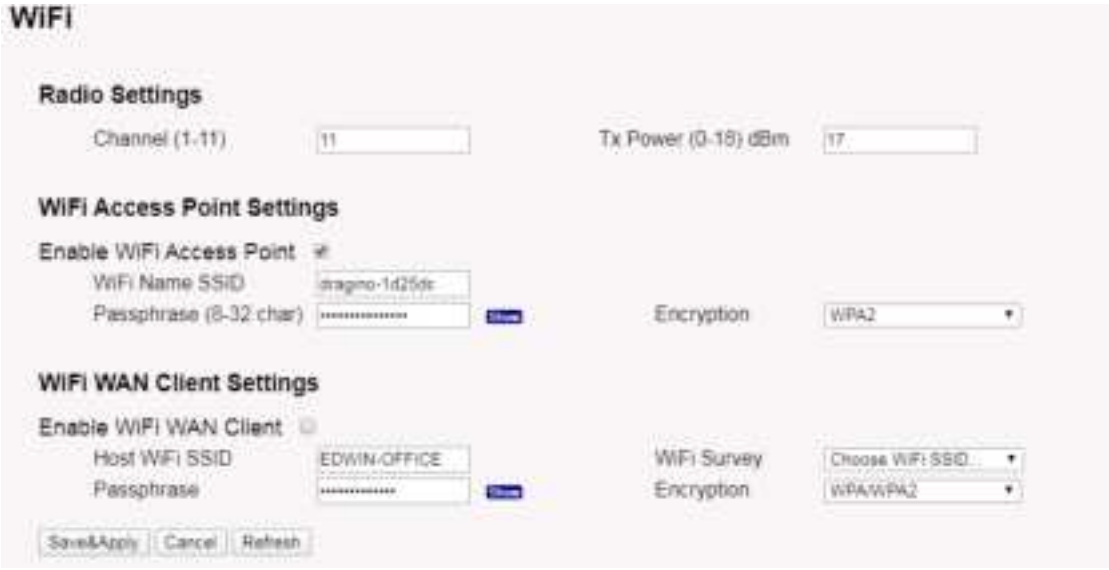
Setting for DLOS8 WAN port

WiFi Settings:

Setting for DLOS8 WiFi IP when use it as WiFi Client

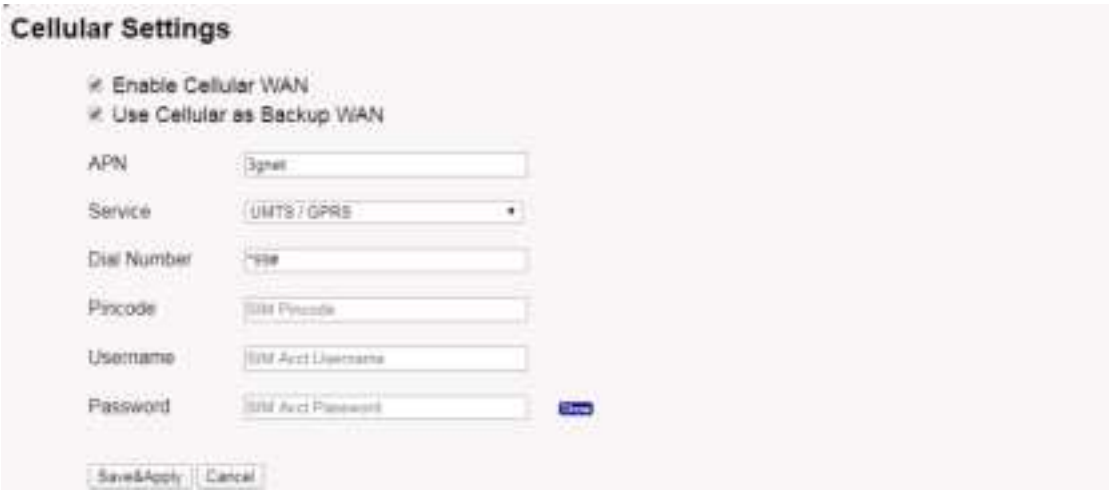
5.5.4 System --> WiFi

DLOS8 WiFi Settings.



5.5.5 System --> Cellular

While use the cellular as Backup WAN, device will use Cellular for internet connection while WAN port or WiFi is not valid and switch back to WAN port or WiFi after they recover.

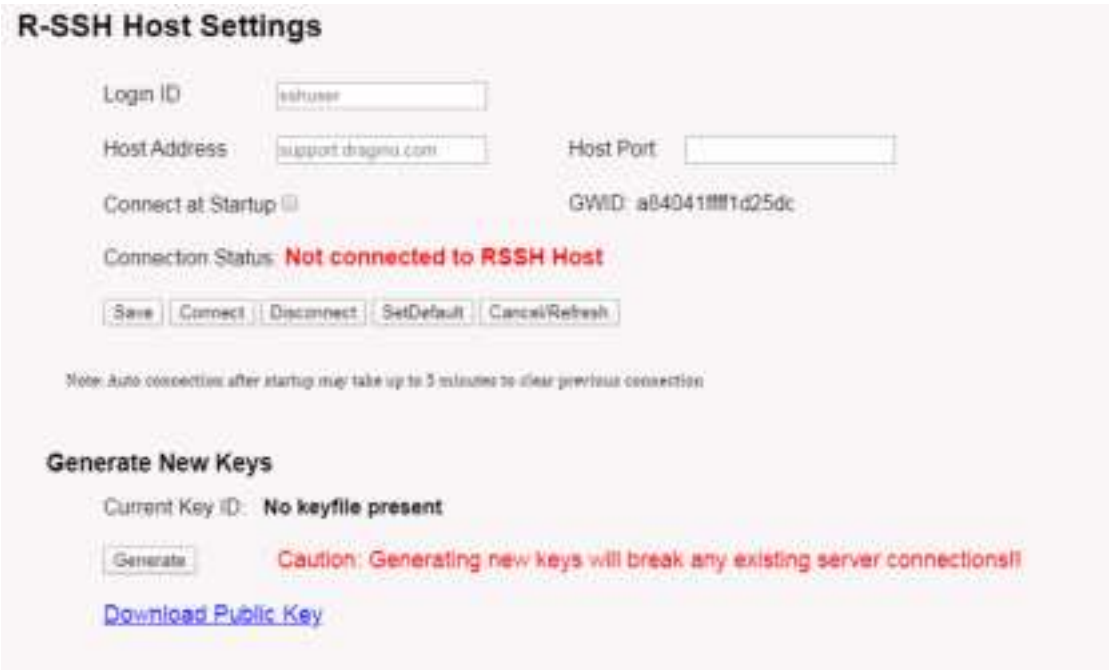


Note *: For DLOS8 which doesn't have the cellular module, this page will shows Cellular not detected.

5.5.6 System --> Network Status

5.5.7 System --> Remote Mgnt

R-SSH is for remote access device and management, introduction for how to use:
http://wiki.dragino.com/index.php?title=Main_Page#Remote_Access_Gateway_via_Reverse_SSH



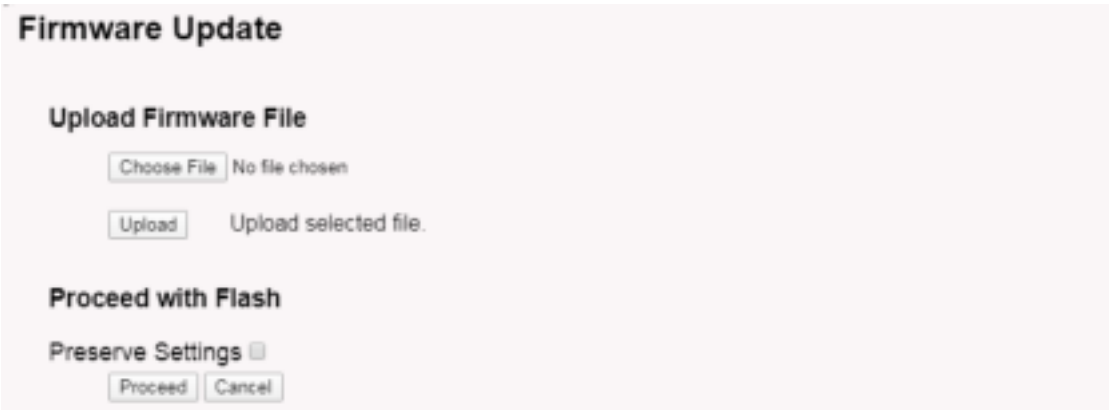
5.5.8 System --> Firmware Upgrade

We keep improving the DLOS8 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/LG02-OLG02/Firmware)
- **Change Log**: 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.

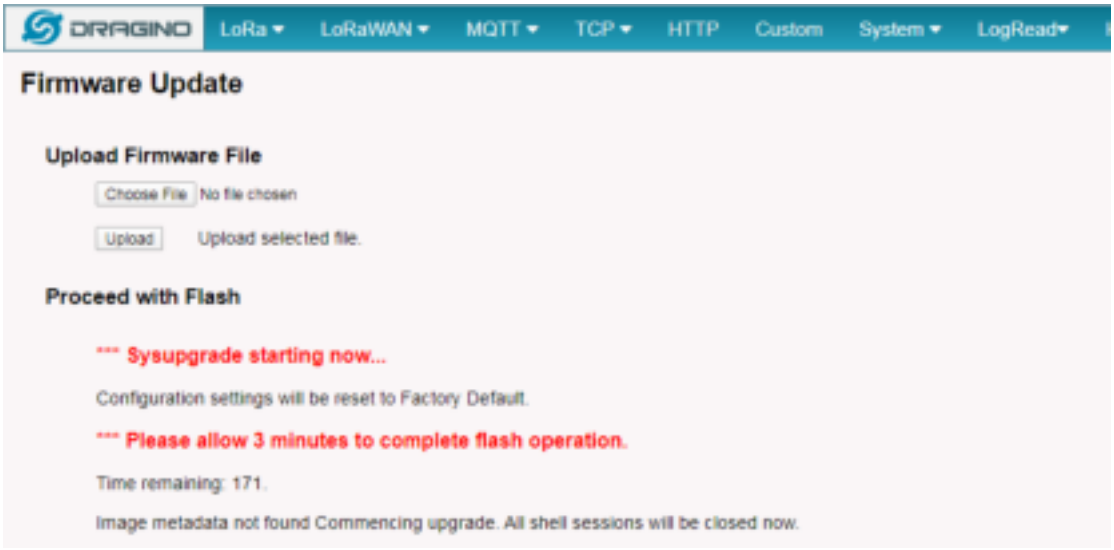
Web → System → Firmware Upgrade



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.

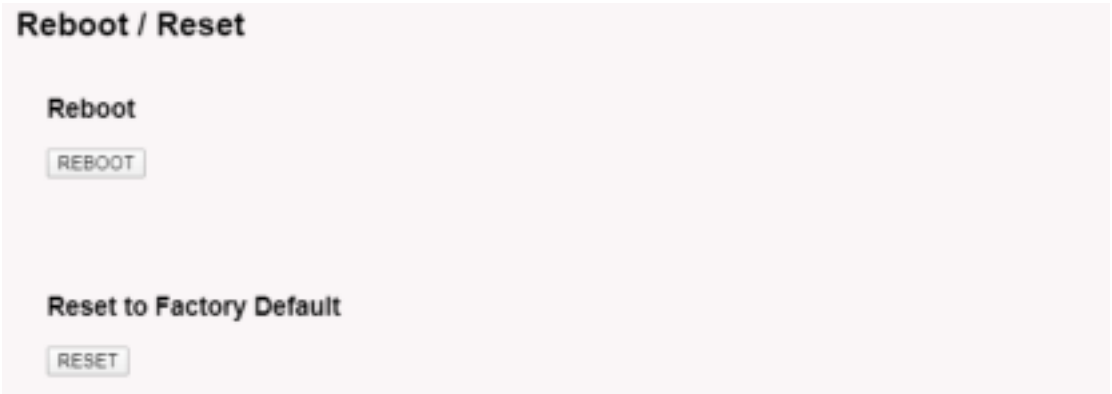


Note *: User can also upgrade firmware via Linux console
SCP the firmware to the system **/var** directory and then run

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.

5.5.9 System --> Reboot/Reset



5.5.10 System --> Package Maintain

Place to show what package has installed and possible to upgrade packages.

5.6 LogRead

5.6.1 LogRead --> LoRa Log

Show the frequency for LoRa Radio and traffics.

5.6.2 LogRead --> System Log

Show the system log

6 More features

6.1 More instructions

http://wiki.dragino.com/index.php?title=Main_Page#LoRa.2FLoRaWAN_Gateway_Instruction

7 Linux System

The DLOS8 is based on the OpenWrt Linux system. It is open source, and users are free to configure and modify the Linux settings.

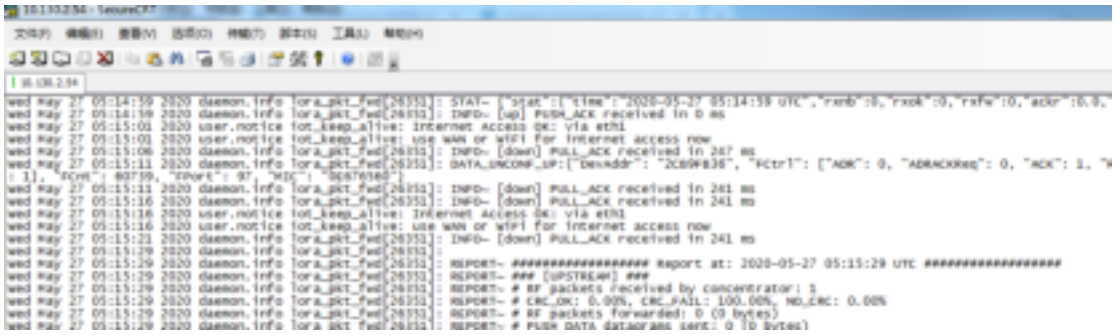
7.1 SSH Access for Linux console

User can access the Linux console via the SSH protocol. Make sure your PC and the DLOS8 are connected to the same network, then use a SSH tool (such as putty in Windows) to access it.

IP address: IP address of DLOS8
Port: 22 (via WiFi AP mode) or 2222 (via WAN Interface)
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.

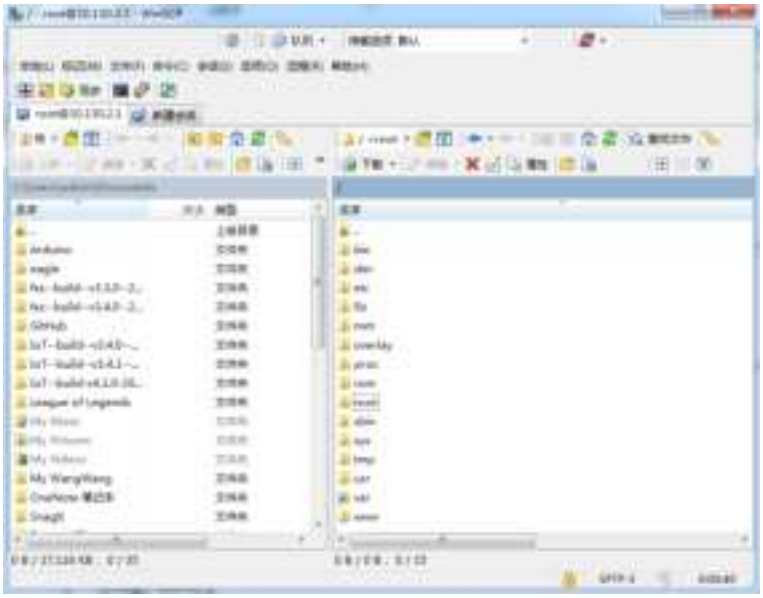


7.2 Edit and Transfer files

The DLOS8 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 DLOS8, or edit the files directly in the windows.

Screenshot is as below:



7.3 File System

The DLOS8 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 DLOS8 flash.
You can use an external USB flash memory device to extend the size of flash memory for storage.

7.4 Package maintenance system

DLOS8 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 DLOS8 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

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/index.php?title=Customized_Frequency_Band_for_Gateway

9.2 Can I connect DLOS8 to LORIOT?

Yes, the set up instruction is here:
http://wiki.dragino.com/index.php?title=Notes_for_LORIOT

9.3 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 DLOS8 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

9.4 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:

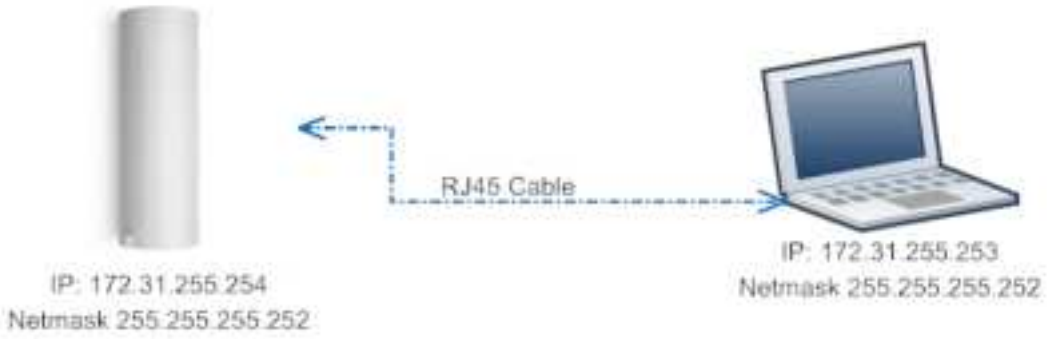
root@dragino-16c538:~# opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk
Installing kmod-dragino2-si3217x (3.10.49+0.2-1) to root…
Collected errors:
* satisfy_dependencies_for: Cannot satisfy the following dependencies for kmod-dragino2-si3217x:
* kernel (= 3.10.49-1-4917516478a753314254643facdf360a) *
 * 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 DLOS8 if the firmware crashes

Please follow this instruction to recover your gateway:
http://wiki.dragino.com/index.php?title=Recover_Gateway

10.3 I configured DLOS8 for WiFi access and lost its IP. What to do now?



The DLOS8 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 DLOS8 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 DLOS8'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 DLOS8 via Web or Console.

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

11 Order Info

PART: DLOS8-XXX-YYY:

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:

- ✓ DLOS8 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

FCC Statement
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.

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.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.