

Get Start with RAK LoRa Develop Kit

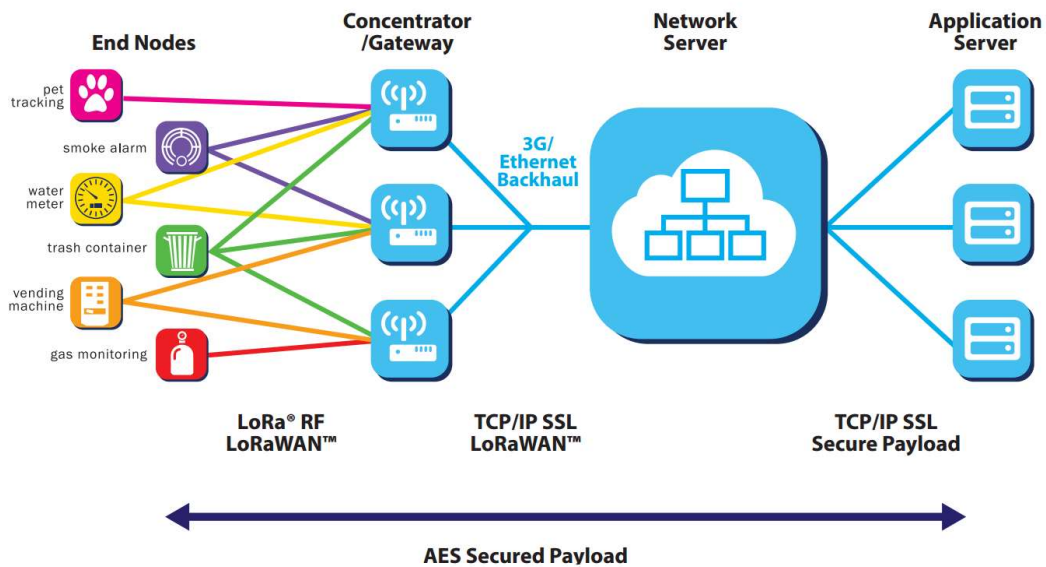
-----The simplest LoRa Kit

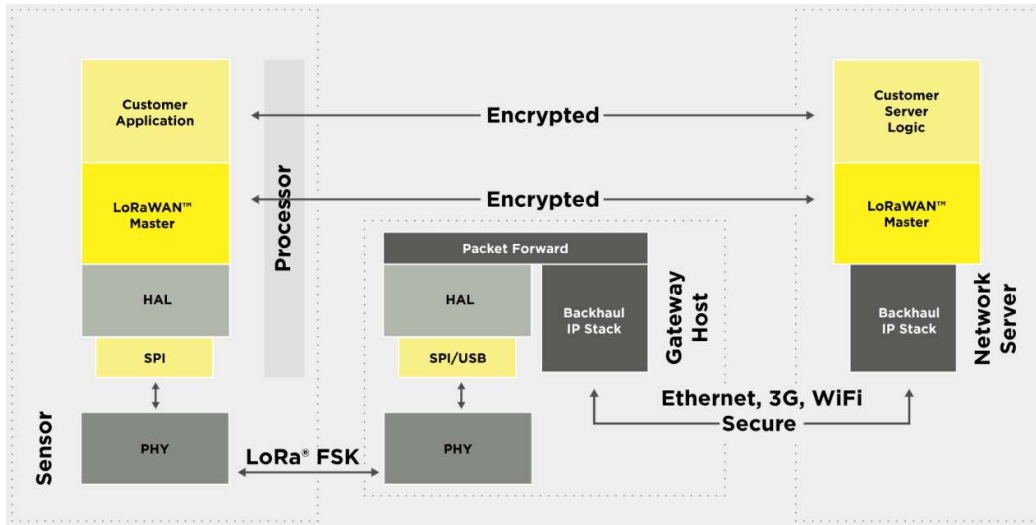
What's LoRa?

LoRaWAN is a long range, low power wireless protocol that is intended for use in building IoT networks. IoT devices ("nodes") send small data packets to any number of "gateways" that may be in the several-kilometer range of a node via the LoRaWAN wireless protocol. The gateways then use more traditional communications such as wired Internet connections to forward the messages to a network-server which validates the packets and forwards the application payload to an application-server.

The nature of the LoRa network potentially allows IoT devices to run for years on small batteries, occasionally sending out small packets of data, waiting for a short time for response messages, and then closing the connection until more data needs to be sent. Devices can also be set up so that they are always listening for messages from their applications, though this obviously requires more power and may be more appropriate for devices that are, say, plugged in to a wall socket.

Of course, there is much more to LoRaWAN than is described here. The LoRaWAN protocol is defined and managed by the [LoRa Alliance](#). There is a great deal of information available there.





About RAK

Shenzhen Rakwireless Technology Co., Ltd. (RAK) was established in June 2014. Based in Shenzhen with a R&D center in Shanghai, a office in Beijing. RAK devoted to developing and supplying advanced IoT technology and services. RAK has become from R&D, production to sales one-stop IoT solution supply company. More information, you can see their official website: <https://www.rakwireless.com/en/>

What's the RAK LoRa Develop Kit?

The RAK LoRa Develop Kit is a set of RAK LoRa devices which has been customized for quick start to use. It can be used easily by anyone who want to study, experience, research, develop, test, or deploy LoRa, even if he/she knows nothing about LoRa.

The RAK LoRa Develop Kit includes the following components mainly:

A RAK LoRa gateway. It may be RAK2243 + Raspberry Pi;

A RAK LoRa server OS image. You can download it from www.rakwireless.com by using the verification code which has been placed in the box of RAK LoRa Develop Kit you bought.

A RAK LoRa node. It may be RAK811.

OK, let's go



Get start with RAK LoRa Develop Kit

What do you need to prepare?

1. A set of RAK LoRa Develop Kit.
2. A PC, if you want to use an independent LoRa Server by installing the RAK LoRa server OS image.

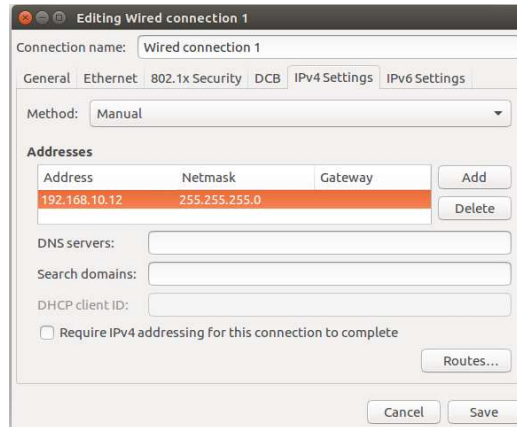
This PC will be used as LoRa Server and Application Server after installing a new system automatically. Please notice that it will erase the old data of this PC.

Note: Maybe you can install the system into a virtual machine, but it may lead to an unfriendly user experience, so we don't recommend this way. Just do it as you like.

3. A PC with tools for SSH and AT command.

This PC will be normally used to configure LoRa gateway through SSH, and LoRa node through AT command.

Note: The IP address of the LoRa gateway ethernet is 192.168.10.10 by default. You must configure the IP address of your PC to the same IP segment with LoRa gateway. If you don't know how to do it, feel free and just google or Baidu. For example:



How do you want to use the RAK LoRa Develop Kit?

In this tutorial, there are three cases to use the RAK LoRa Develop Kit:

[Case 1: I know nothing or few things about LoRa, but I want to set up a LoRa network quickly for learning, experiencing, testing, or using, in 3 minutes.](#)

[Case 2: I want to set up a LoRa network quickly with an independent LoRa Server, not an integrated one.](#)

[Case 3: I want to set up a LoRa network quickly, but I want to use TTN as my LoRa server.](#)

OK, Let's have a look at these cases.

Case 1: I know nothing or few things about LoRa, but I want to set up a LoRa network quickly for learning, experiencing, testing, or using, in 3 minutes.

Really? in 3 minutes?

Oh, yes! What you read is right! You can set up a LoRa network by yourself in 3 minutes using the RAK LoRa Develop Kit, even if you know nothing about LoRa.

Now, do as the following steps to set up your LoRa network:

Step 1: Power on the RAK LoRa gateway;

Step 2: Send several AT command to the LoRa node from PC as follow:

- 1) Set the dev_eui and app_key, which you'll find in the box of the RAK LoRa Develop Kit or in this tutorial, into the LoRa node through AT command:

```
"at+set_config=dev_eui:1111111111111111"
```

```
"at+set_config=app_eui:70B3D57ED00157D1"
```

```
"at+set_config=app_key:ecbb8ac2bdf563dbe505d2f850219c17"
```

- 2) Join the LoRaWAN network through AT command "at+join=otaa". If you see "at+recv=3,0,0", it indicates that the LoRa node has joined the LoRaWAN network successfully.

- 3) Try to send some data to the application server.

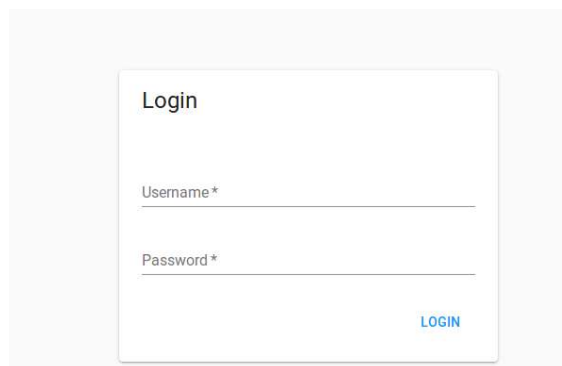
For example:

```
"at+send=0,2,000000000000007F00000000000000"
```

Step 3: Nothing else. That's all! Congratulations! You've set up a LoRa network successfully.

If you want to check the data on the website of LoRa server and LoRa application server, please do as follow:

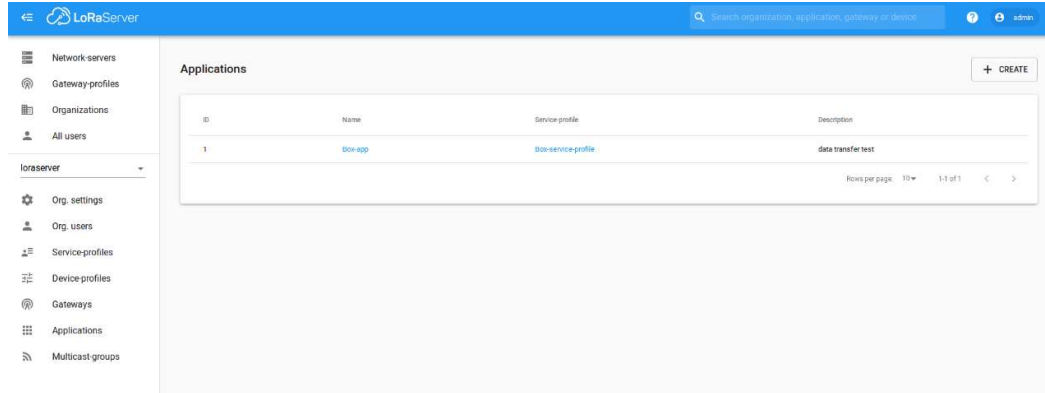
- 1) Open the browser and type <http://192.168.10.10:8080>, you will see the login page of LoRa server as follow:



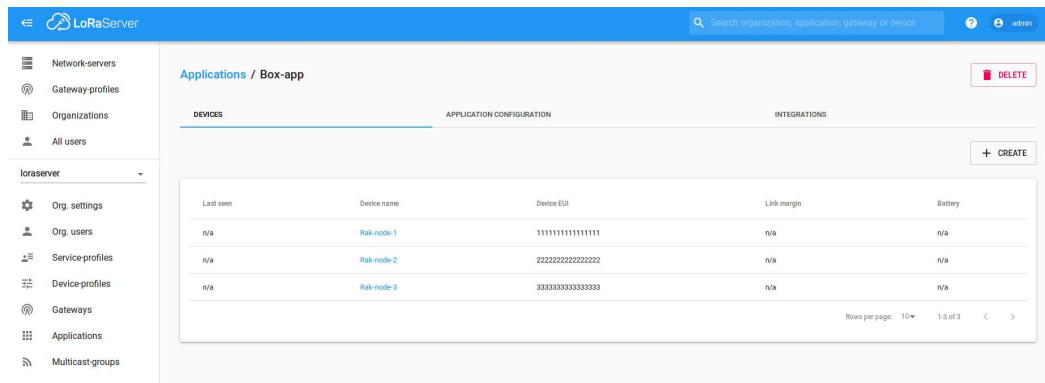
The image shows a simple web form for logging in. It has a title "Login" at the top. Below the title are two input fields: "Username*" and "Password*", each with a horizontal line for text entry. At the bottom right of the form is a blue button labeled "LOGIN".

Login the LoRa server. The default username and password are both "admin".

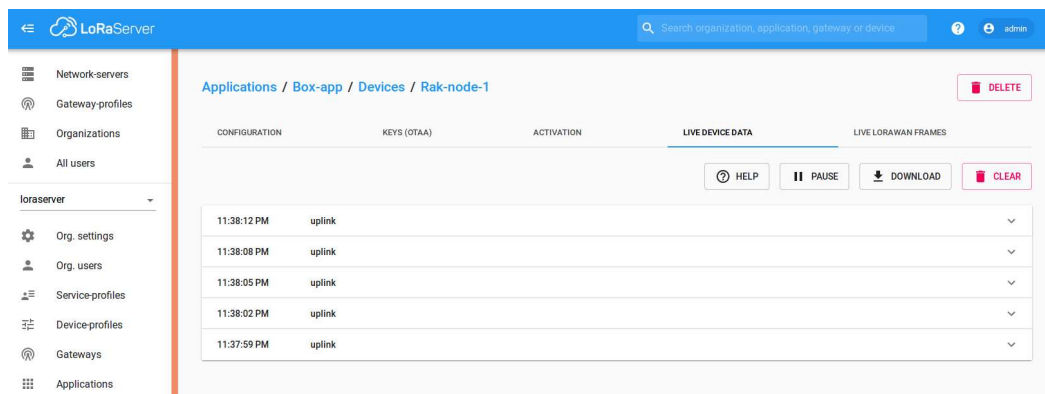
- 2) You can see the following page:

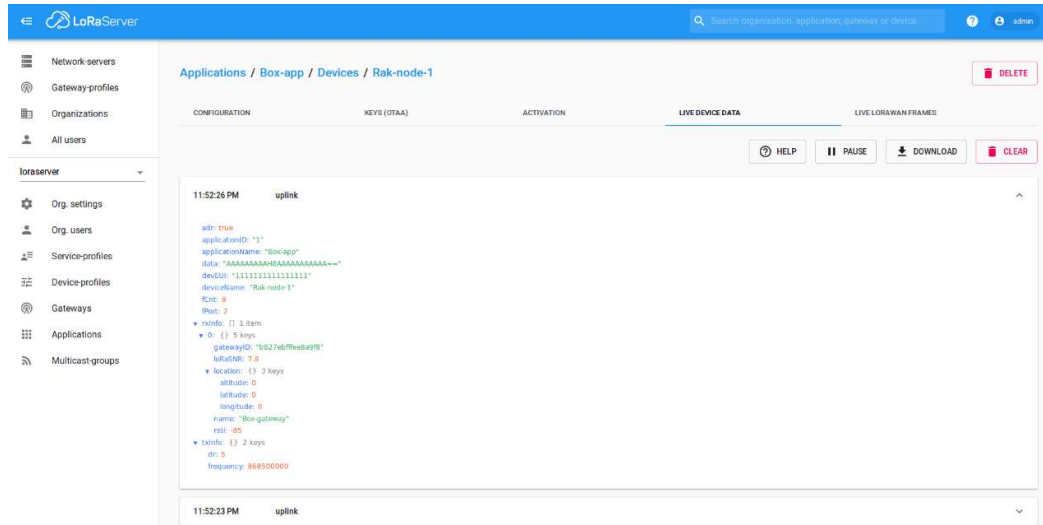


3) Enter “Box-app”, there are three pre-configured devices, and you have got their dev_eui and app_key from the box of the RAK LoRa Develop Kit or this tutorial:



You can check the status and data of LoRa node by click the “Device name” of LoRa node which you are using on this page.





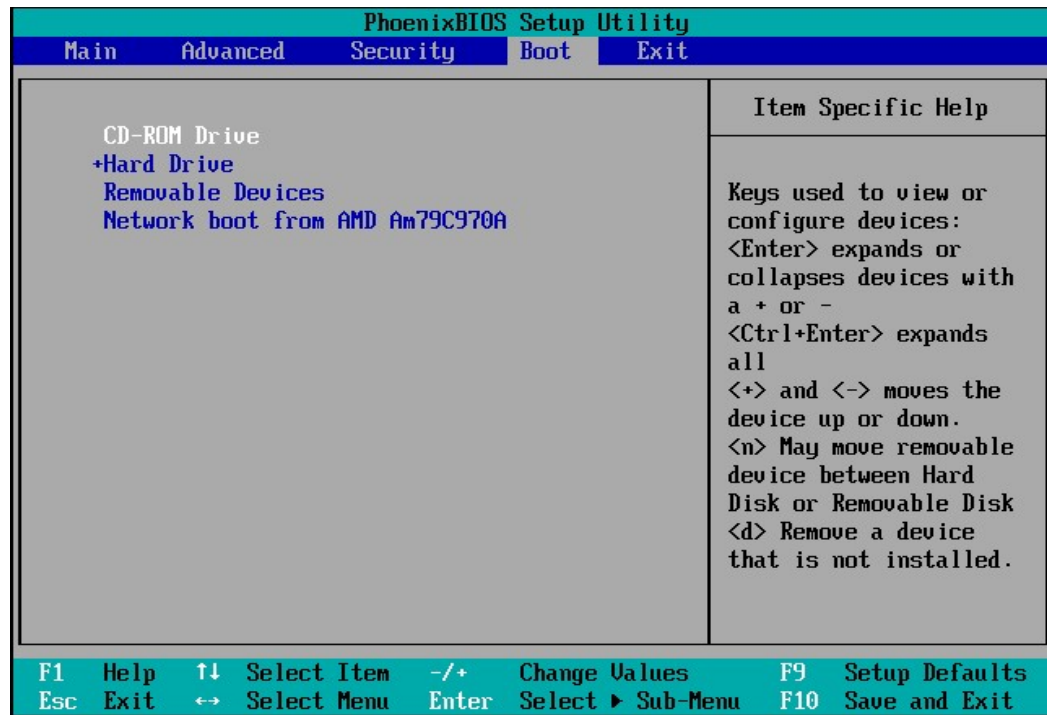
Note: There is a RAK LoRa gateway in the RAK LoRa Develop Kit you bought. By default, a LoRa server and a LoRa application server have been integrated into this LoRa gateway too. When you power on this RAK LoRa gateway, it will do some configurations automatically to finish all the steps of LoRa gateway, LoRa server, and LoRa application server. Normally, people call this feature “**plus and play**”.

Case 2: I want to set up a LoRa network quickly with an independent LoRa Server, not an integrated one.

Just do as the following steps:

Step 1: Build a LoRa server by installing the RAK LoRa Server OS.

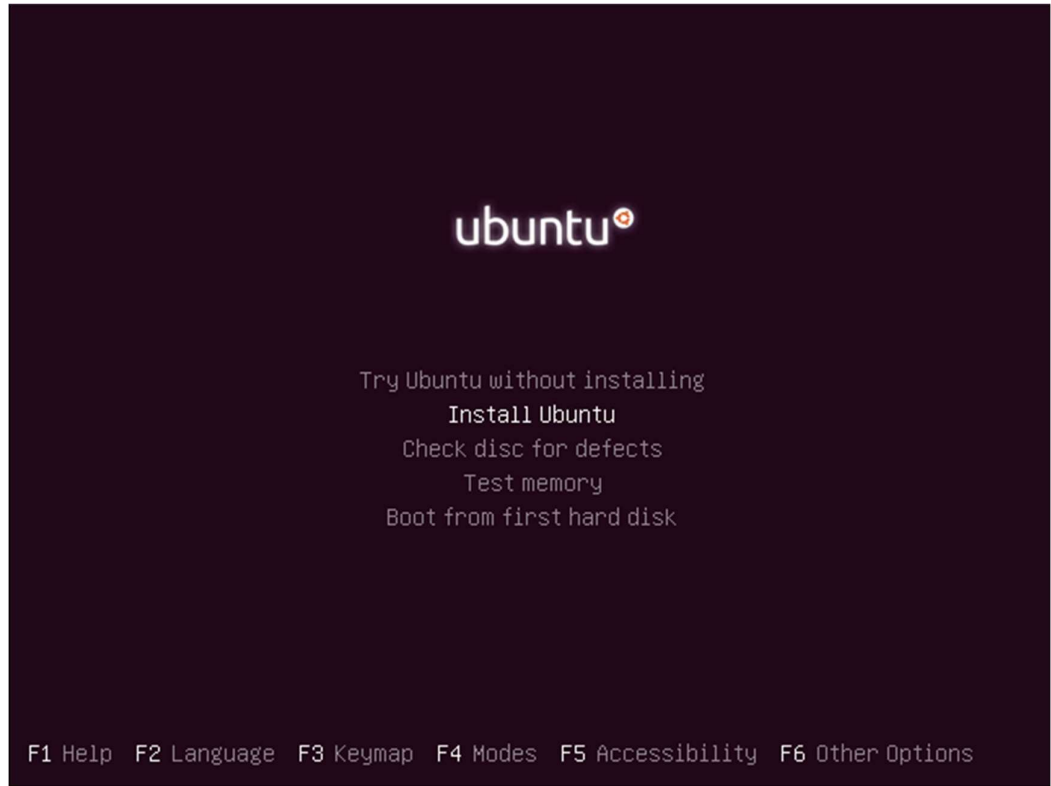
- 1) Make a startup disk using the RAK LoRa server OS image into an USB disk or a CD-ROM, if you can't make it, please google or Baidu;
- 2) Install the OS from USB disk or CD-ROM as follow. Actually, it is a normal process of installing an ubuntu OS, so if you have any issues in the process of installing, you can find the solution on google or Baidu;
- 3) Enter BIOS and configure the boot way, “CD-ROM Drive” or “Removable Devices”;



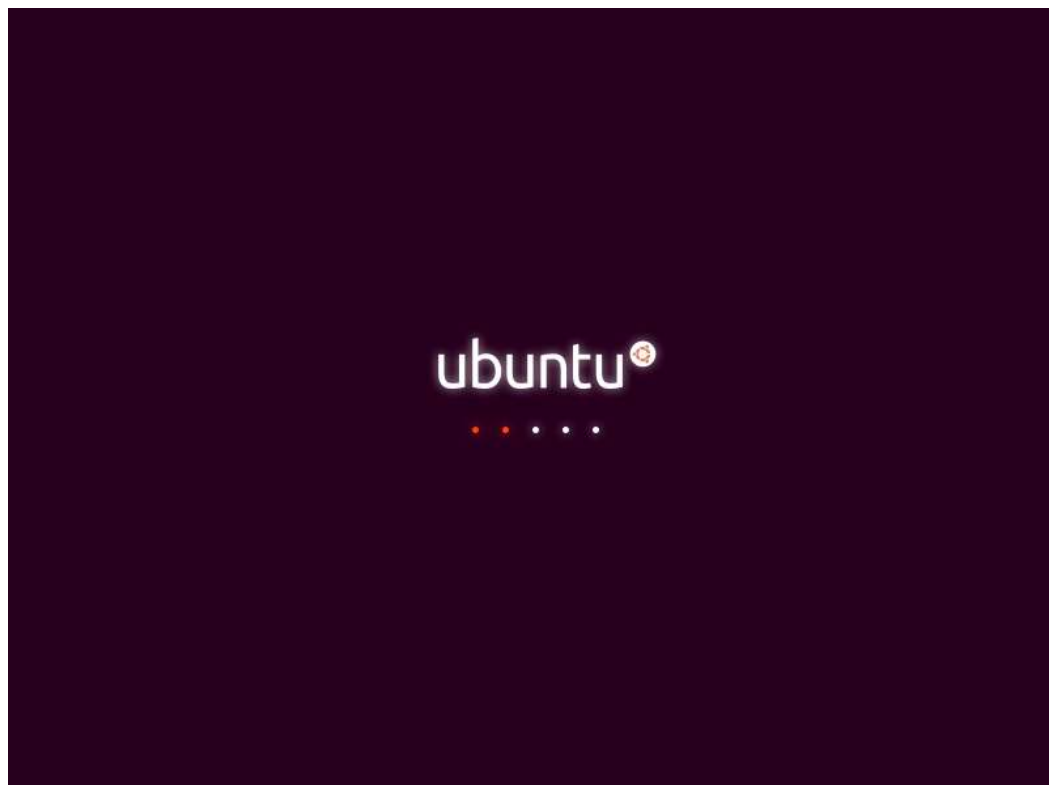
- 4) When beginning to install, it will remind you to choose the language as the following picture, and we recommend you to choose “English”.



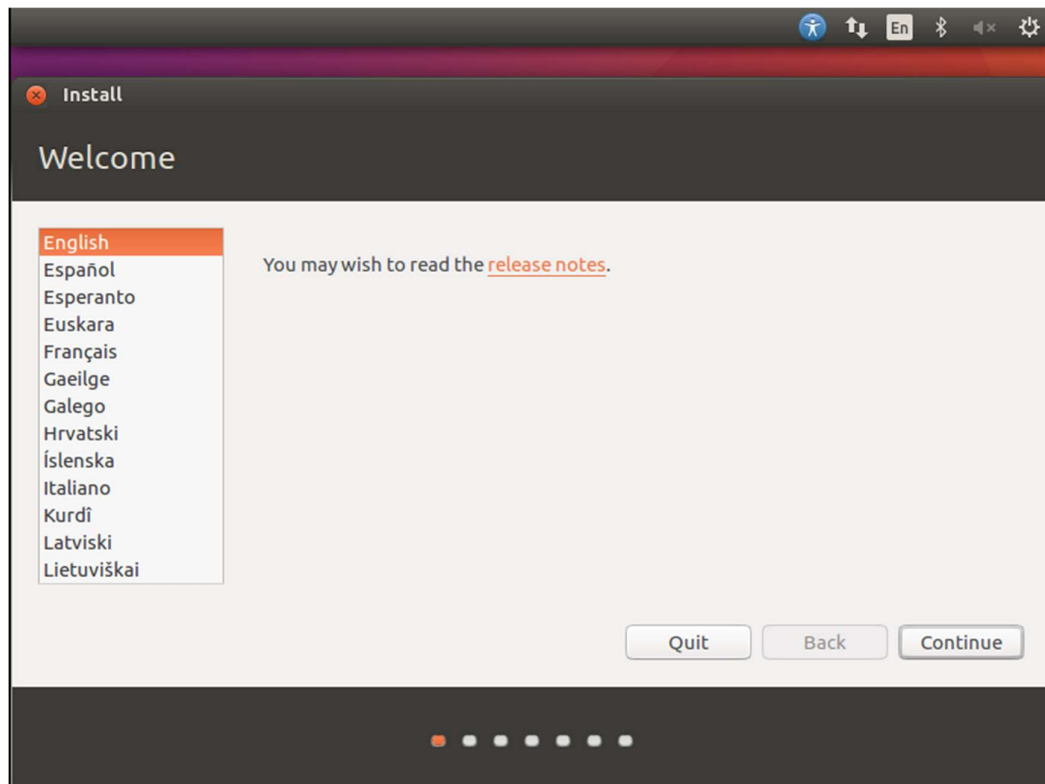
- 5) Select “Install Ubuntu” to install the customized OS which is based on Ubuntu and includes a LoRa server and an Application server. We call it “the LoRa Server OS” in this tutorial.



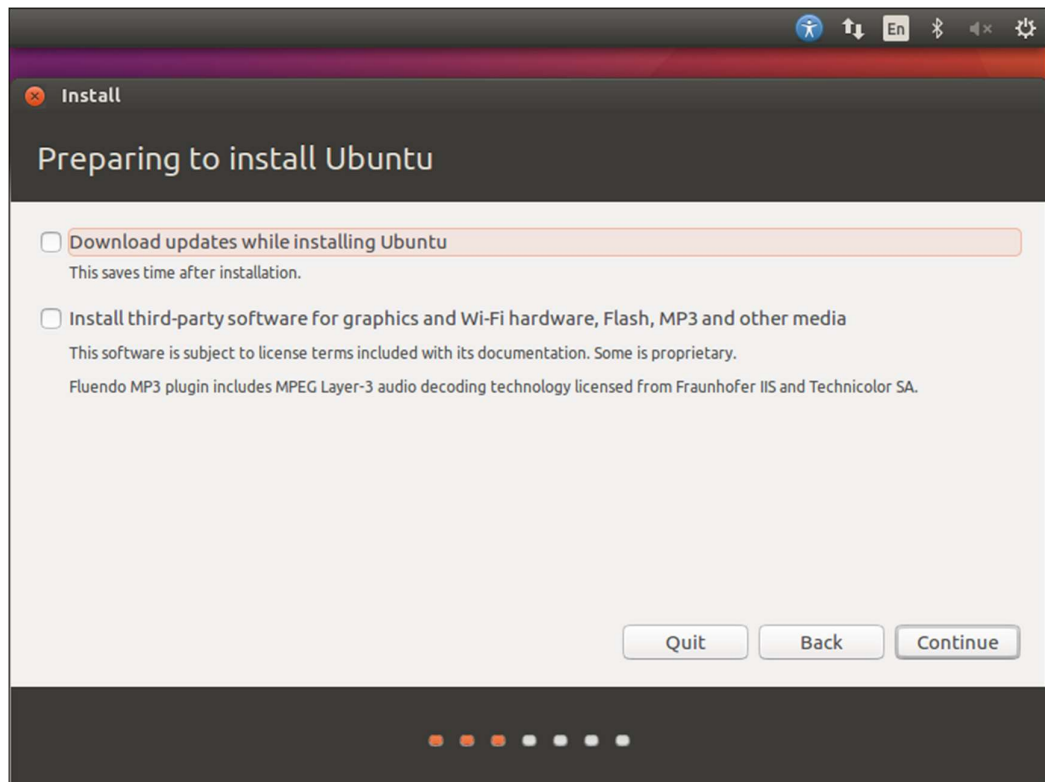
6) Wait for loading...



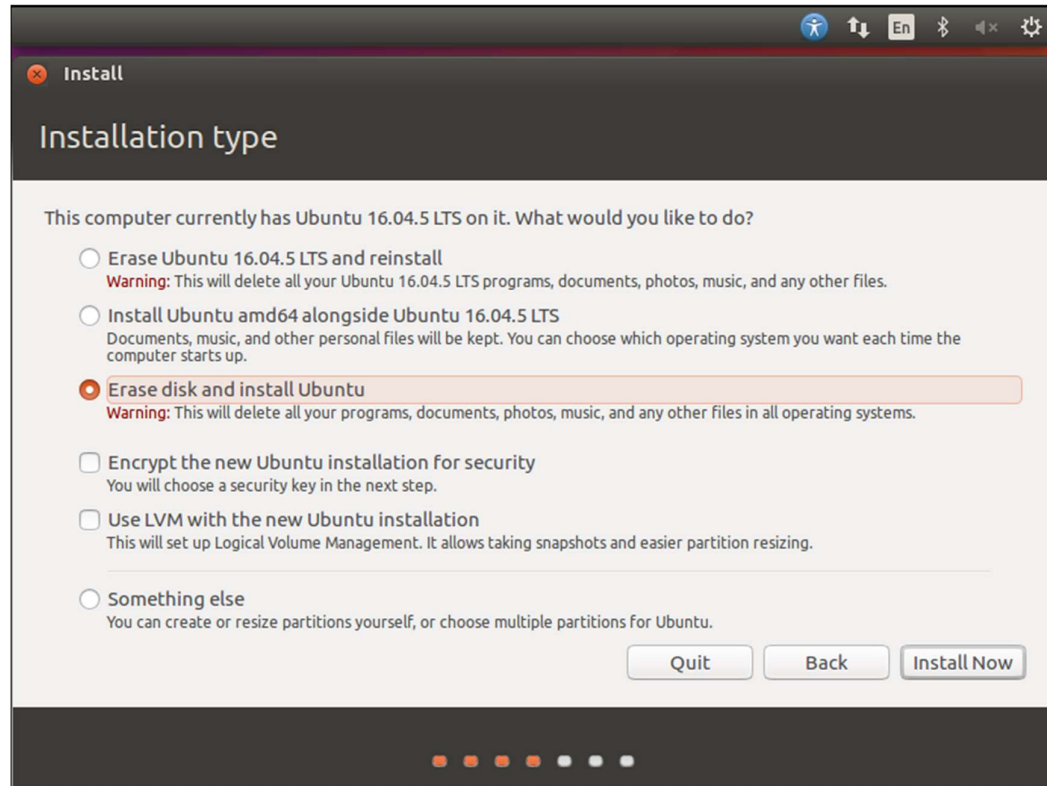
7) After loading, select the language again and “Continue” to the next page.



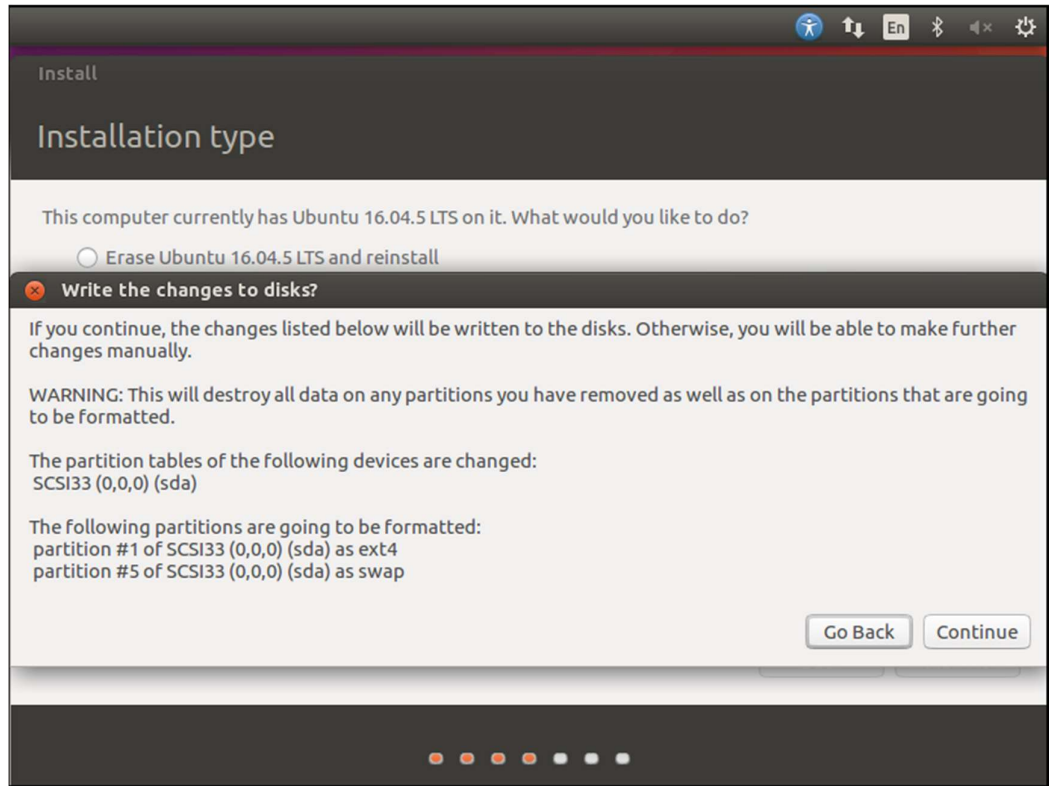
8) In this page, please don't select anyone of the check boxes.



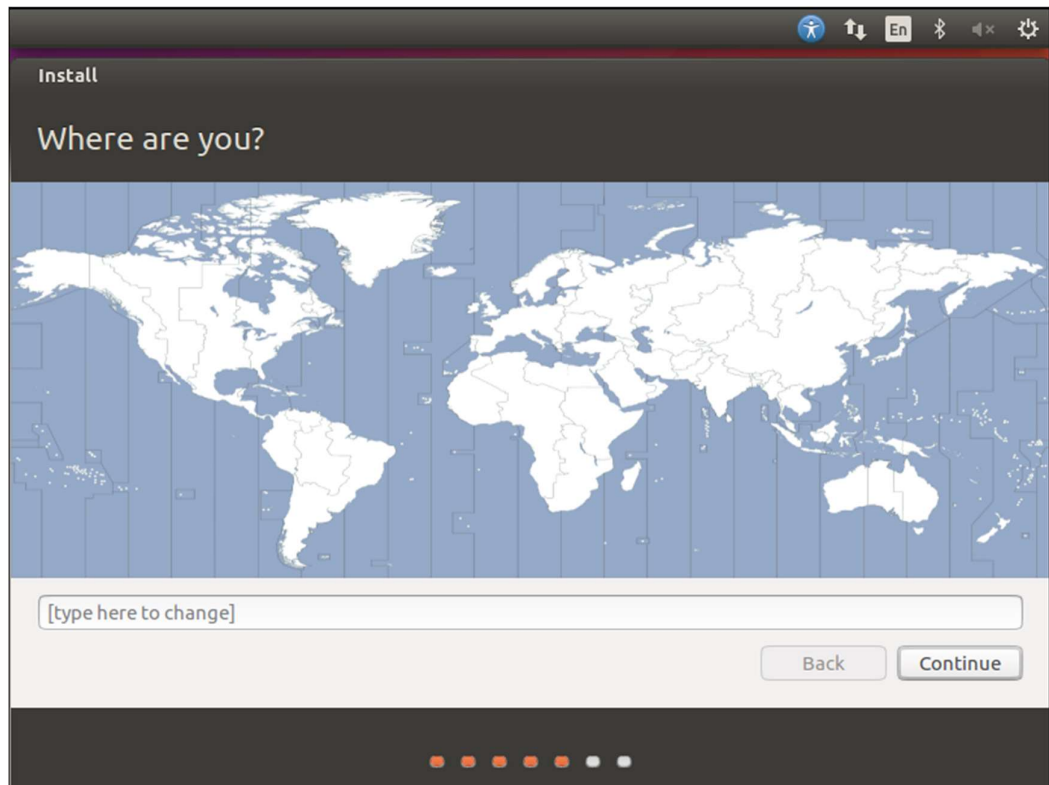
- 9) In the following page, you need to select “Erase disk and install Ubuntu” and click the “Install Now” button, but before that, you should notice that this will delete all your programs, documents, photos, music, and any other files in the old OS if it existed yet.



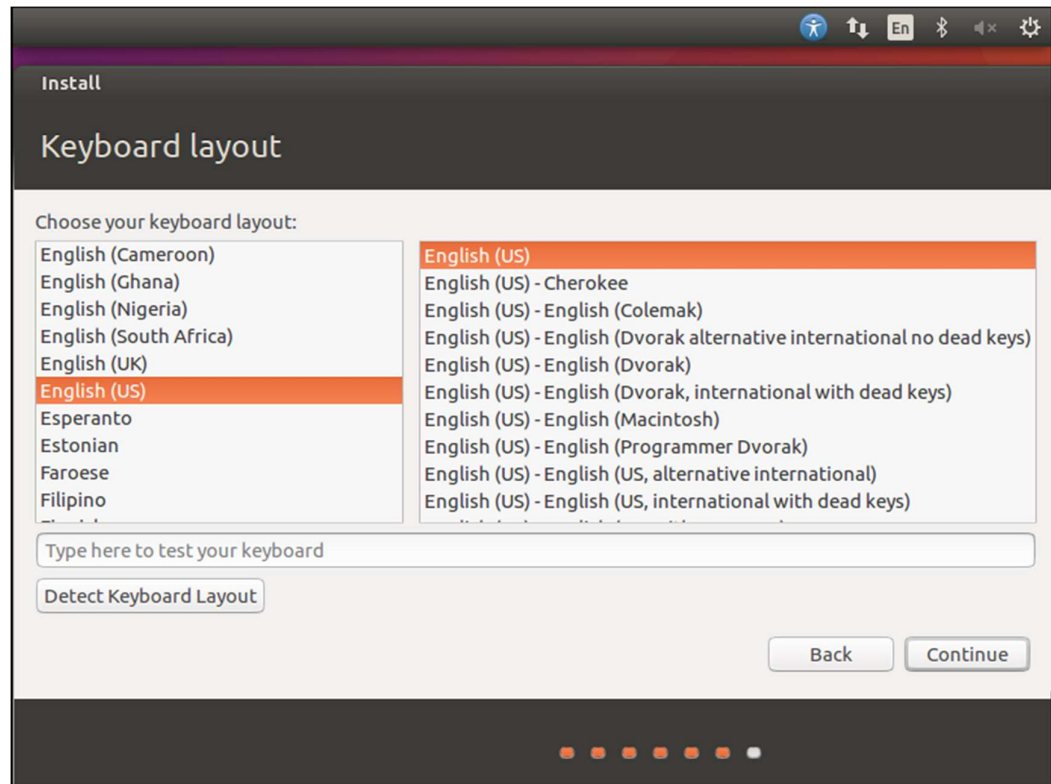
- 10) A pop-up dialog, just click the “Continue” button.



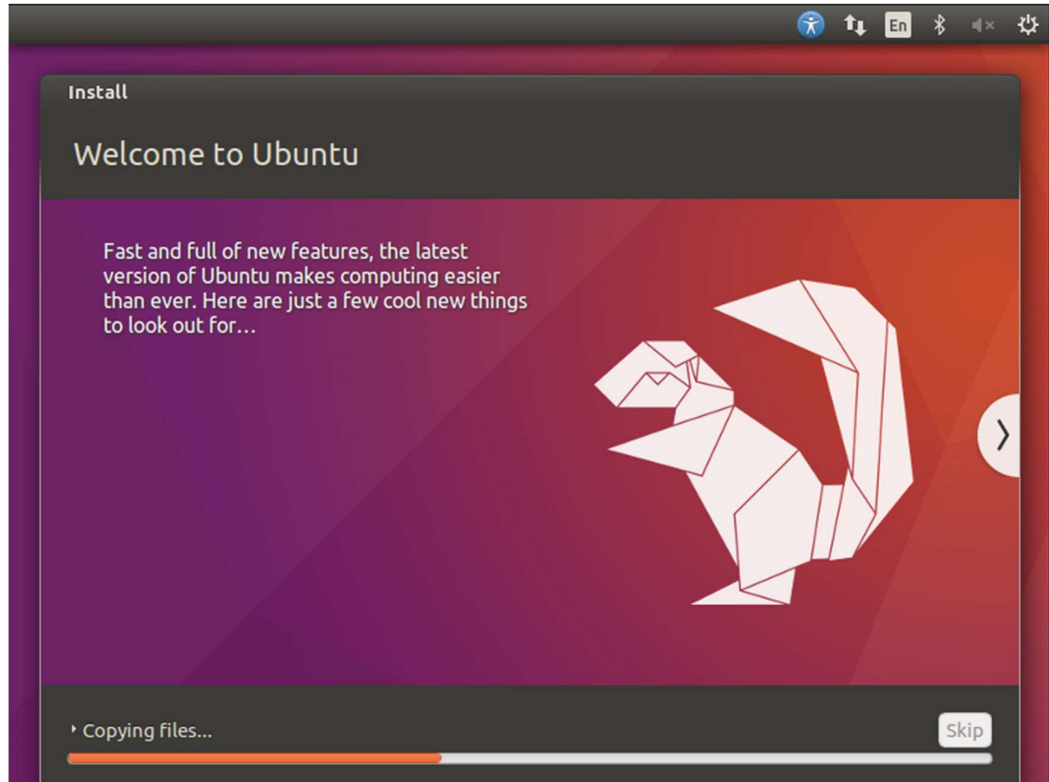
- 11) Select the time zone by typing the name of the time zone or selecting in the map directly. Then "Continue".



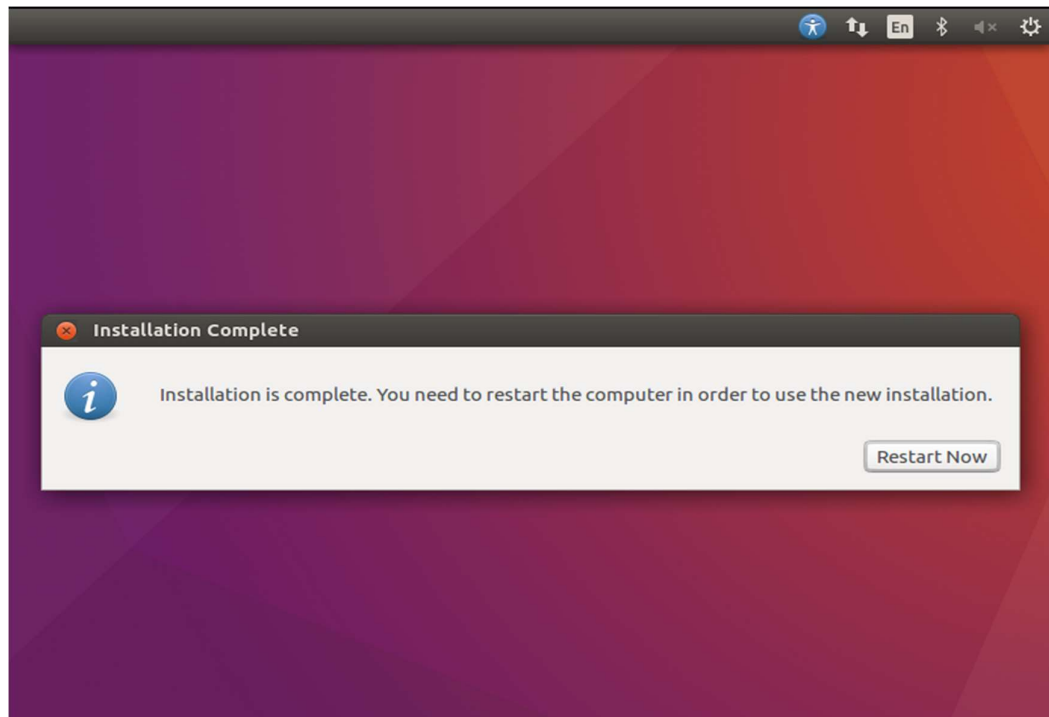
12) Select the keyboard layout as follow.



13) After these steps above, you will see the following page. Now it begin to install the LoRa server OS, and this step will take several minutes or more, just wait patiently.

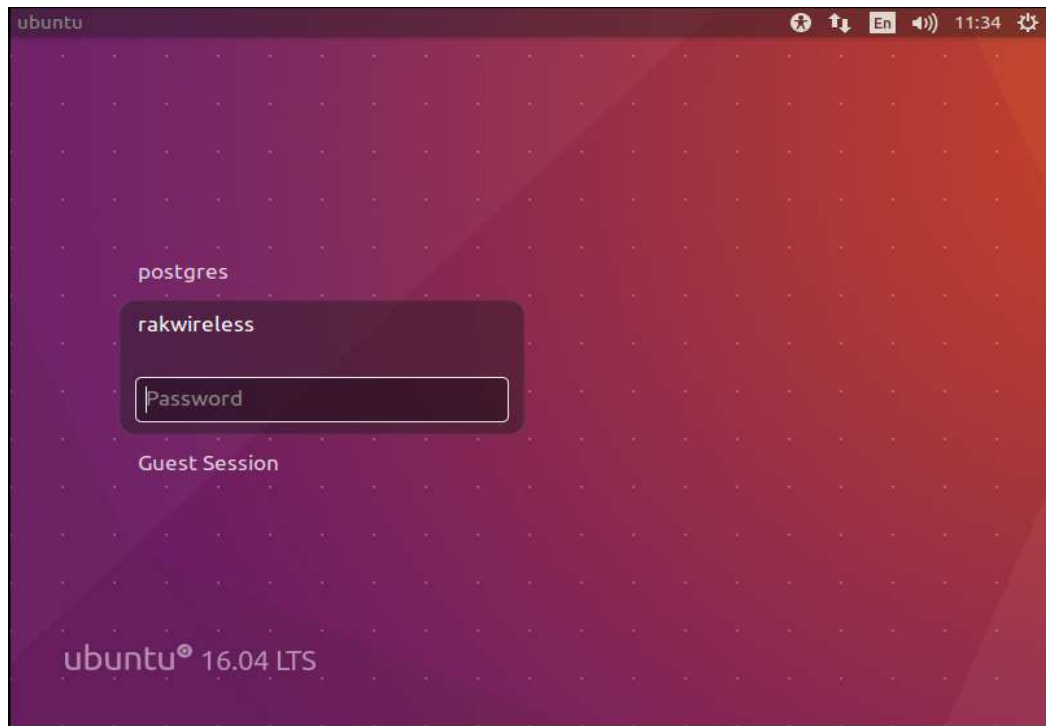


14) When it finishes, you should “Restart Now” in the following page.



15) After restarting, you will see the login page as follow, it means that you have installed the LoRa Server OS successfully! Just select the user “rakwireless”

and type the default password “rakwireless” to enter the OS.



- 16) Now, Configure the IP address of your LoRa server, and remember it because you will use it in the next step when configuring your LoRa gateway.
- 17) What? Don't know how to configure the IP address? Just google or Baidu "How to configure IP address for Ubuntu".

Step 2: Configure your LoRa gateway

There are some kinds of RAK LoRa gateway, e.g. RAK831, RAK833, RAK2243, RAK2247, etc. You may have anyone of them.

In this tutorial, we'll use "RAK2243 + Raspberry Pi + LoRa gateway OS" which have been placed into the box of the RAK LoRa develop Kit you bought as our LoRa gateway to show how to configure it.

Just do as follow:

- 1) Login the Raspberry Pi through SSH, the default username and password are both "admin".

Note: By default, the IP address of the LoRa gateway ethernet is 192.168.10.10, and you can connect to it through wire using a PC and SSH.

For example:

```
jimmy@jimmy-Rak: ~  
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10
```

```
jimmy@jimmy-Rak: ~  
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10  
The authenticity of host '192.168.10.10 (192.168.10.10)' can't be established.  
RSA key fingerprint is SHA256:qf+U1erxKMU0ckmyKkiCPLTFq4rPX2NwrUb4WM7XwKQ.  
Are you sure you want to continue connecting (yes/no)?
```

```
jimmy@jimmy-Rak: ~  
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10  
The authenticity of host '192.168.10.10 (192.168.10.10)' can't be established.  
RSA key fingerprint is SHA256:qf+U1erxKMU0ckmyKkiCPLTFq4rPX2NwrUb4WM7XwKQ.  
Are you sure you want to continue connecting (yes/no)? yes  
Failed to add the host to the list of known hosts (/home/jimmy/.ssh/known_hosts)  
admin@192.168.10.10's password:
```

Note: If you don't know how to use SSH, please google or Baidu.

- 2) After that, you will see the following page, which indicates you have login successfully.


```
jimmy@jimmy-Rak: ~
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10
The authenticity of host '192.168.10.10 (192.168.10.10)' can't be established.
RSA key fingerprint is SHA256:qf+U1erxKMU0ckmyKkiCPLTFq4rPX2NwrUb4WM7XwKQ.
Are you sure you want to continue connecting (yes/no)? yes
Failed to add the host to the list of known hosts (/home/jimmy/.ssh/known_hosts)
admin@192.168.10.10's password:
┌───────────────────────────────────────────────────────────────────────────────────┐
│                                     LORASERVER.IO                               │
└───────────────────────────────────────────────────────────────────────────────────┘

documentation and copyright information: www.loraserver.io

Commands:
> sudo gateway-config - configure the gateway
> sudo monit status   - display service monitor

raspberrypi3:~$ sudo gateway-config
```

```
admin@192.168.10.10's password:
┌───────────────────────────────────────────────────────────────────────────────────┐
│                                     LORASERVER.IO                               │
└───────────────────────────────────────────────────────────────────────────────────┘

documentation and copyright information: www.loraserver.io

Commands:
> sudo gateway-config - configure the gateway
> sudo monit status   - display service monitor

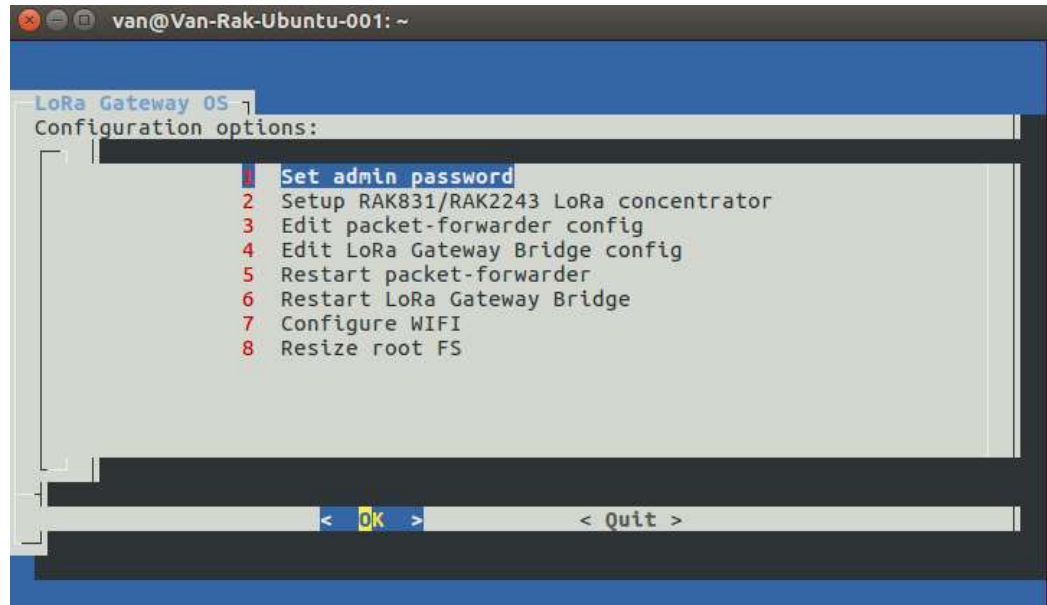
raspberrypi3:~$ sudo gateway-config

We trust you have received the usual lecture from the local System
Administrator. It usually boils down to these three things:

    #1) Respect the privacy of others.
    #2) Think before you type.
    #3) With great power comes great responsibility.

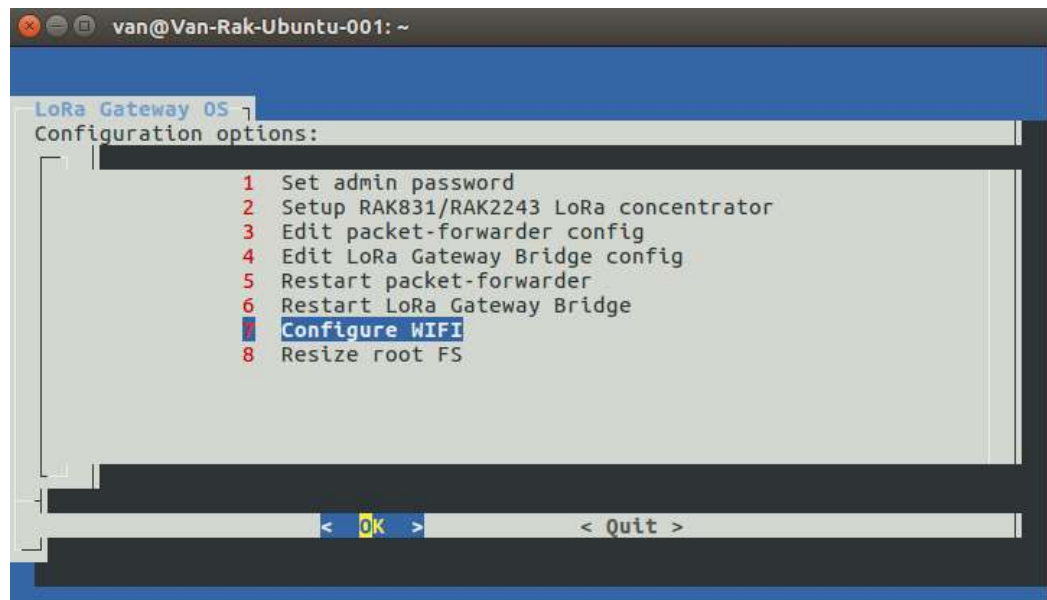
Password: █
```

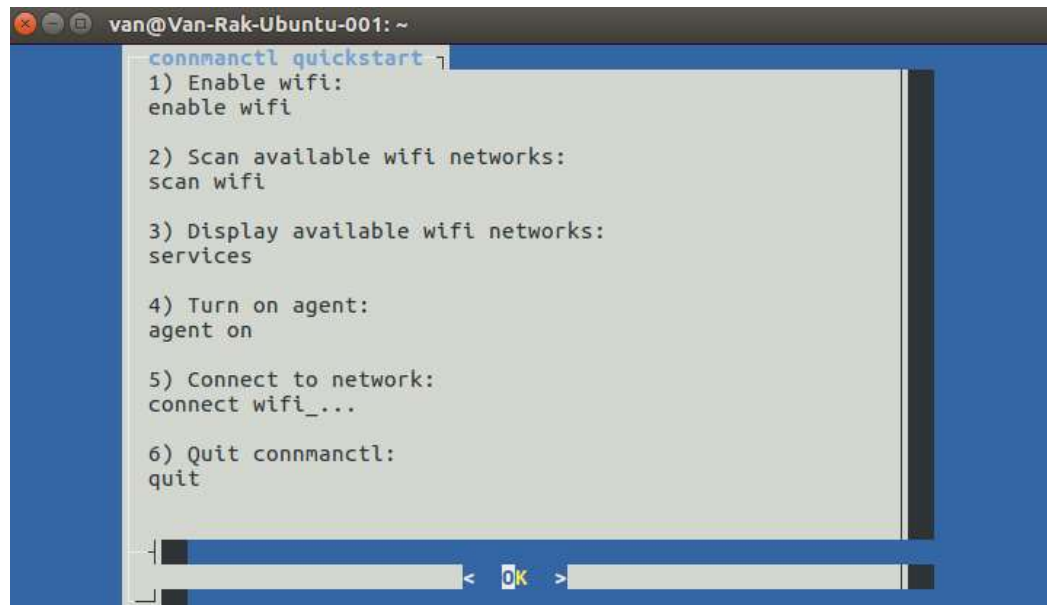
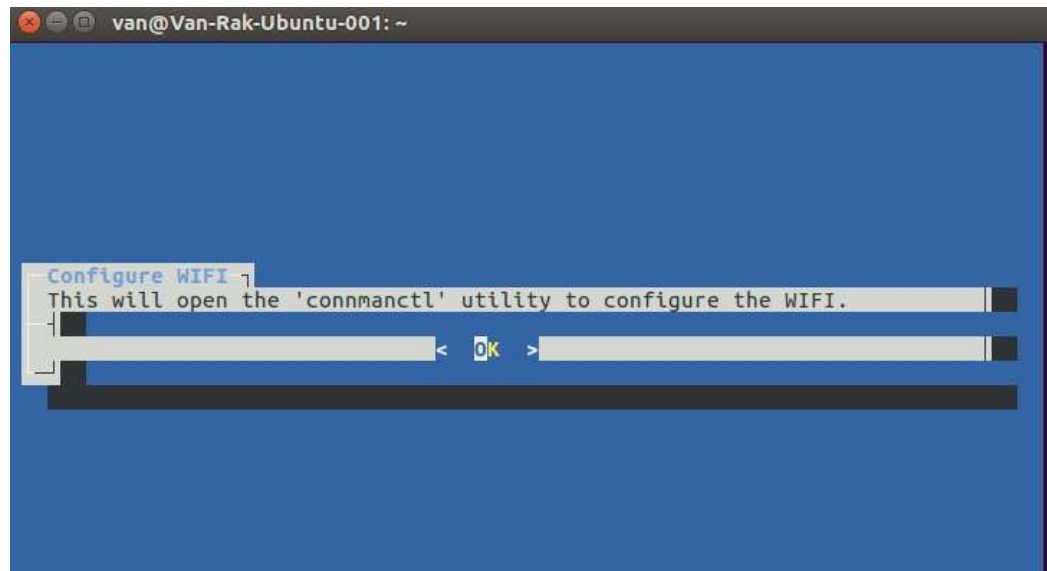
4) Now, you should see a configuration page as follow:



Note: In this tutorial, you may only use the option 1, 2, 3, and 7.

5) If you want to connect the LoRa gateway to a WiFi network, just do as follow:





```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> █
```

Enable WiFi:

```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> enable wifi  
Enabled wifi  
connmanctl> █
```

Scan WiFi:

```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> enable wifi  
Enabled wifi  
connmanctl> scan wifi  
Scan completed for wifi  
connmanctl> █
```

Check services:


```
van@Van-Rak-Ubuntu-001: ~
Error getting VPN connections: The name net.connman.vpn was not provided by any
connmanctl> enable wifi
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired ethernet_b827ebe8a9f8_cable
AccessMe wifi_b827ebdfcad_4163636573734d65_managed_psk
AccessMeTest wifi_b827ebdfcad_4163636573734d6554657374_managed_psk
SENDCOM wifi_b827ebdfcad_53454e44434f4d_managed_psk
WENSEN wifi_b827ebdfcad_57454e53454e_managed_psk
SENFAs wifi_b827ebdfcad_53454e4641_managed_psk
sxxxnyjk wifi_b827ebdfcad_737878786e796a6b_managed_psk
HWJD wifi_b827ebdfcad_48574a44_managed_psk
SXRKGGK wifi_b827ebdfcad_5358524b474b_managed_psk
XAYNKJ wifi_b827ebdfcad_5841594e4b4a_managed_psk
HT-WIFI wifi_b827ebdfcad_48542d57494649_managed_psk
connmanctl>
```

Agent on:

```
van@Van-Rak-Ubuntu-001: ~
Error getting VPN connections: The name net.connman.vpn was not provided by any
connmanctl> enable wifi
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired ethernet_b827ebe8a9f8_cable
AccessMe wifi_b827ebdfcad_4163636573734d65_managed_psk
AccessMeTest wifi_b827ebdfcad_4163636573734d6554657374_managed_psk
SENDCOM wifi_b827ebdfcad_53454e44434f4d_managed_psk
SENFAs wifi_b827ebdfcad_53454e4641_managed_psk
WENSEN wifi_b827ebdfcad_57454e53454e_managed_psk
SXRKGGK wifi_b827ebdfcad_5358524b474b_managed_psk
HWJD wifi_b827ebdfcad_48574a44_managed_psk
TAINENG wifi_b827ebdfcad_5441494e454e47_managed_psk
XAYNKJ wifi_b827ebdfcad_5841594e4b4a_managed_psk
HT-WIFI wifi_b827ebdfcad_48542d57494649_managed_psk
connmanctl> agent on
Agent registered
connmanctl>
```

Connect WiFi as fowllow (notice what you need to enter isn't the SSID):

```
van@Van-Rak-Ubuntu-001: ~
Error getting VPN connections: The name net.connman.vpn was not provided by any
connmanctl> enable wifi
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebddfca4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebddfca4163636573734d6554657374_managed_psk
  SENDCOM          wifi_b827ebddfca453454e44434f4d_managed_psk
  SENFA            wifi_b827ebddfca453454e4641_managed_psk
  WENSEN           wifi_b827ebddfca457454e53454e_managed_psk
  SXRKKGK          wifi_b827ebddfca45358524b474b_managed_psk
  HWJD             wifi_b827ebddfca448574a44_managed_psk
  TAINENG          wifi_b827ebddfca45441494e454e47_managed_psk
  XAYNKJ           wifi_b827ebddfca45841594e4b4a_managed_psk
  HT-WIFI          wifi_b827ebddfca448542d57494649_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebddfca4163636573734d65_managed_psk
Agent RequestInput wifi_b827ebddfca4163636573734d65_managed_psk
  Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase? █
```

After entering the password, if you see “connected ...”, it indicates the LoRa gateway has connected WiFi successfully.

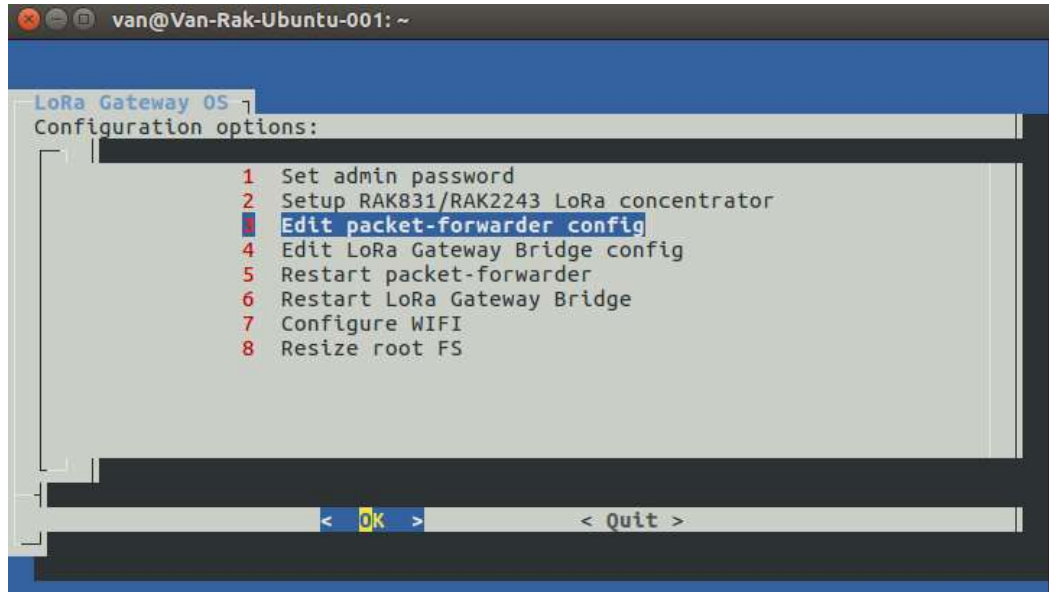
```
van@Van-Rak-Ubuntu-001: ~
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebddfca4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebddfca4163636573734d6554657374_managed_psk
  SENDCOM          wifi_b827ebddfca453454e44434f4d_managed_psk
  SENFA            wifi_b827ebddfca453454e4641_managed_psk
  WENSEN           wifi_b827ebddfca457454e53454e_managed_psk
  sxxxnyjk         wifi_b827ebddfca4737878786e796a6b_managed_psk
  SXRKKGK          wifi_b827ebddfca45358524b474b_managed_psk
  HWJD             wifi_b827ebddfca448574a44_managed_psk
  HT-WIFI          wifi_b827ebddfca448542d57494649_managed_psk
  XAYNKJ           wifi_b827ebddfca45841594e4b4a_managed_psk
  TAINENG          wifi_b827ebddfca45441494e454e47_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebddfca4163636573734d65_managed_psk
Agent RequestInput wifi_b827ebddfca4163636573734d65_managed_psk
  Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase? rakwireless.2018
Connected wifi_b827ebddfca4163636573734d65_managed_psk
connmanctl> █
```

Then quit the WiFi configuration page:

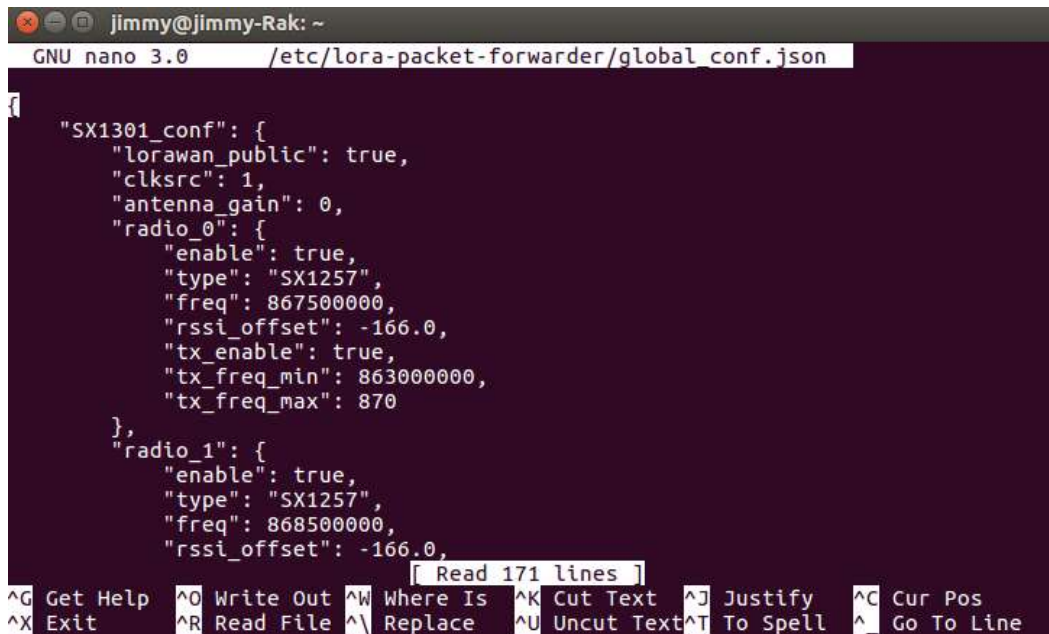
```
van@Van-Rak-Ubuntu-001: ~
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired
AccessMe ethernet_b827ebe8a9f8_cable
AccessMeTest wifi_b827ebdbfcad_4163636573734d65_managed_psk
SENDCOM wifi_b827ebdbfcad_53454e44434f4d_managed_psk
SENFA wifi_b827ebdbfcad_53454e4641_managed_psk
WENSEN wifi_b827ebdbfcad_57454e53454e_managed_psk
sxxxnyjk wifi_b827ebdbfcad_737878786e796a6b_managed_psk
SXRKGGK wifi_b827ebdbfcad_5358524b474b_managed_psk
HWJD wifi_b827ebdbfcad_48574a44_managed_psk
HT-WIFI wifi_b827ebdbfcad_48542d57494649_managed_psk
XAYNKJ wifi_b827ebdbfcad_5841594e4b4a_managed_psk
TAINENG wifi_b827ebdbfcad_5441494e454e47_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebdbfcad_4163636573734d65_managed_psk
Agent RequestInput wifi_b827ebdbfcad_4163636573734d65_managed_psk
Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase? rakwireless.2018
Connected wifi_b827ebdbfcad_4163636573734d65_managed_psk
connmanctl> quit
```

```
van@Van-Rak-Ubuntu-001: ~
LoRa Gateway OS
Configuration options:
1 Set admin password
2 Setup RAK831/RAK2243 LoRa concentrator
3 Edit packet-forwarder config
4 Edit LoRa Gateway Bridge config
5 Restart packet-forwarder
6 Restart LoRa Gateway Bridge
7 Configure WIFI
8 Resize root FS
< OK > < Quit >
```

6) When you power on this LoRa gateway firstly, it works on EU868(EU_863_870) and points to the internal LoRa server by default. If you want to check the detail, you can select the option 3



7) Now, you can see the detail of the “global_conf.json” file:



Note: Do you see the gateway ID in the end of this file as shown as the following picture? It is important to remember it!

```
jimmy@jimmy-Rak: ~
GNU nano 3.0 /etc/lora-packet-forwarder/global_conf.json

"gateway_conf": {
  "gateway_ID": b827ebffffee8a9f8,
  /* change with default server address/ports, or overwrite in lo$
  "server_address": "router.eu.thethings.network",
  "serv_port_up": 1700,
  "serv_port_down": 1700,
  /* adjust the following parameters for your network */
  "keepalive_interval": 10,
  "stat_interval": 30,
  "push_timeout_ms": 100,
  /* forward only valid packets */
  "forward_crc_valid": true,
  "forward_crc_error": false,
  "forward_crc_disabled": false,
  /* gps enable */
  "gps": true,
  "gps_tty_path": "/dev/i2c-1",
  "fake_gps": false,
  "ref_latitude": 10,
}

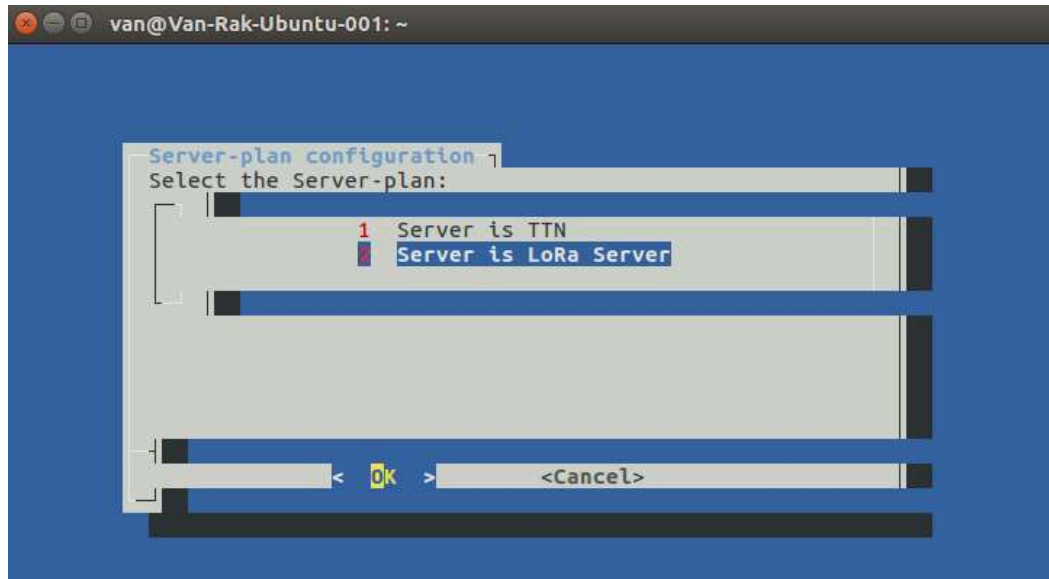
^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File  ^\ Replace   ^U Uncut Text ^T To Spell  ^_ Go To Line
```

8) Now, let's modify the IP address of the LoRa server which the gateway points to, just do as follow:

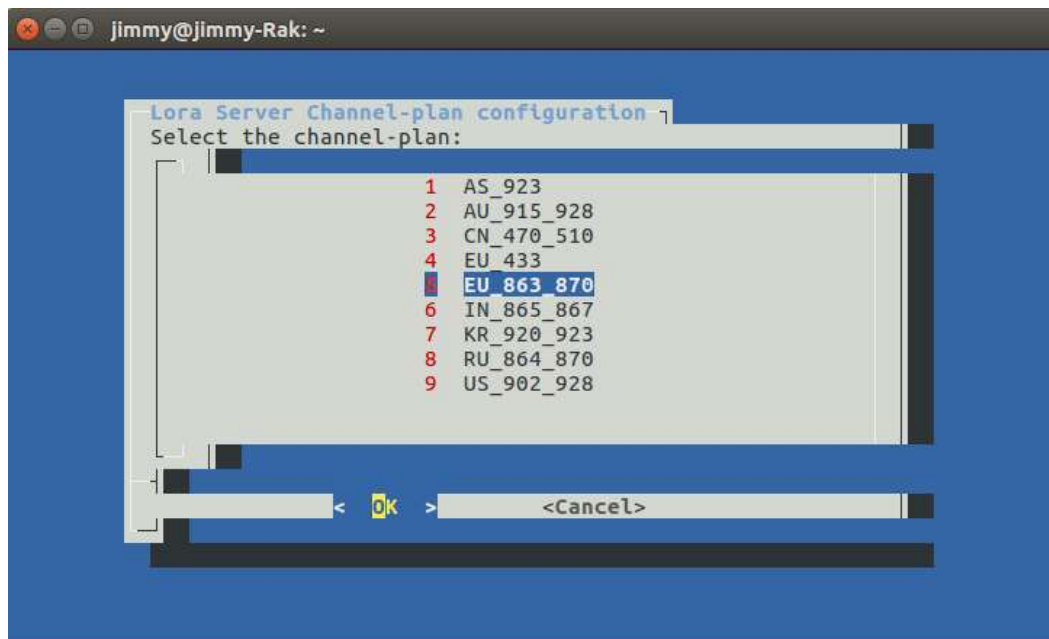
Firstly, select the option 2 "Setup RAK831/RAK2243 LoRa concentrator".

```
van@Van-Rak-Ubuntu-001: ~
LoRa Gateway 05
Configuration options:
1 Set admin password
2 Setup RAK831/RAK2243 LoRa concentrator
3 Edit packet-forwarder config
4 Edit LoRa Gateway Bridge config
5 Restart packet-forwarder
6 Restart LoRa Gateway Bridge
7 Configure WIFI
8 Resize root FS
< OK > < Quit >
```

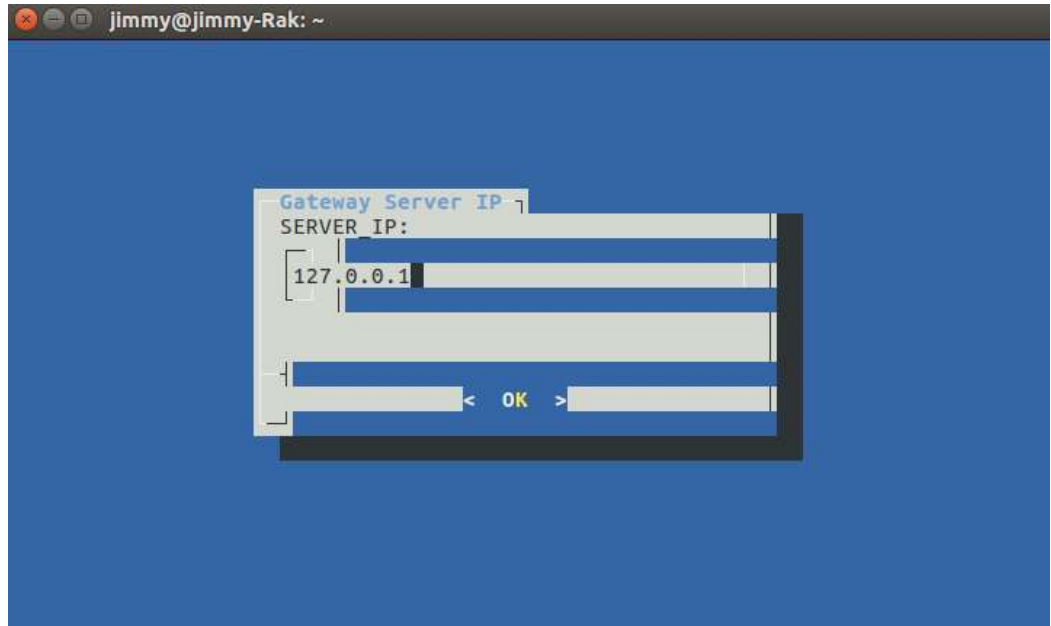
Then, select the Server-plan 2 "Server is LoRa Server":



Select the channel-plan 5 to set the EU_863_870 frequency.

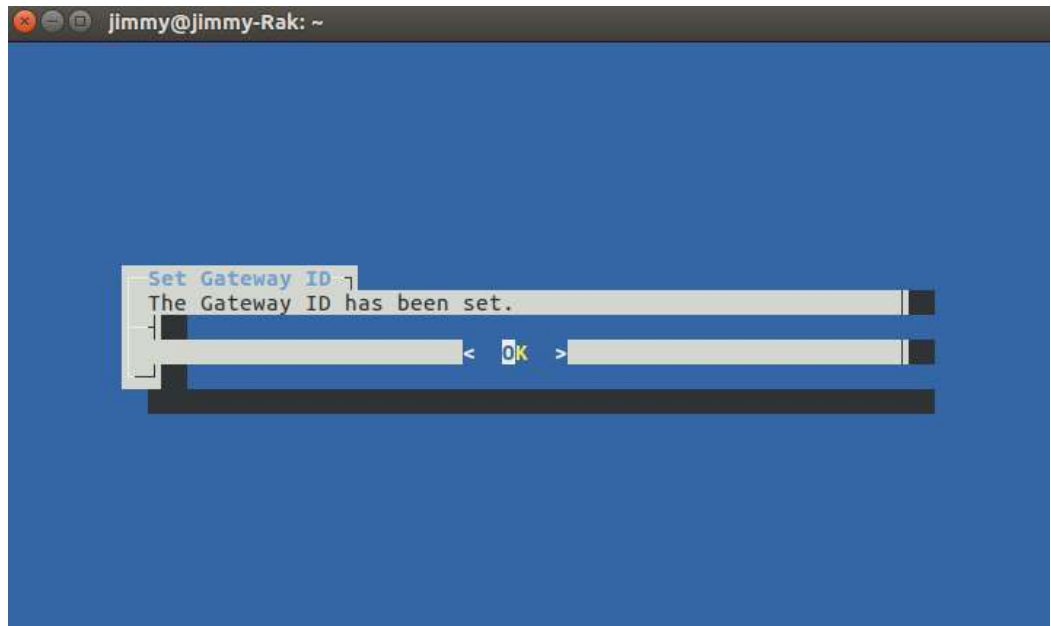


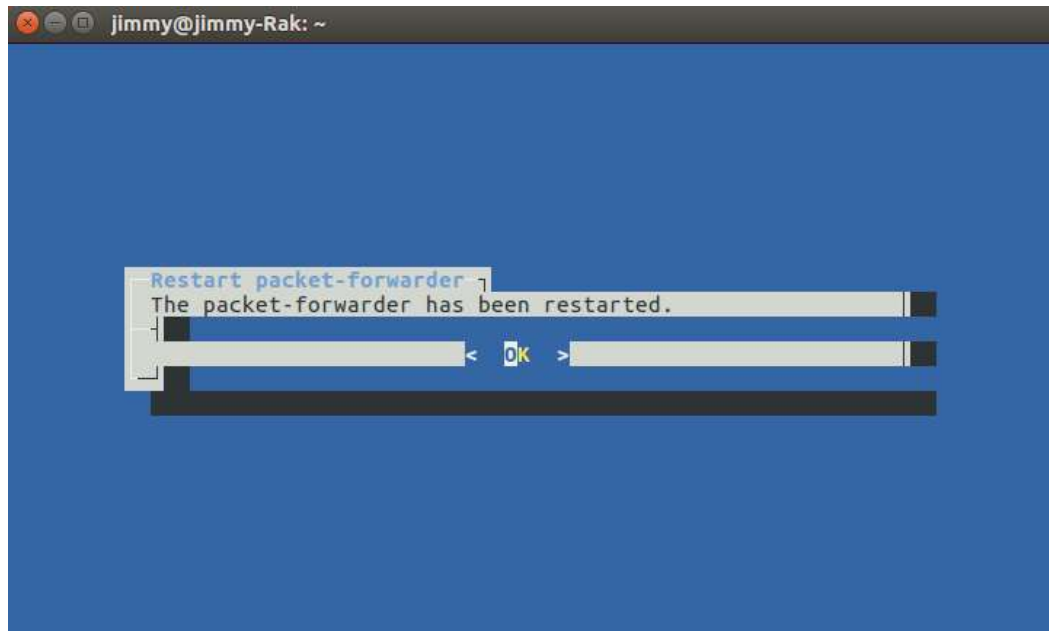
9) Enter the IP address of the LoRa server you want to use.



Note: "127.0.0.1" is the default IP address, and it indicates the internal LoRa server. You can enter the IP address of your independent LoRa server which has been setup in the step 1.

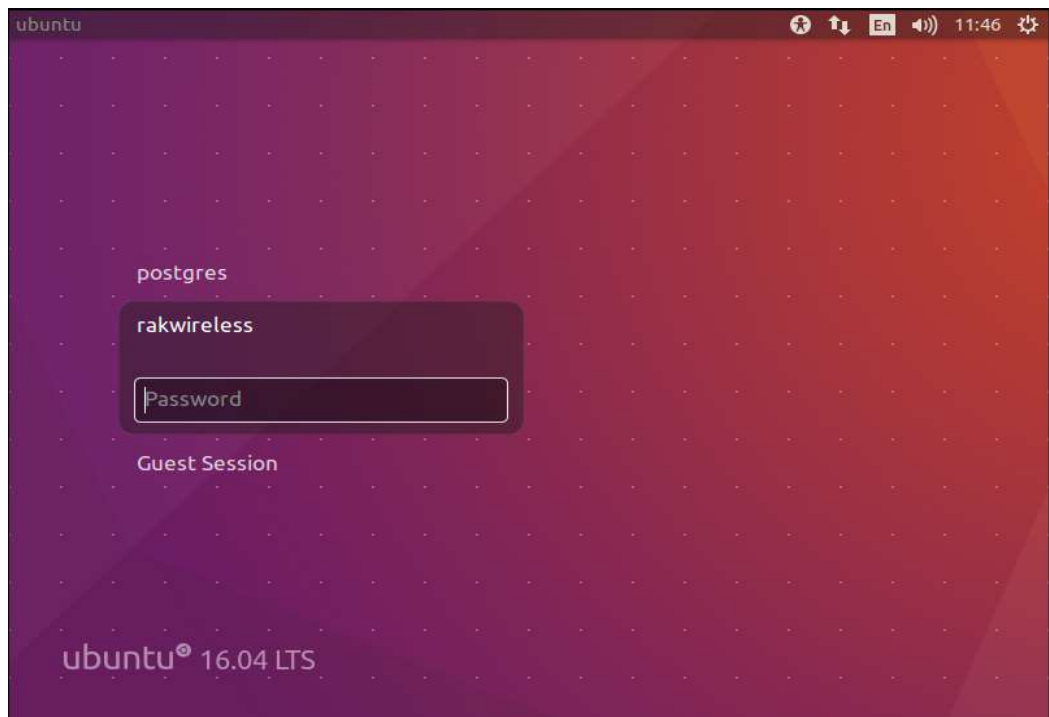
- 10) After enter the IP address of your independent LoRa server and "OK", you will need two more "OK" as follow:



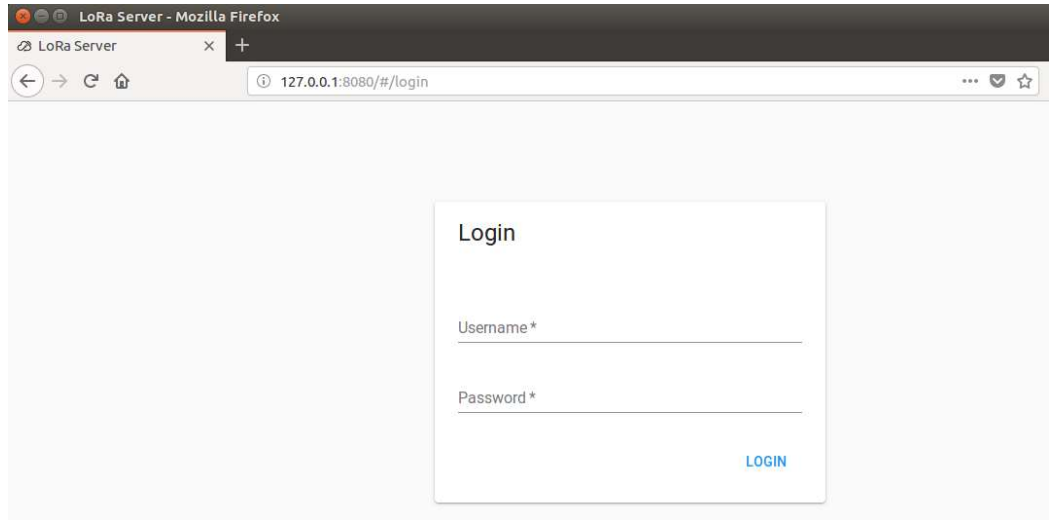


Step 3: Configure your LoRa server to add a LoRa gateway.

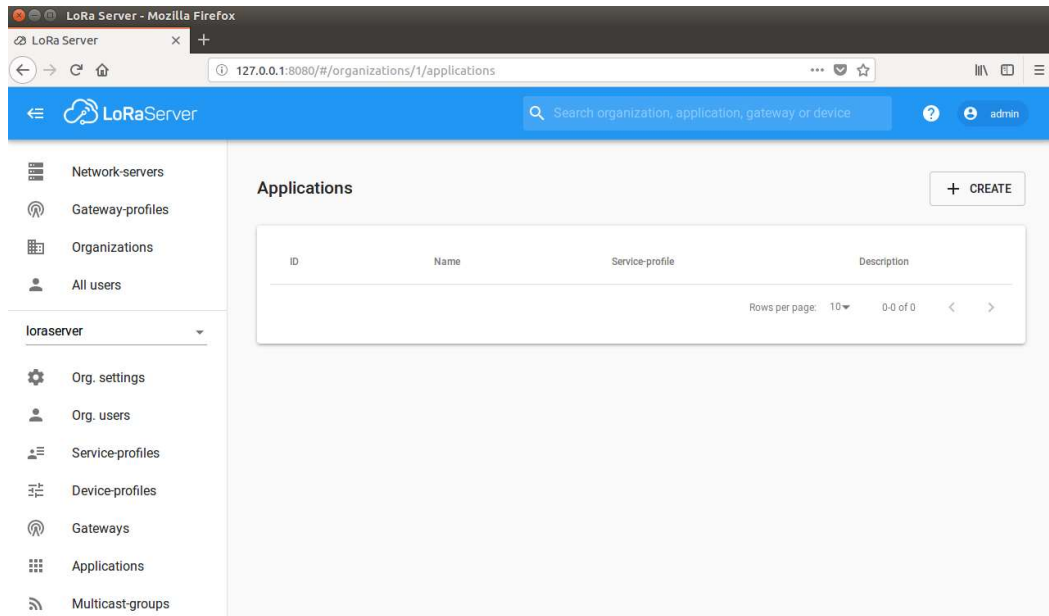
- 1) Login the PC installed the LoRa server OS.



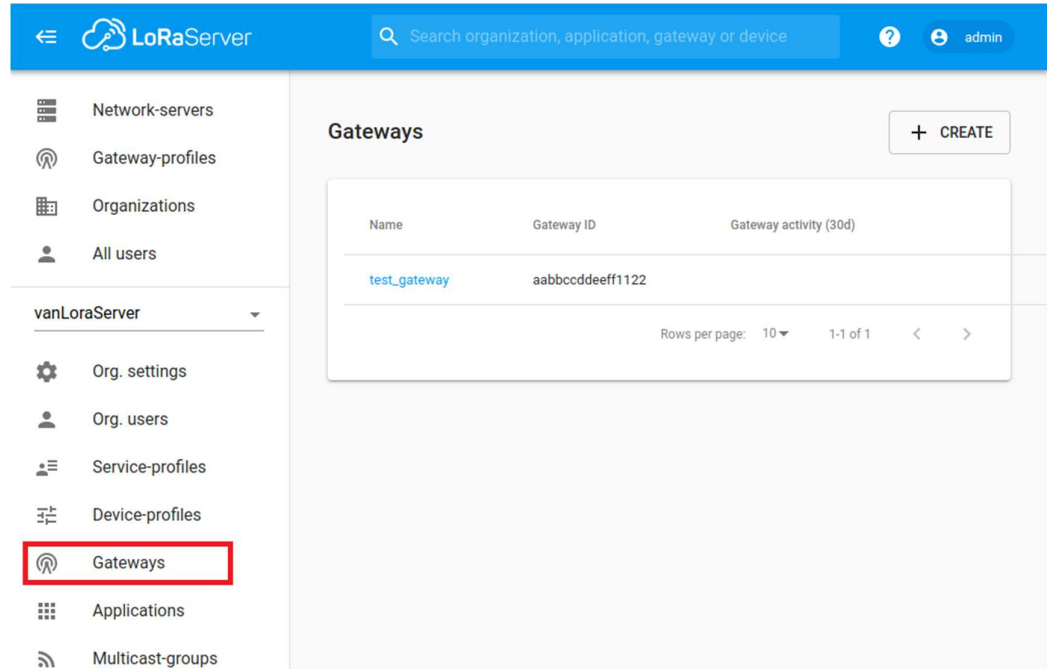
- 2) Open the browser and type <http://127.0.0.1:8080>, you will see the login page of LoRa server as follow:



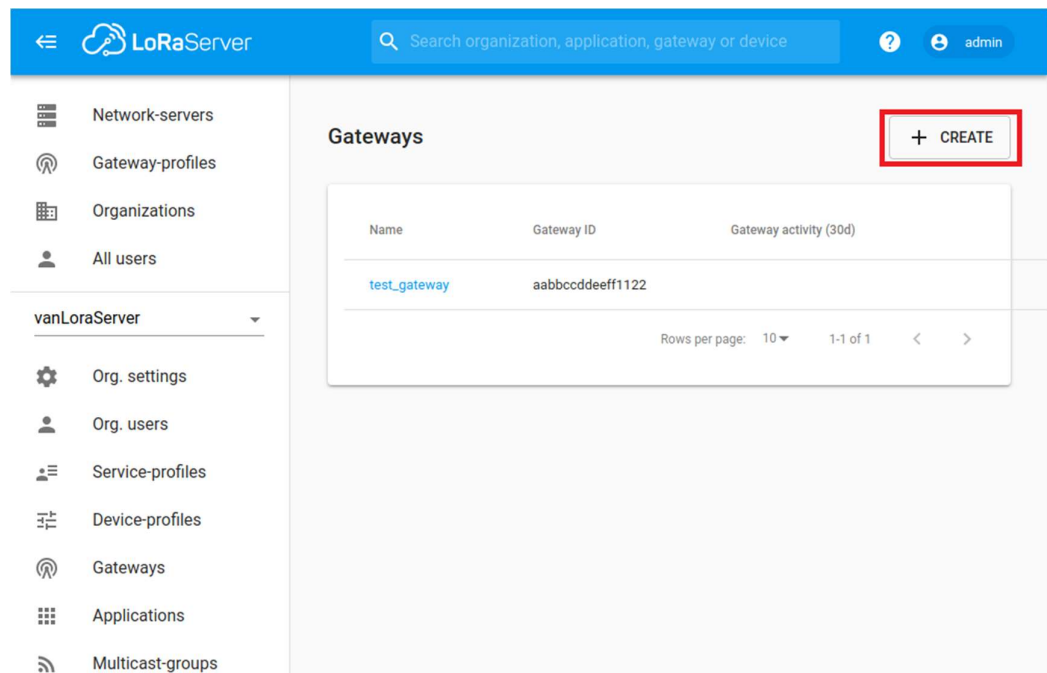
3) Login the LoRa server. The default username and password are both “admin”.



4) Click the “Gateways” in the left menu of the page. There is already a LoRa gateway which has been added, but it is only used to show as a demo and you can also delete it.



- 5) Create a new item for your LoRa gateway by Click the “CREATE” button in the upper right corner of the following page.



- 6) Then, you can see the following page and just fill them as follow except “Gateway name”, “Gateway description”, and “Gateway ID”. “Gateway name” and “Gateway description” can be filled in with any contents you want, but you must fill in “Gateway ID” with the gateway EUI/ID which you

got in the step 2.

← LoRaServer Search organization, application, gateway or device ? admin

- Network-servers
- Gateway-profiles
- Organizations
- All users

vanLoraServer

- Org. settings
- Org. users
- Service-profiles
- Device-profiles
- Gateways
- Applications
- Multicast-groups

Gateways / Create

Gateway name *
test_gateway
The name may only contain words, numbers and dashes.

Gateway description *
test_gateway

Gateway ID *
AABBCCDDEEFF1122

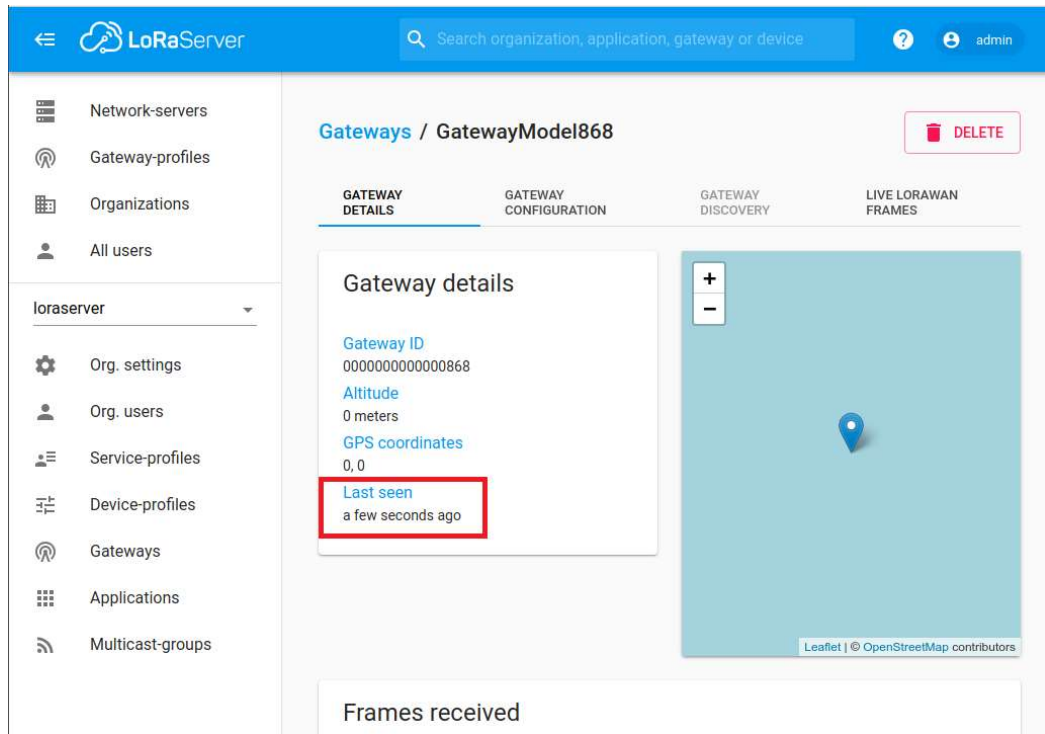
Network-server *
test_network_servers
Select the network-server to which the gateway will connect. When no network-servers are available in the dropdown, make sure a service-profile exists for this organization.

Gateway-profile
test_gateway_profiles ✕

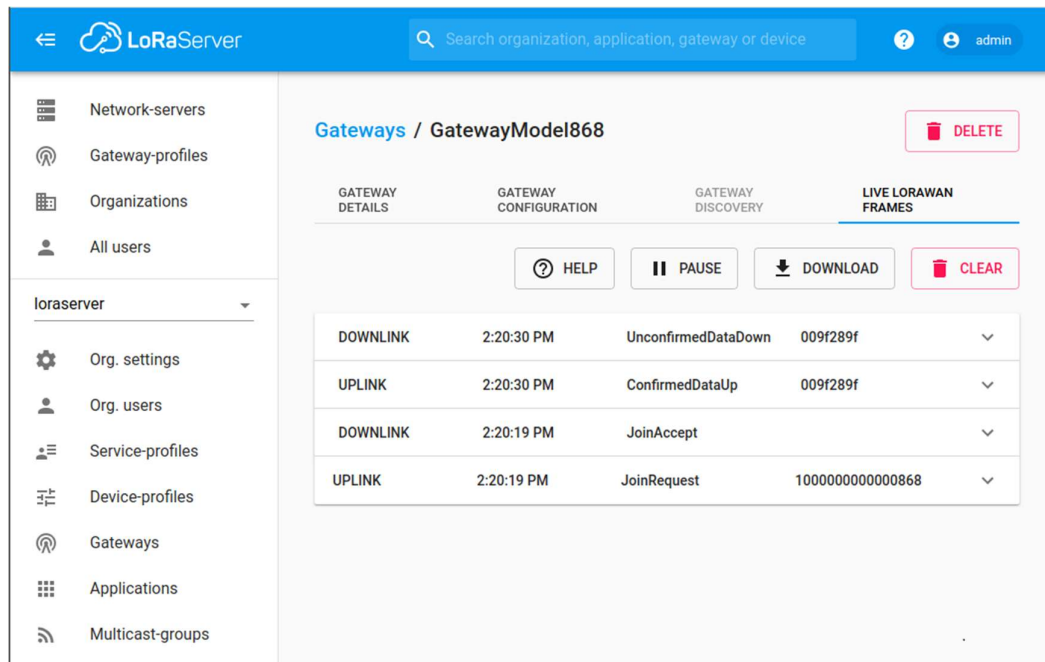
Gateway discovery enabled
When enabled (and LoRa Server is configured with the gateway discover feature enabled), the gateway will send out periodical pings to test its coverage by other gateways in the same network.

Gateway altitude (meters) *
0
When the gateway has an onboard GPS this value will be set automatically when the network receives statistics.

7) If your LoRa gateway has connected with the LoRa server (ping successfully), you can see the following state page.



8) Congratulations! That means your LoRa gateway has been online now!



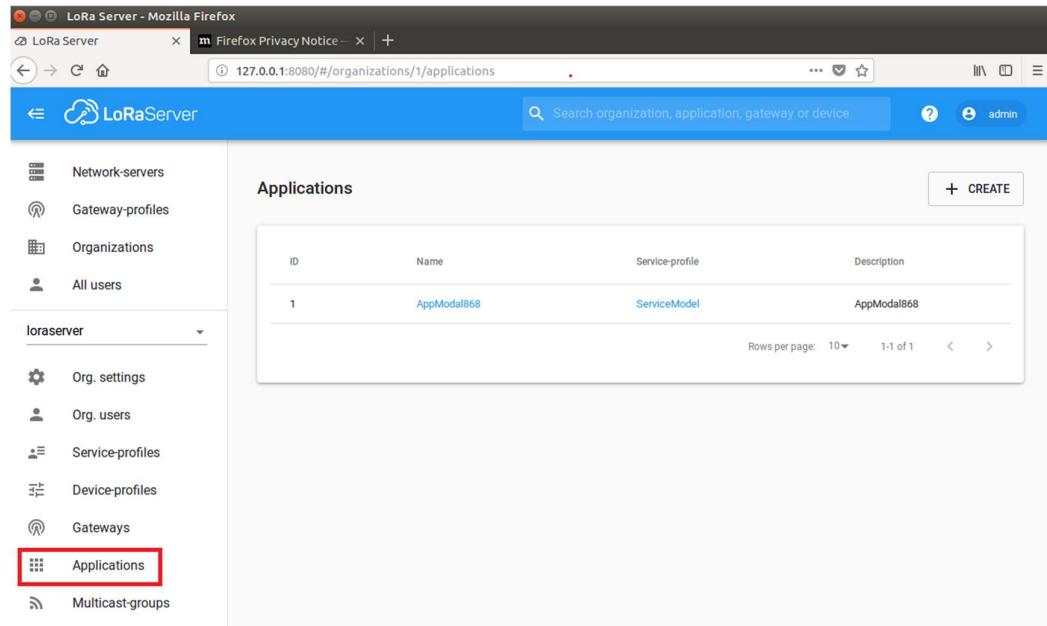
Step 4: Configure your LoRa application server to add a LoRa node.

Actually, you can skip this step by using the preconfigured LoRa node content which we have been placed in the LoRa box you bought, including dev_eui, app_eui,

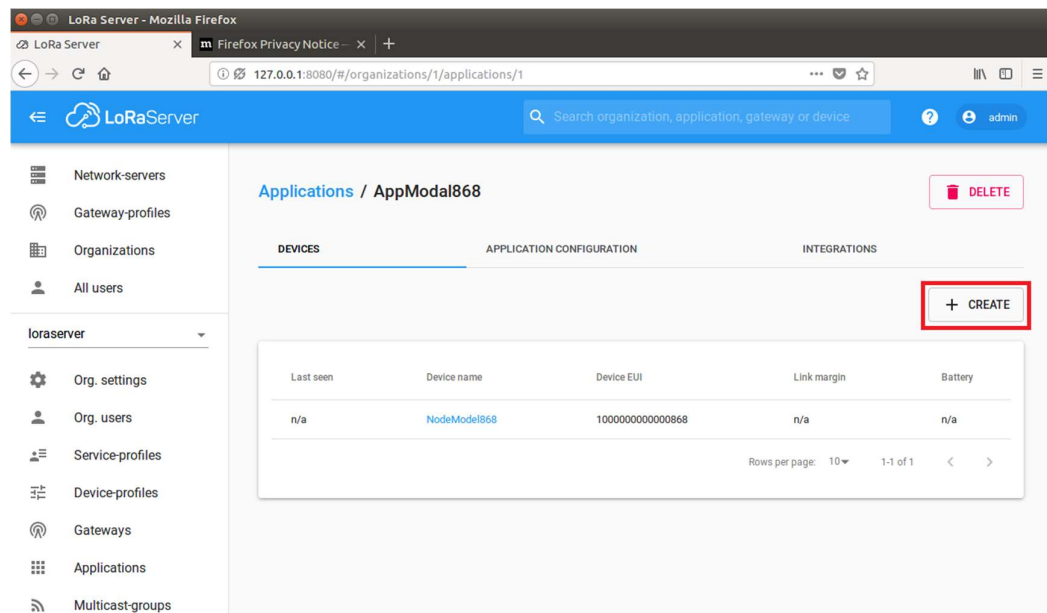
and app_key, just for testing.


If you want to create a new LoRa node in your application server, please do it as follow:

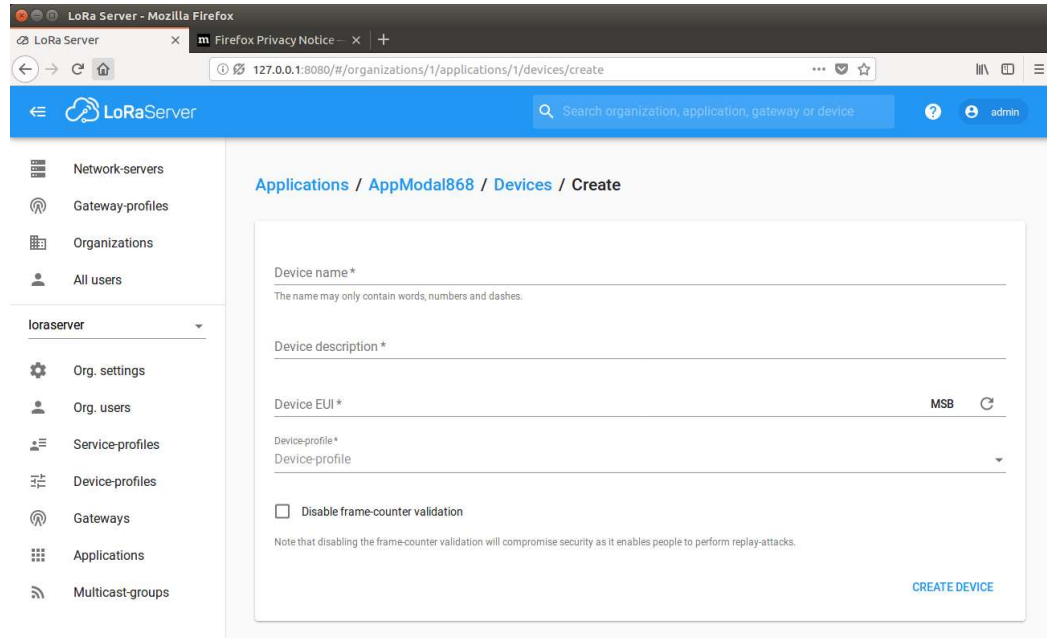
- 1) Click “Application” in the left menu of the following page.



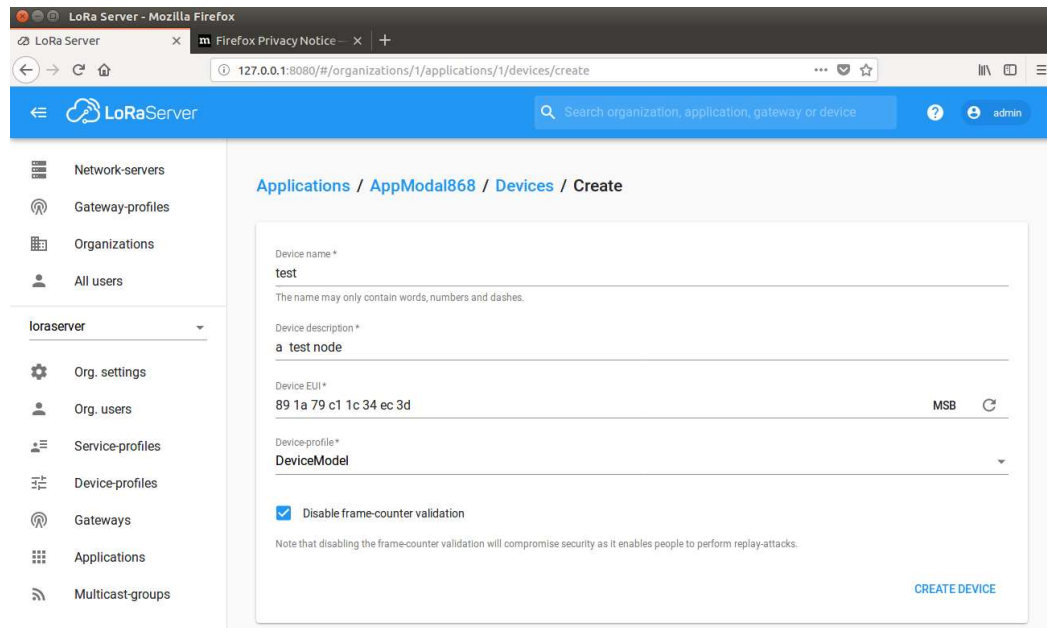
- 2) Click the existed application name, like “AppModal868” in the above page, to enter the following page, then click the “CREATE” button to add a LoRa node.




- 3) Fill in “Device name” and “Device description” freely. Fill in “Device EUI” or click  to generate randomly. Select a item for “Device-profile” and select the check box “Disable frame-counter validation”. Then click “CREATE DEVICE” in the lower right corner.

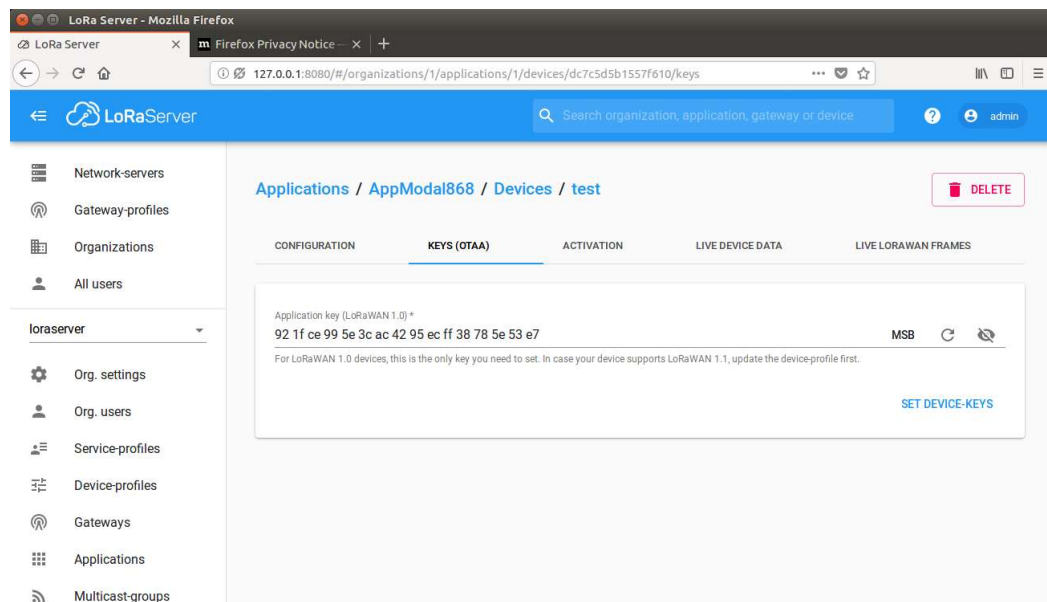
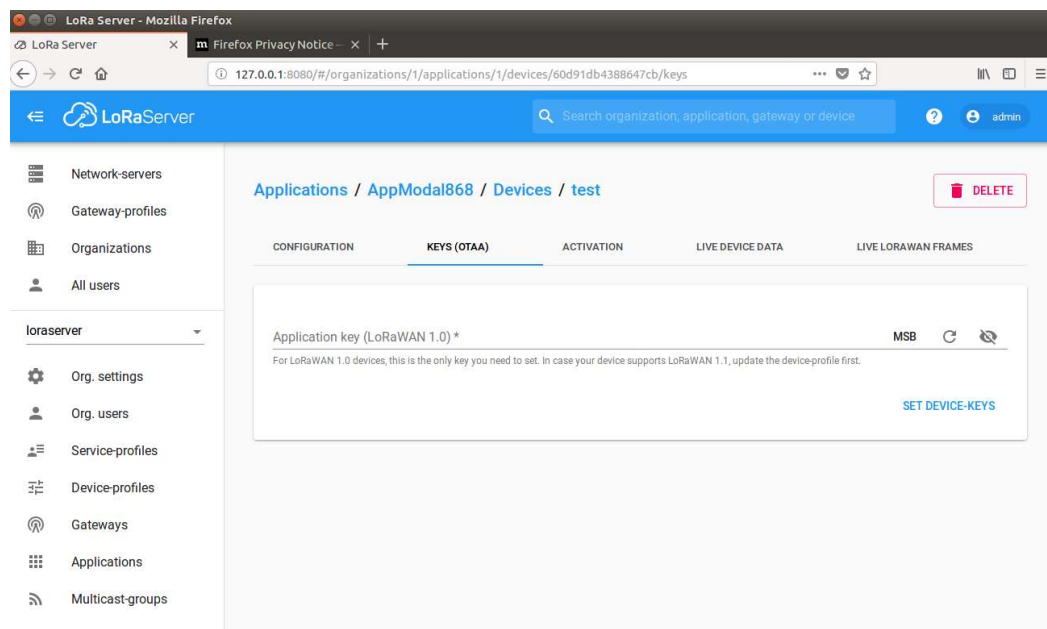


For example:



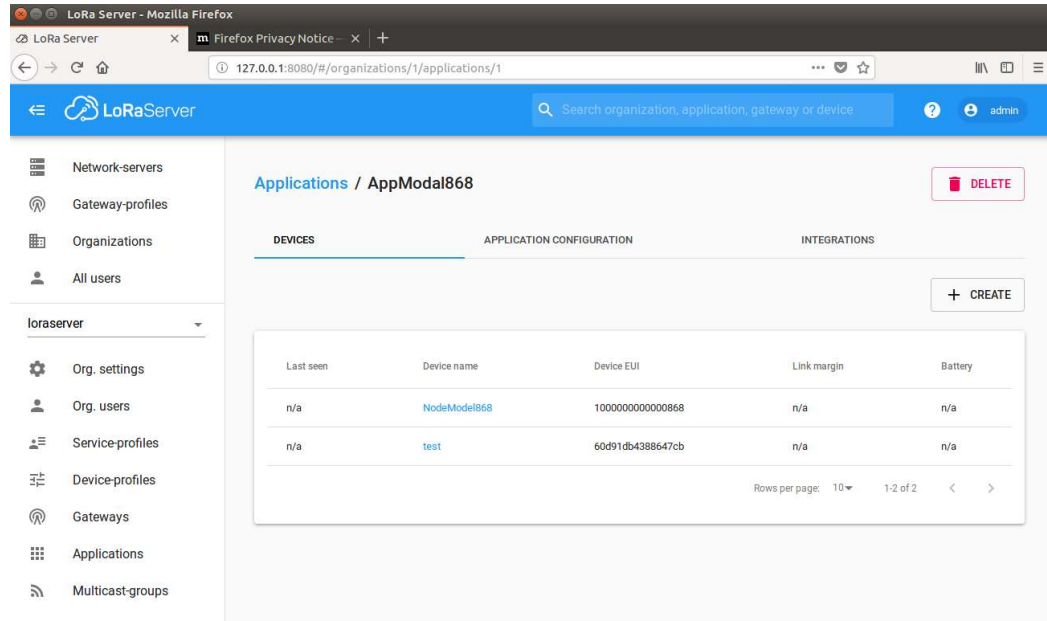
Note: Remember the value of Device EUI you have set, because it will be used on your LoRa node as `dev_eui`.

- 4) Set Application key. You can also click  to generate randomly. Then click "SET DEVICE-KEYS".

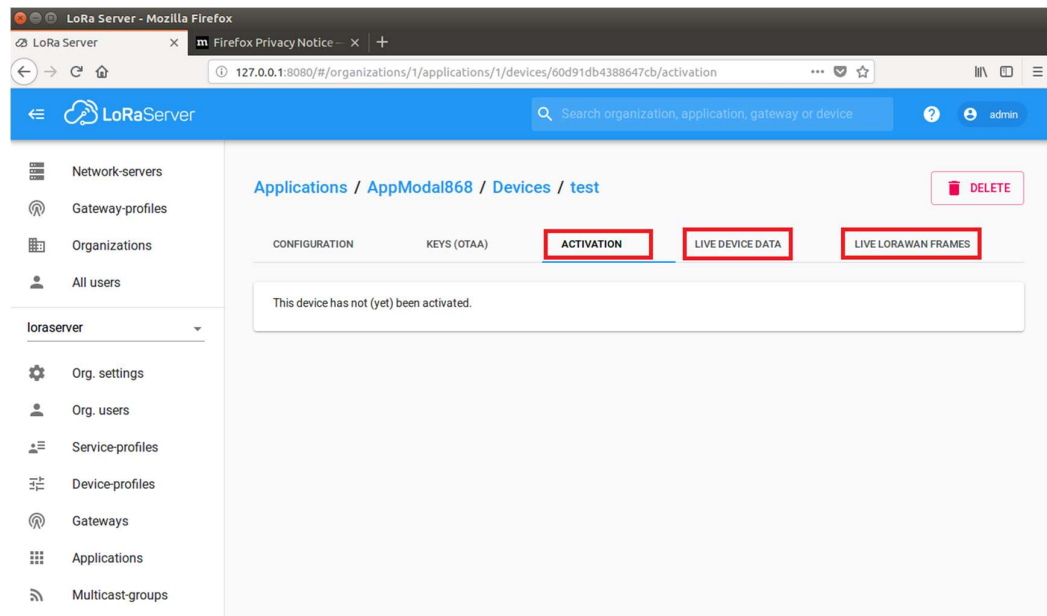


Note: Remember the value of this key you have set, because it will be used on your LoRa node as `app_key`.

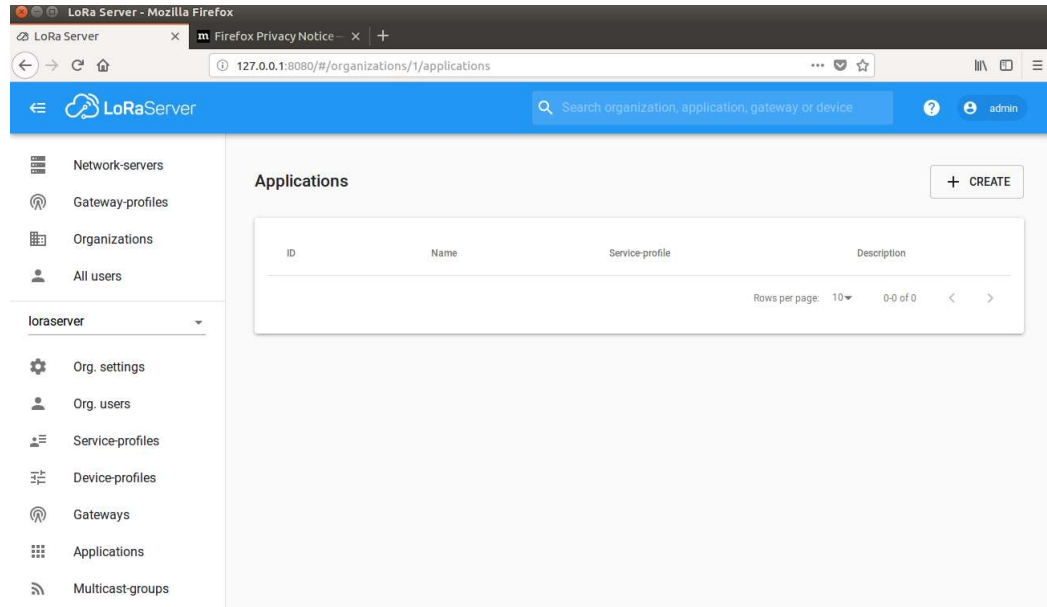
- 5) OK, you've added a LoRa node successfully now.



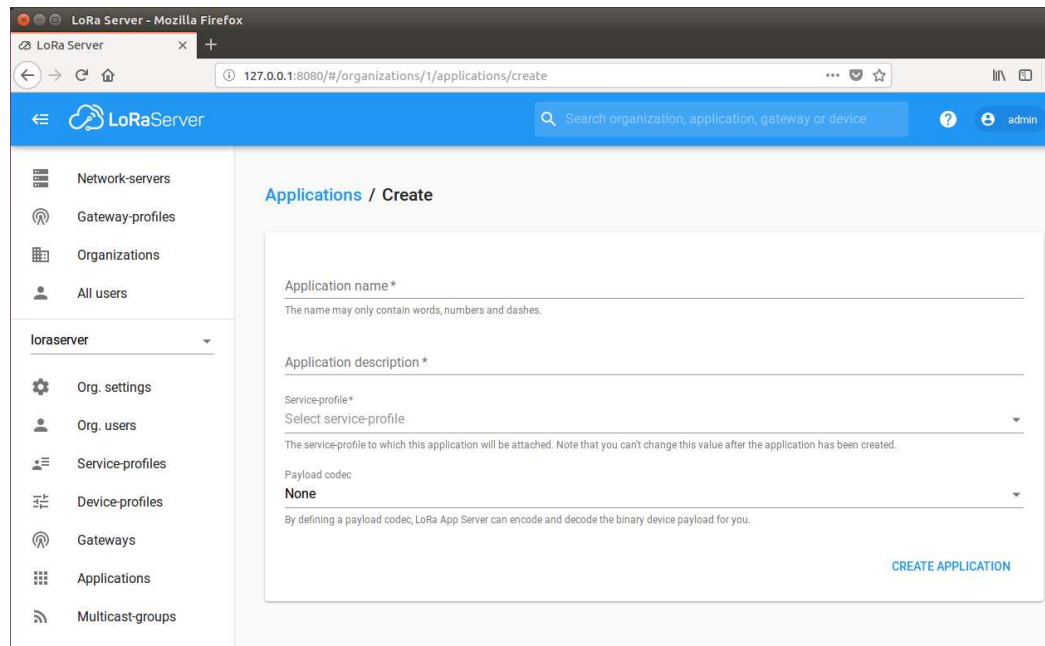
- 6) Once a LoRa node, which has been set with the dev_eui and app_key generated above, joins and sends data, you will see the contents on the following pages.



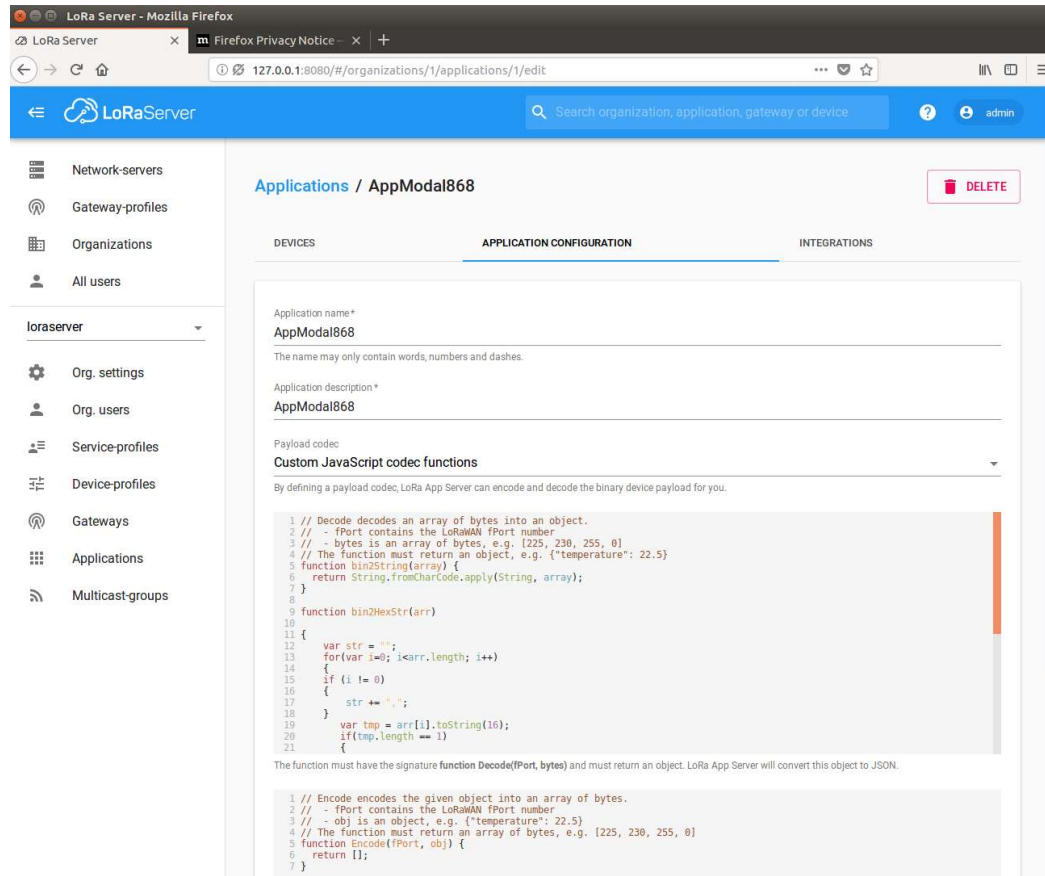
What? There is no existed Applications item like the following page showing or you want to add a new Applications item? Just do something as follow to create a new application before creating a new LoRa node. Otherwise, just skip to the step 5.



Click “CREATE” to add a new application. You can see the following page and fill in “Application name” and “Application description” with any contents freely, select an item for “Service-profile”. Then you need to select the “Custom JavaScript codec functions” item for “Payload Codec” to decode the received uplink payloads from bytes to a meaningful data object and to encode downlink data objects to bytes.



For example:



Note: When you select “Custom JavaScript codec functions” item for “Payload Codec”, you need to copy the following contents to the first source code edit box on the above page:

```
// Decode decodes an array of bytes into an object.

// - fPort contains the LoRaWAN fPort number

// - bytes is an array of bytes, e.g. [225, 230, 255, 0]

// The function must return an object, e.g. {"temperature": 22.5}
```

```
function bin2String(array)
{
    return String.fromCharCode.apply(String, array);
}
```

```
function bin2HexStr(arr)
{
    var str = "";
```

```

for(var i=0; i<arr.length; i++)

{

    if (i != 0)

    {

        str += ",";

    }

    var tmp = arr[i].toString(16);

    if(tmp.length == 1)

    {

        tmp = "0" + tmp;

    }

    str += "0x";

    str += tmp;

}

return str;

}

function Decode(fPort, bytes)

{

    var myObj = {"DecodeDataString":"","DecodeDataHex":""};

    var toString=bin2String(bytes);

    var toHextring=bin2HexStr(bytes);

    myObj.DecodeDataString = toString;

    myObj.DecodeDataHex = toHextring;

    return myObj;

}

```

Then copy the following contents to the second source code edit box:

```

// Encode encodes the given object into an array of bytes.

// - fPort contains the LoRaWAN fPort number

```



```
// - obj is an object, e.g. {"temperature": 22.5}

// The function must return an array of bytes, e.g. [225, 230, 255, 0]

function Encode(fPort, obj)

{

    return [];

}

}
```

Step 5: Set your LoRa node to join the LoRaWAN network.

In this tutorial, we use RAK811 as LoRa node to show how a LoRa node could join the LoRaWAN network.

- 4) Set the dev_eui and app_key, which you got in the step 4, into the LoRa node through AT command.

For example:

```
[10:03:47.639]发->◇attset_config=dev_eui:100000000000868
□
[10:03:48.808]收<-◆OK

[10:03:59.414]发->◇attset_config=app_eui:70B3D57ED00157D1
□
[10:04:00.584]收<-◆OK

[10:04:12.070]发->◇attset_config=app_key:1111111111111111111111111111868
□
[10:04:13.241]收<-◆OK
|
```

- 5) Join the LoRaWAN network through AT command.

“at+recv=3,0,0” indicates that the LoRa node has joined the LoRaWAN network successfully.

```
[10:49:19.615]发->◇attjoin=otaa
□
[10:49:19.657]收<-◆OK
[10:49:26.159]收<-◆at+recv=3,0,0
```

- 6) Try to send some data to the application server.

For example:

```
[10:50:33.991]发->◇attsend=1,3,48454c4c4f20574f524c44
□
[10:50:34.002]收<-◆OK
[10:50:37.837]收<-◆at+recv=1,0,0
```

“at+recv=1,0,0” indicates the LoRa node has sent the data successfully.

7) Now you can see the contents sent by LoRa node on the LoRa application page as follow.

The screenshot shows the LoRaServer interface. The left sidebar contains navigation options: Network-servers, Gateway-profiles, Organizations, All users, and a dropdown for 'loraserver' with sub-items: Org. settings, Org. users, Service-profiles, Device-profiles, Gateways, Applications, and Multicast-groups. The main content area is titled 'Applications / AppModal868 / Devices / NodeModel868' and includes a 'DELETE' button. Below the title are tabs for 'ACTIVATION', 'KEYS (OTAA)', 'ACTIVATION', 'LIVE DEVICE DATA', and 'LIVE LORAWAN FRAMES'. The 'LIVE LORAWAN FRAMES' tab is active, showing a table with columns for direction, time, and message type. The UPLINK row is highlighted with a red box.

DIRECTION	TIME	MESSAGE TYPE	PAYLOAD
DOWNLINK	9:45:20 AM	JoinAccept	
UPLINK	9:45:20 AM	JoinRequest	100000000000868

The screenshot shows the detailed view of the UPLINK frame. The frame is an uplink message at 9:54:34 AM. The 'object' field is expanded to show 'DecodeDataHex' as '0x48,0x45,0x4c,0x4c,0x4f,0x20,0x57,0x4f,0x52,0x4c,0x44' and 'DecodeDataString' as 'HELLO WORLD!'. The 'D' field shows gatewayID, loRaSNR, and location.

```
9:54:34 AM    uplink

  adr: true
  applicationID: "1"
  applicationName: "AppModal868"
  data: "SEVMTE8gV09STEQ="
  devEUI: "100000000000868"
  deviceName: "NodeModel868"
  fCnt: 2
  fPort: 3
  object: { 2 keys
    DecodeDataHex: "0x48,0x45,0x4c,0x4c,0x4f,0x20,0x57,0x4f,0x52,0x4c,0x44"
    DecodeDataString: "HELLO WORLD!"
  }
  D: { 5 keys
    gatewayID: "000000000000868"
    loRaSNR: 8.5
    location: { 3 keys
      altitude: 0
    }
  }

```

Case 3: I want to set up a LoRa network quickly, but I want to use TTN as my LoRa server.

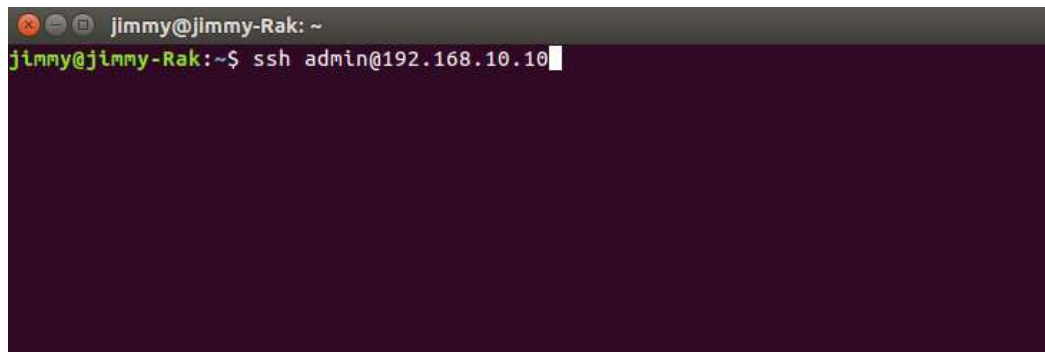
Just do as the following steps:

Step 1: Configure your LoRa gateway

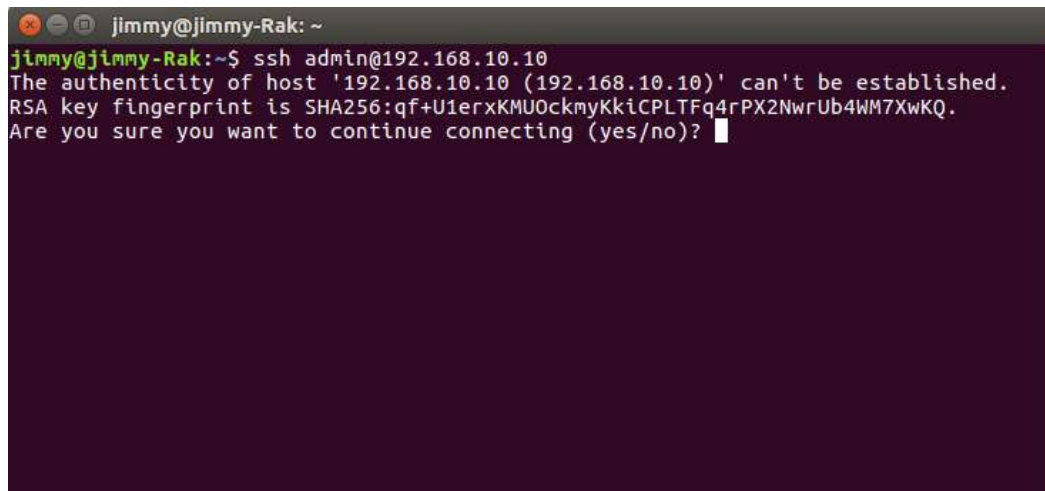
- 1) Login the Raspberry Pi through SSH, the default username and password are both "admin".

Note: By default, the IP address of the LoRa gateway ethernet is 192.168.10.10, and you can connect to it through wire using a PC and SSH.

For example:



```
jimmy@jimmy-Rak: ~  
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10
```



```
jimmy@jimmy-Rak: ~  
jimmy@jimmy-Rak:~$ ssh admin@192.168.10.10  
The authenticity of host '192.168.10.10 (192.168.10.10)' can't be established.  
RSA key fingerprint is SHA256:qf+U1erxKMU0ckmyKkicPLTFq4rPX2NwrUb4WM7XwKQ.  
Are you sure you want to continue connecting (yes/no)?
```



```
jimmy@jimmy-Rak: ~
admin@192.168.10.10's password:
LoRaServer.io
documentation and copyright information: www.loraserver.io
Commands:
> sudo gateway-config - configure the gateway
> sudo monit status    - display service monitor
raspberrypi3:~$ sudo gateway-config
We trust you have received the usual lecture from the local System
Administrator. It usually boils down to these three things:

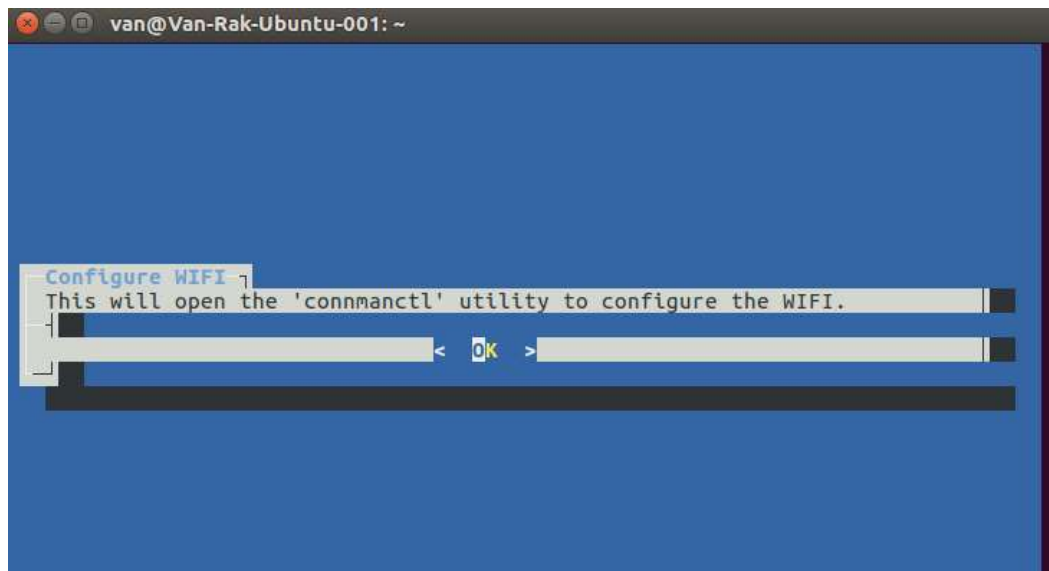
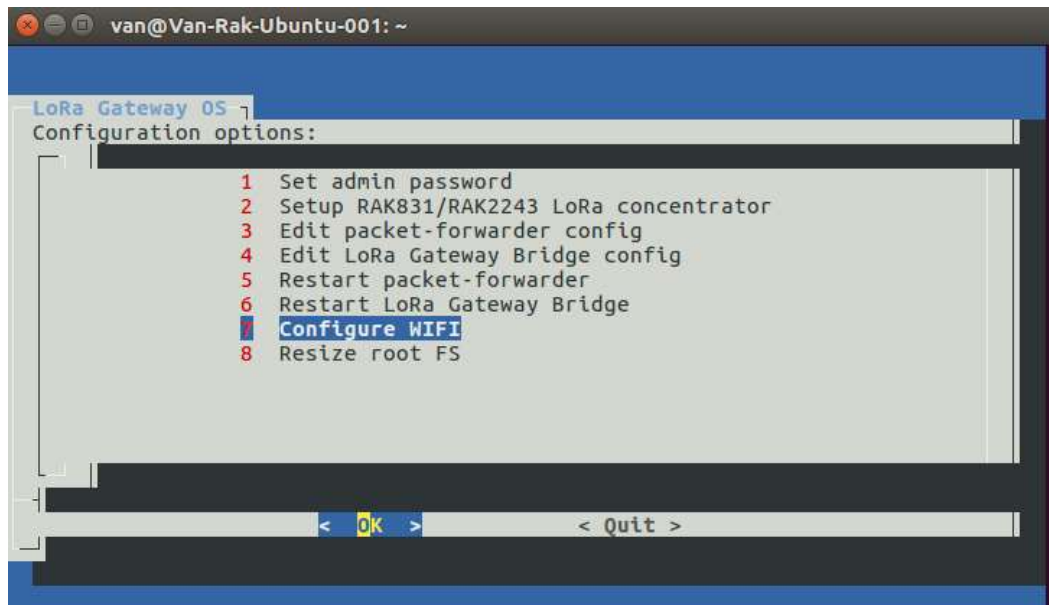
#1) Respect the privacy of others.
#2) Think before you type.
#3) With great power comes great responsibility.
Password: █
```

4) Now, you should see a configuration page as follow:

```
van@Van-Rak-Ubuntu-001: ~
LoRa Gateway OS
Configuration options:
1 Set admin password
2 Setup RAK831/RAK2243 LoRa concentrator
3 Edit packet-forwarder config
4 Edit LoRa Gateway Bridge config
5 Restart packet-forwarder
6 Restart LoRa Gateway Bridge
7 Configure WIFI
8 Resize root FS
< OK > < Quit >
```

Note: In this tutorial, you may only use the option 1, 2, 3, and 7.

5) If you want to connect the LoRa gateway to a WiFi network, just do as follow:



```
van@Van-Rak-Ubuntu-001: ~  
connmanctl quickstart  
1) Enable wifi:  
enable wifi  
  
2) Scan available wifi networks:  
scan wifi  
  
3) Display available wifi networks:  
services  
  
4) Turn on agent:  
agent on  
  
5) Connect to network:  
connect wifi_...  
  
6) Quit connmanctl:  
quit
```

```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl>
```

Enable WiFi:

```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> enable wifi  
Enabled wifi  
connmanctl>
```

Scan WiFi:


```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> enable wifi  
Enabled wifi  
connmanctl> scan wifi  
Scan completed for wifi  
connmanctl> █
```

Check services:

```
van@Van-Rak-Ubuntu-001: ~  
Error getting VPN connections: The name net.connman.vpn was not provided by any  
connmanctl> enable wifi  
Enabled wifi  
connmanctl> scan wifi  
Scan completed for wifi  
connmanctl> services  
*AR Wired ethernet_b827ebe8a9f8_cable  
AccessMe wifi_b827ebdbfcad_4163636573734d65_managed_psk  
AccessMeTest wifi_b827ebdbfcad_4163636573734d6554657374_managed_psk  
SENDCOM wifi_b827ebdbfcad_53454e44434f4d_managed_psk  
WENSEN wifi_b827ebdbfcad_57454e53454e_managed_psk  
SENFAs wifi_b827ebdbfcad_53454e4641_managed_psk  
sxxxnyjk wifi_b827ebdbfcad_737878786e796a6b_managed_psk  
HWJD wifi_b827ebdbfcad_48574a44_managed_psk  
SXRKGGK wifi_b827ebdbfcad_5358524b474b_managed_psk  
XAYNKJ wifi_b827ebdbfcad_5841594e4b4a_managed_psk  
HT-WIFI wifi_b827ebdbfcad_48542d57494649_managed_psk  
connmanctl> █
```

Agent on:

```
van@Van-Rak-Ubuntu-001: ~
Error getting VPN connections: The name net.connman.vpn was not provided by any
connmanctl> enable wifi
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebdbfcad_4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebdbfcad_4163636573734d6554657374_managed_psk
  SENDCOM          wifi_b827ebdbfcad_53454e44434f4d_managed_psk
  SENFA            wifi_b827ebdbfcad_53454e4641_managed_psk
  WENSEN           wifi_b827ebdbfcad_57454e53454e_managed_psk
  SXRKGGK          wifi_b827ebdbfcad_5358524b474b_managed_psk
  HWJD             wifi_b827ebdbfcad_48574a44_managed_psk
  TAINENG          wifi_b827ebdbfcad_5441494e454e47_managed_psk
  XAYNKJ           wifi_b827ebdbfcad_5841594e4b4a_managed_psk
  HT-WIFI          wifi_b827ebdbfcad_48542d57494649_managed_psk
connmanctl> agent on
Agent registered
connmanctl>
```

Connect WiFi as follow (notice what you need to enter isn't the SSID):

```
van@Van-Rak-Ubuntu-001: ~
Error getting VPN connections: The name net.connman.vpn was not provided by any
connmanctl> enable wifi
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebdbfcad_4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebdbfcad_4163636573734d6554657374_managed_psk
  SENDCOM          wifi_b827ebdbfcad_53454e44434f4d_managed_psk
  SENFA            wifi_b827ebdbfcad_53454e4641_managed_psk
  WENSEN           wifi_b827ebdbfcad_57454e53454e_managed_psk
  SXRKGGK          wifi_b827ebdbfcad_5358524b474b_managed_psk
  HWJD             wifi_b827ebdbfcad_48574a44_managed_psk
  TAINENG          wifi_b827ebdbfcad_5441494e454e47_managed_psk
  XAYNKJ           wifi_b827ebdbfcad_5841594e4b4a_managed_psk
  HT-WIFI          wifi_b827ebdbfcad_48542d57494649_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebdbfcad_4163636573734d65_managed_psk
Agent Request input wifi_b827ebdbfcad_4163636573734d65_managed_psk
  Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase?
```

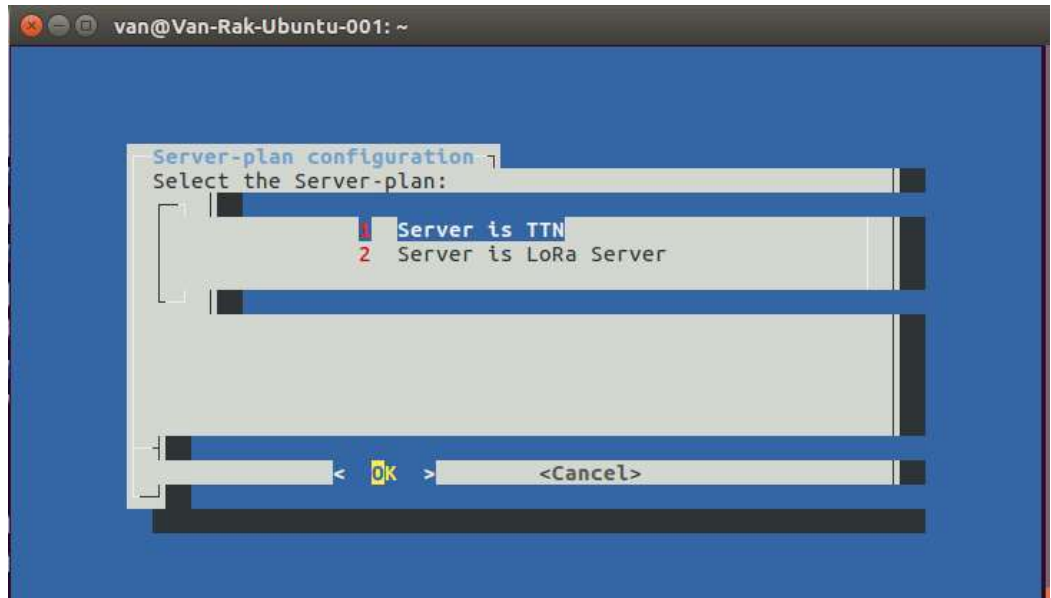
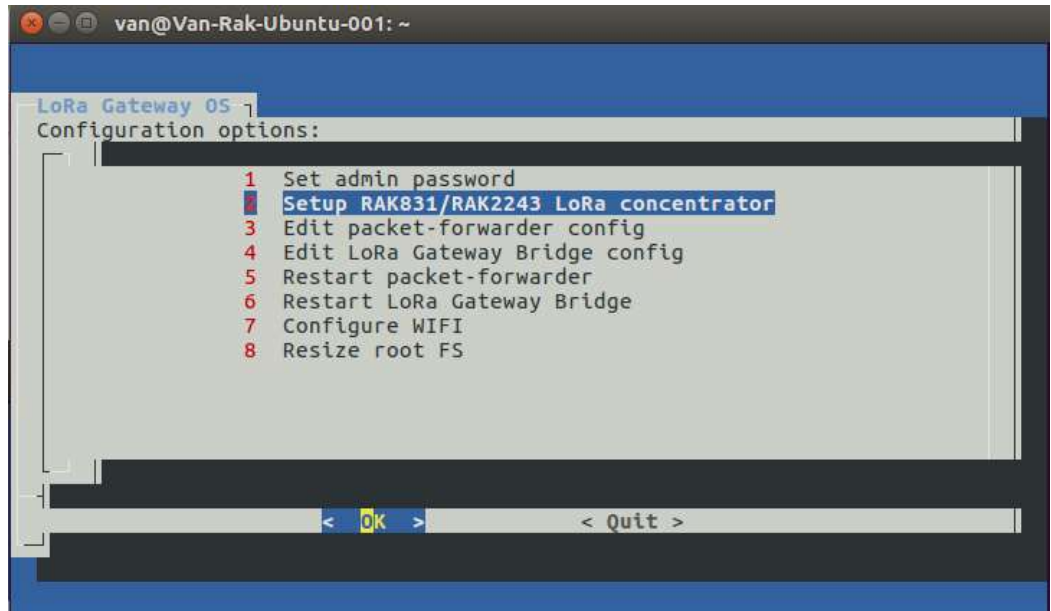
After entering the password, if you see “connected ...”, it indicates the LoRa gateway has connected WiFi successfully.

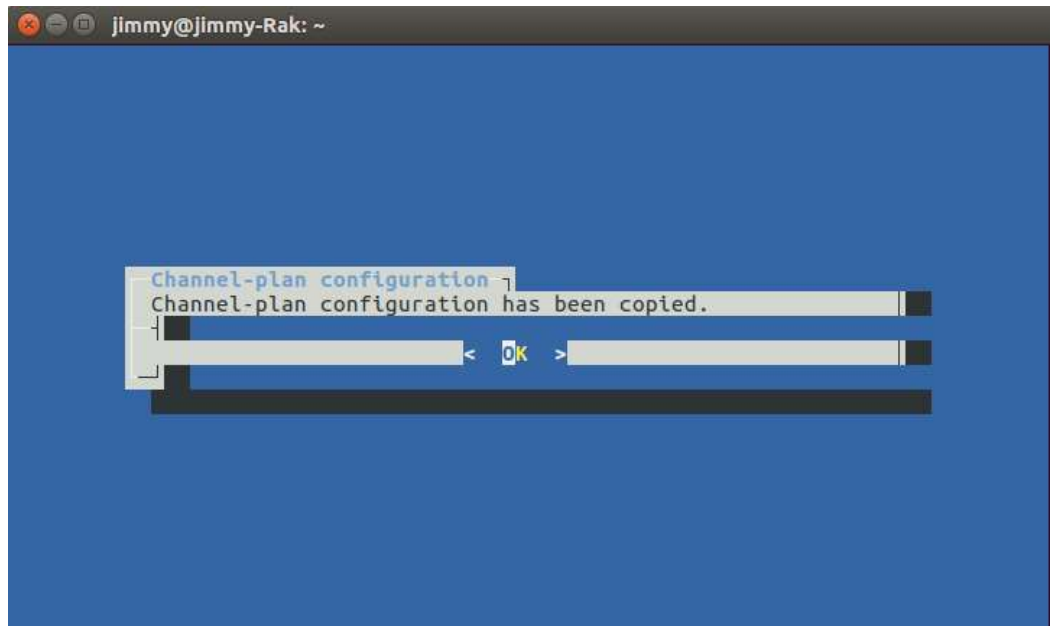
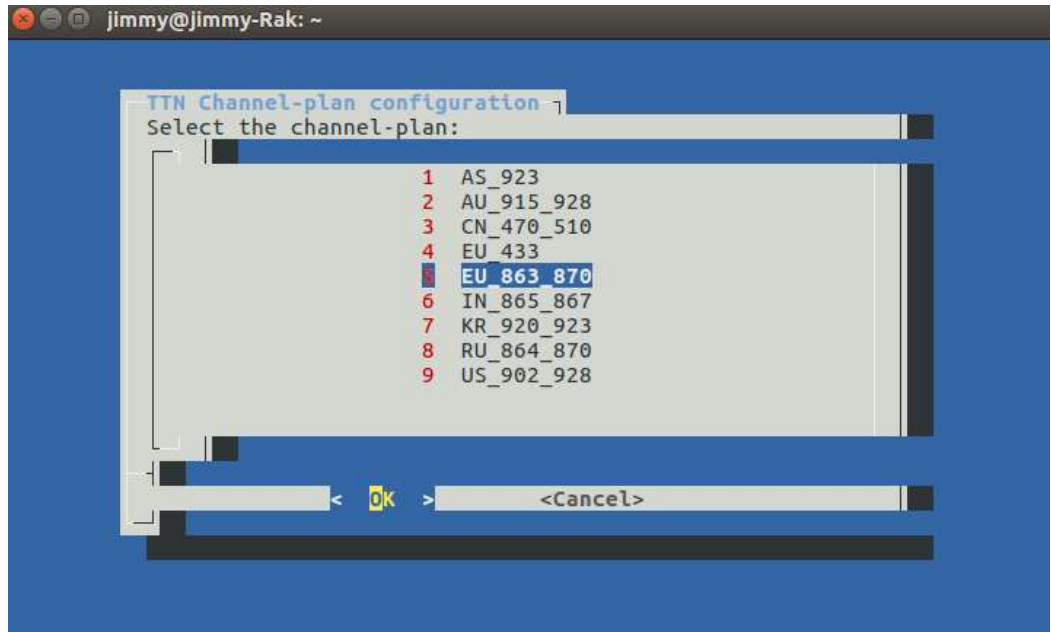
```
van@Van-Rak-Ubuntu-001: ~
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebddfcd_4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebddfcd_4163636573734d6554657374_managed_psk
  SENDCOM         wifi_b827ebddfcd_53454e44434f4d_managed_psk
  SENFA           wifi_b827ebddfcd_53454e4641_managed_psk
  WENSEN         wifi_b827ebddfcd_57454e53454e_managed_psk
  sxxxnyjk        wifi_b827ebddfcd_737878786e796a6b_managed_psk
  SXRKKGK         wifi_b827ebddfcd_5358524b474b_managed_psk
  HWJD           wifi_b827ebddfcd_48574a44_managed_psk
  HT-WIFI         wifi_b827ebddfcd_48542d57494649_managed_psk
  XAYNKJ          wifi_b827ebddfcd_5841594e4b4a_managed_psk
  TAINENG         wifi_b827ebddfcd_5441494e454e47_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebddfcd_4163636573734d65_managed_psk
Agent RequestInput wifi_b827ebddfcd_4163636573734d65_managed_psk
  Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase? rakwireless.2018
Connected wifi_b827ebddfcd_4163636573734d65_managed_psk
connmanctl>
```

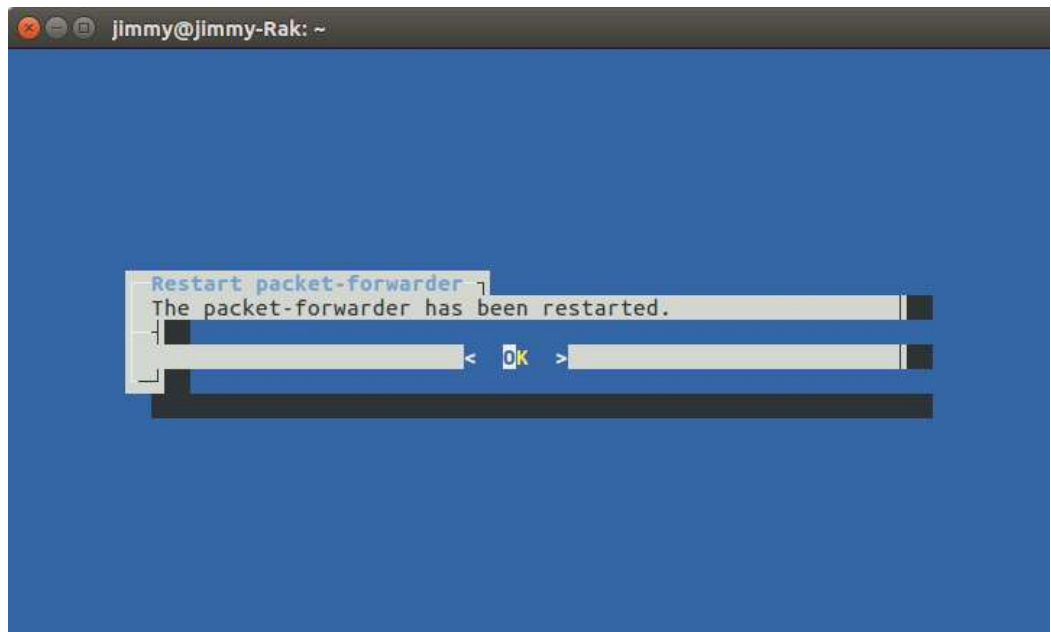
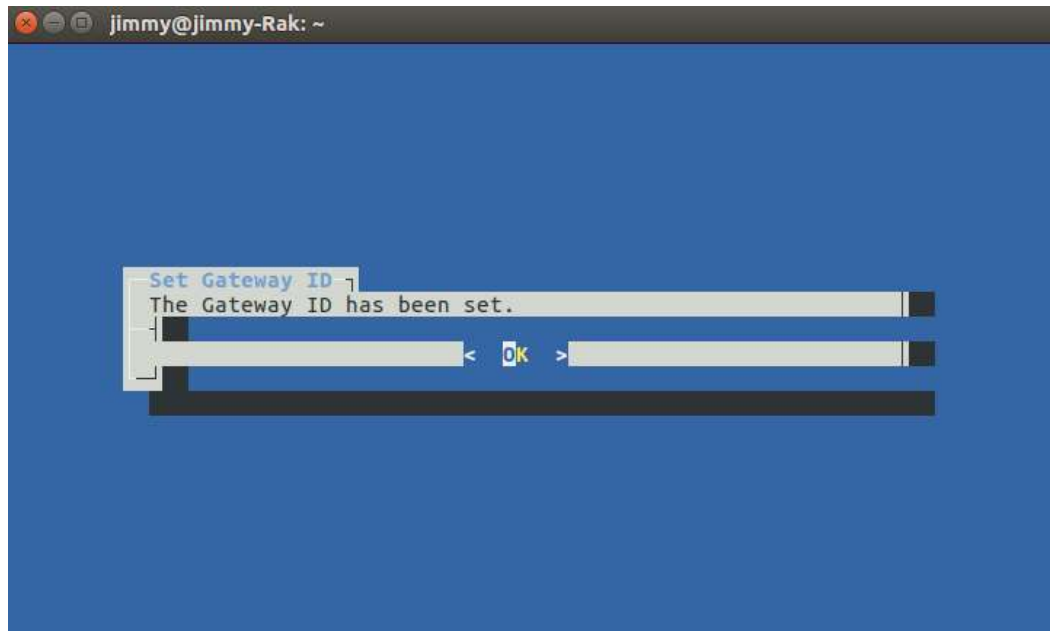
Then quit the WiFi configuration page:

```
van@Van-Rak-Ubuntu-001: ~
Enabled wifi
connmanctl> scan wifi
Scan completed for wifi
connmanctl> services
*AR Wired          ethernet_b827ebe8a9f8_cable
  AccessMe         wifi_b827ebddfcd_4163636573734d65_managed_psk
  AccessMeTest     wifi_b827ebddfcd_4163636573734d6554657374_managed_psk
  SENDCOM         wifi_b827ebddfcd_53454e44434f4d_managed_psk
  SENFA           wifi_b827ebddfcd_53454e4641_managed_psk
  WENSEN         wifi_b827ebddfcd_57454e53454e_managed_psk
  sxxxnyjk        wifi_b827ebddfcd_737878786e796a6b_managed_psk
  SXRKKGK         wifi_b827ebddfcd_5358524b474b_managed_psk
  HWJD           wifi_b827ebddfcd_48574a44_managed_psk
  HT-WIFI         wifi_b827ebddfcd_48542d57494649_managed_psk
  XAYNKJ          wifi_b827ebddfcd_5841594e4b4a_managed_psk
  TAINENG         wifi_b827ebddfcd_5441494e454e47_managed_psk
connmanctl> agent on
Agent registered
connmanctl> connect wifi_b827ebddfcd_4163636573734d65_managed_psk
Agent RequestInput wifi_b827ebddfcd_4163636573734d65_managed_psk
  Passphrase = [ Type=psk, Requirement=mandatory ]
Passphrase? rakwireless.2018
Connected wifi_b827ebddfcd_4163636573734d65_managed_psk
connmanctl> quit
```

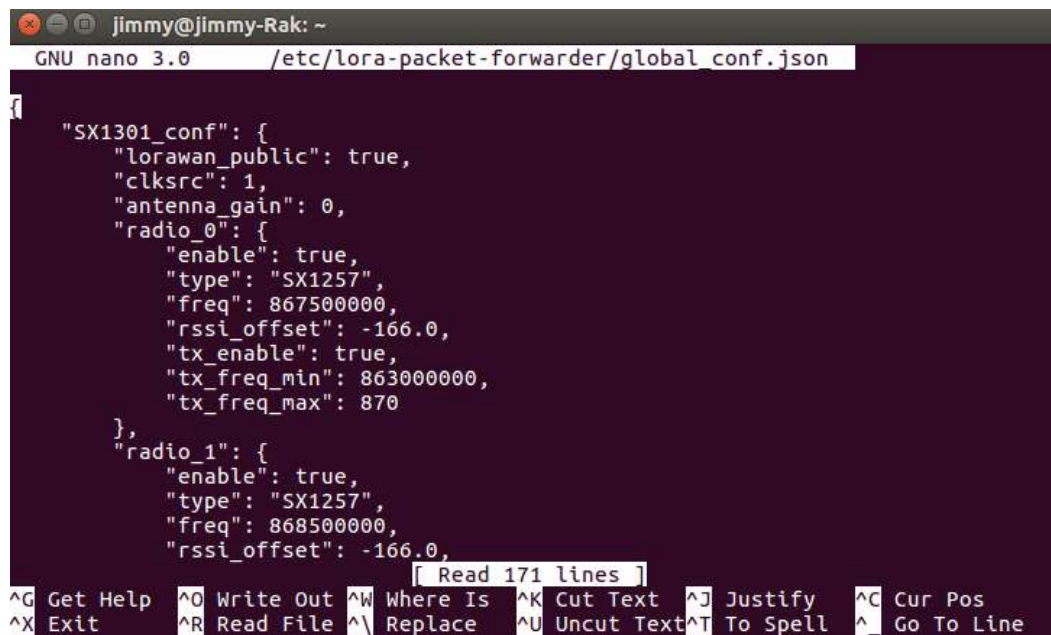
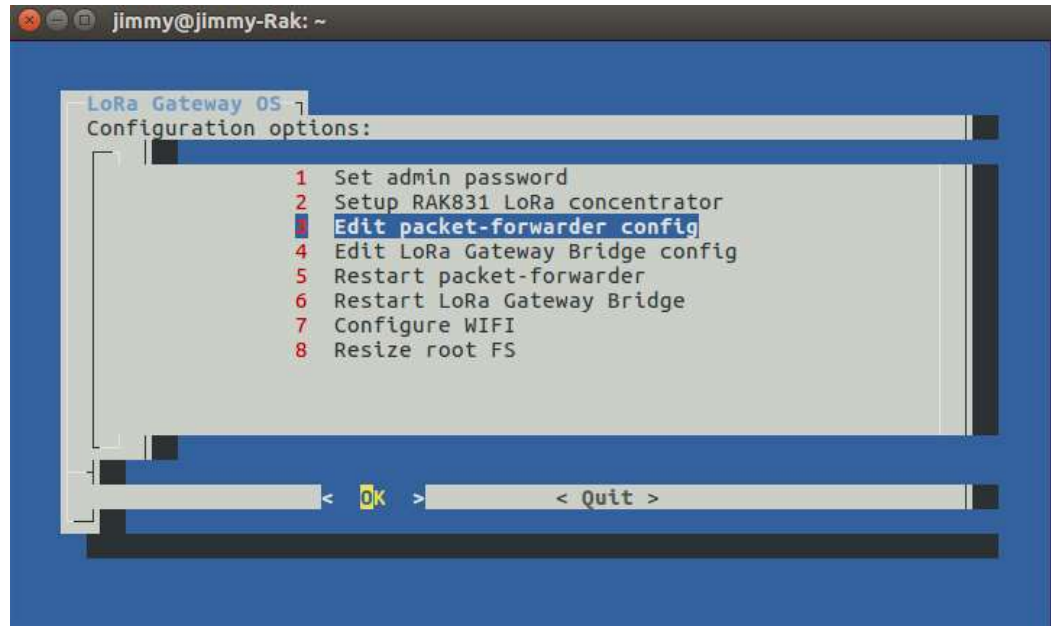
- 6) When you power on this LoRa gateway firstly, it works on EU868(EU_863_870) and points to the internal LoRa server by default. Now, let's change the pointed LoRa server to TTN, just do as follow







- 7) OK, that's OK.
- 8) Let's see the global_conf.json file to check:



```
jimmy@jimmy-Rak: ~
GNU nano 3.0 /etc/lora-packet-forwarder/global_conf.json

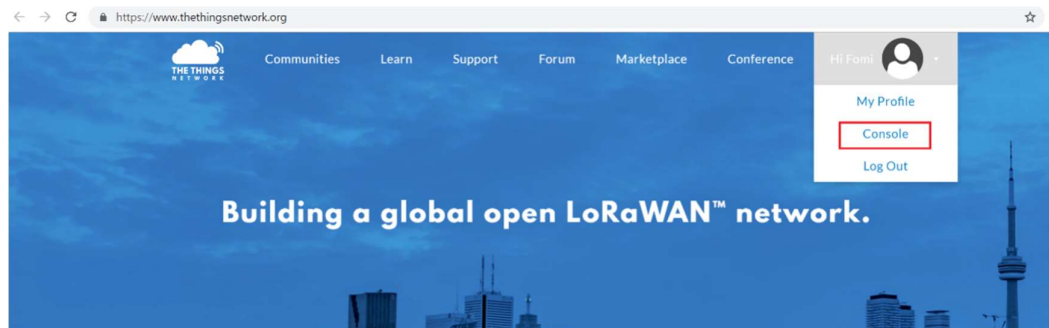
"gateway_conf": {
  "gateway_ID": b827ebffffee8a9f8,
  /* change with default server address/ports, or overwrite in lo$
  "server_address": "router.eu.thethings.network",
  "serv_port_up": 1700,
  "serv_port_down": 1700,
  /* adjust the following parameters for your network */
  "keepalive_interval": 10,
  "stat_interval": 30,
  "push_timeout_ms": 100,
  /* forward only valid packets */
  "forward_crc_valid": true,
  "forward_crc_error": false,
  "forward_crc_disabled": false,
  /* gps enable */
  "gps": true,
  "gps_tty_path": "/dev/i2c-1",
  "fake_gps": false,
  "ref_latitude": 10,
}

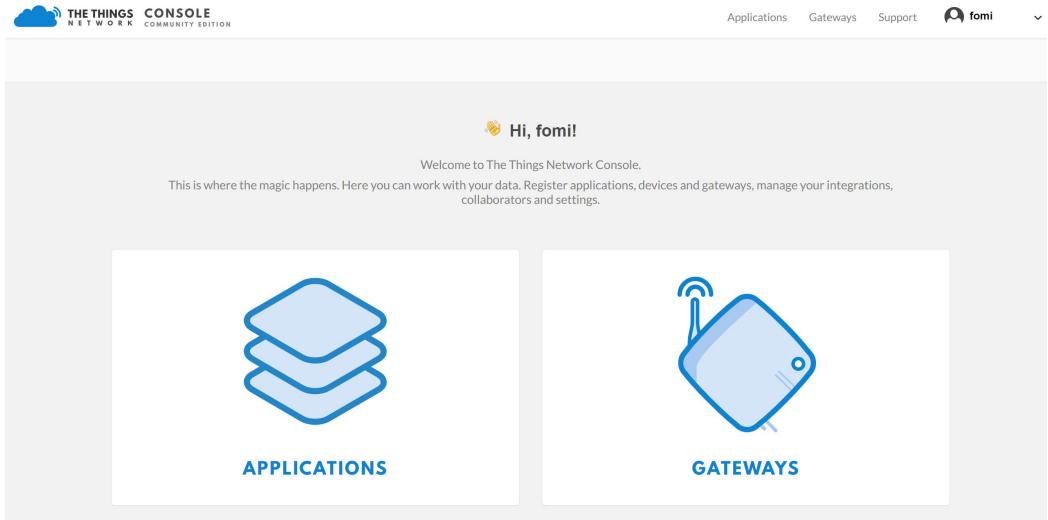
^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File  ^\ Replace   ^U Uncut Text ^T To Spell  ^_ Go To Line
```

Note: Do you see the gateway ID in the end of this file as shown as the following picture? It is important to remember it!

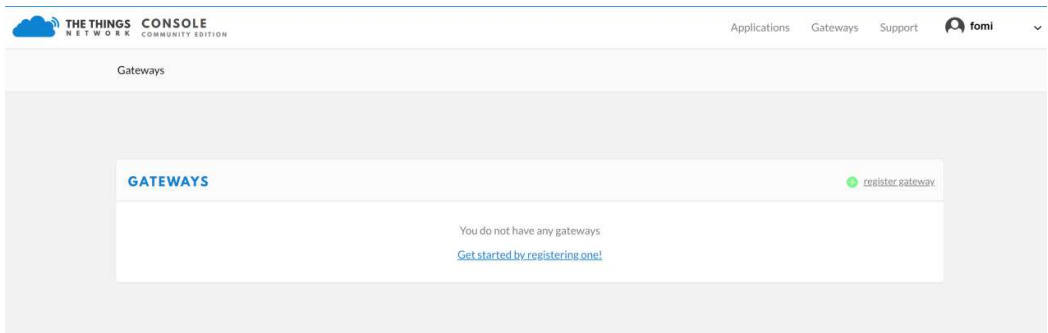
Step 2: Register your LoRa gateway to TTN LoRa server.

- 1) Login to <https://www.thethingsnetwork.org/>, and open your Console panel;

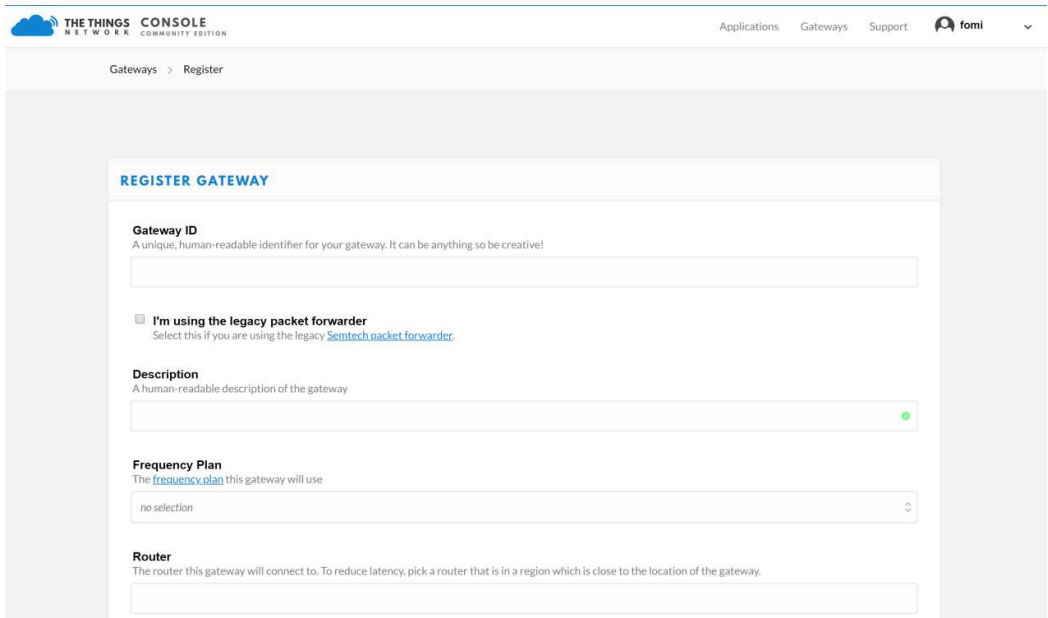




2) Click on “GATEWAYS”, and “register gateway”:



3) You'll see the following page:



4) Fill in them as follow:

Gateways > Register

REGISTER GATEWAY

Gateway EUI
The EUI of the gateway as read from the LoRa module

BB 27 EB FF FE E8 A9 F8 0 bytes

I'm using the legacy packet forwarder
Select this if you are using the legacy [Semtech packet forwarder](#).

Description
A human-readable description of the gateway

a test gateway 0

Frequency Plan
The [frequency plan](#) this gateway will use

- Europe: 868MHz
- Asia: 920-923MHz
- Asia: 923-925MHz
- Australia: 915MHz
- China: 470-510MHz
- Europe: 868MHz
- India: 865-867MHz
- Korea: 920-923MHz
- Russia: 864-870MHz
- United States: 915MHz

Gateways > Register

REGISTER GATEWAY

Gateway EUI
The EUI of the gateway as read from the LoRa module

BB 27 EB FF FE E8 A9 F8 0 bytes

I'm using the legacy packet forwarder
Select this if you are using the legacy [Semtech packet forwarder](#).

Description
A human-readable description of the gateway

a test gateway 0

Frequency Plan
The [frequency plan](#) this gateway will use

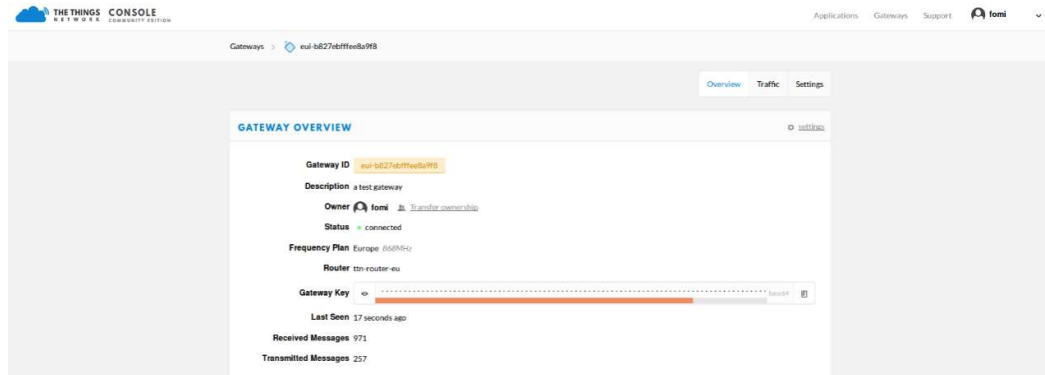
Europe: 868MHz

Router
The router this gateway will connect to. To reduce latency, pick a router that is in a region which is close to the location of the gateway.

ltm-router-eu 0

Note: Remember to select the check box “I’m using the legacy packet forwarder”, and type the Gateway EUI which you have got in the step 1;

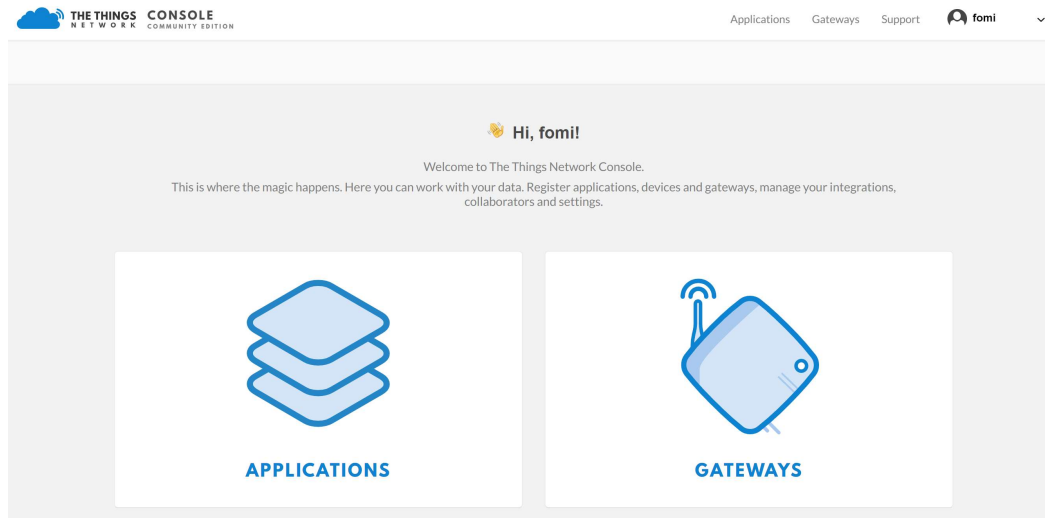
- 5) After the above operations, click “Register Gateway” in the bottom right corner of this page to register your gateway;
- 6) If register successfully, you will see the following page:



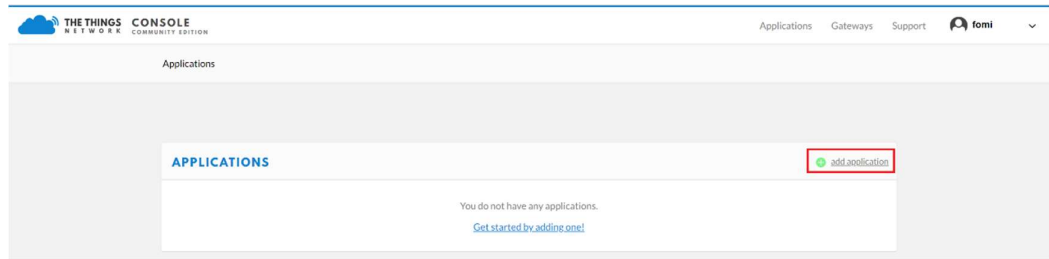
Please notice the “Status” item in the above page, “connected” indicates that your gateway has connected with TTN LoRa server successfully;

Step 2: Add a LoRa node on TTN LoRa application server.

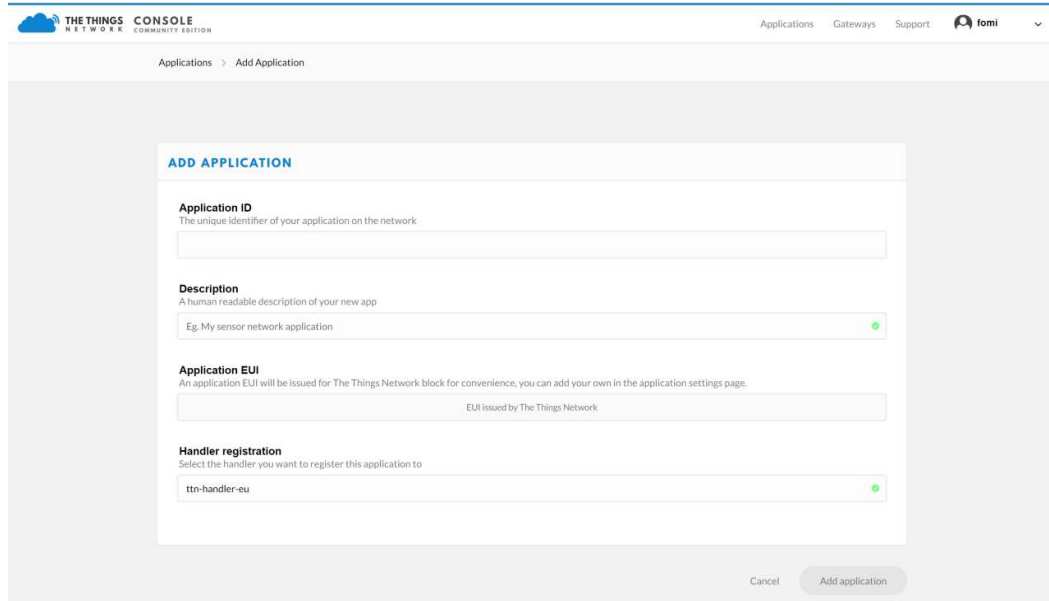
- 1) Login <https://www.thethingsnetwork.org/> , and open the Console panel:



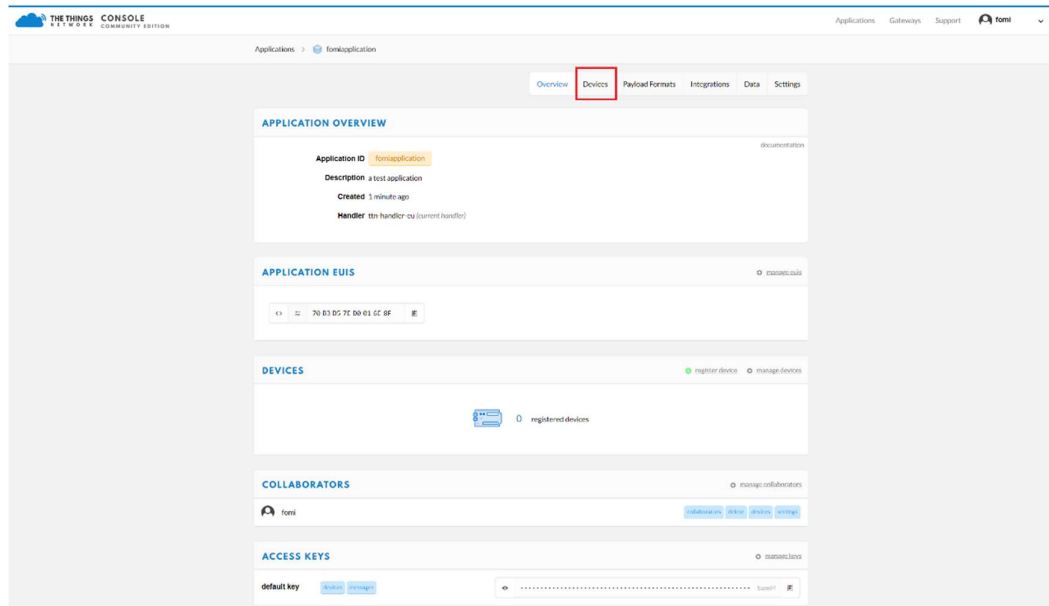
- 2) Click on “APPLICATIONS”, then you can see the following page. Click “add application”:



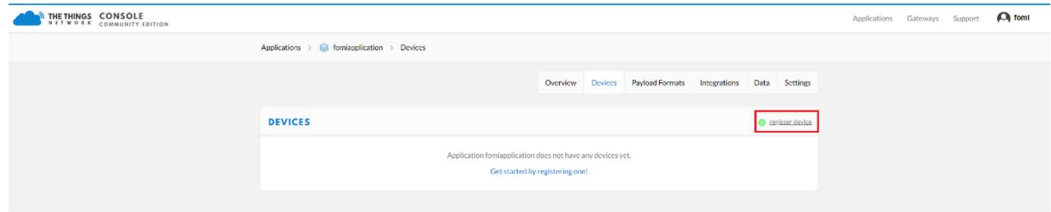
3) Fill in the following items, and click “Add application”:



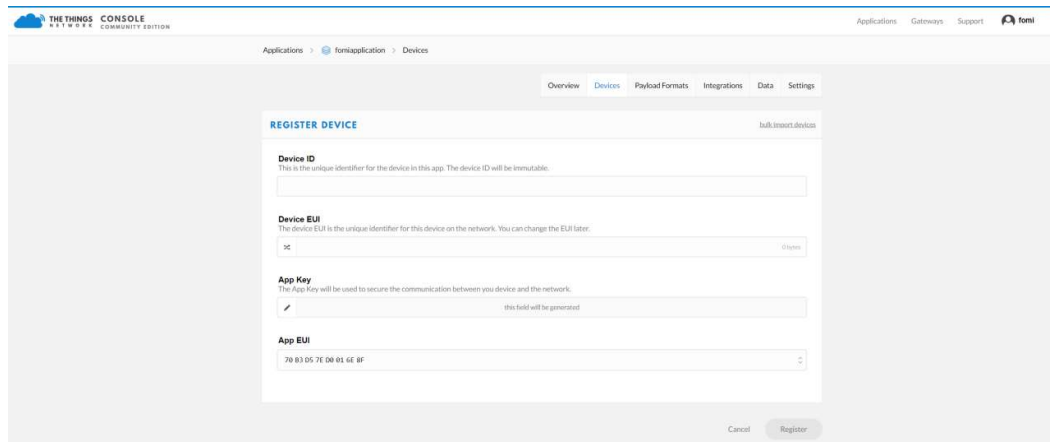
4) You’ll see the following page, and click “Devices” as follow:



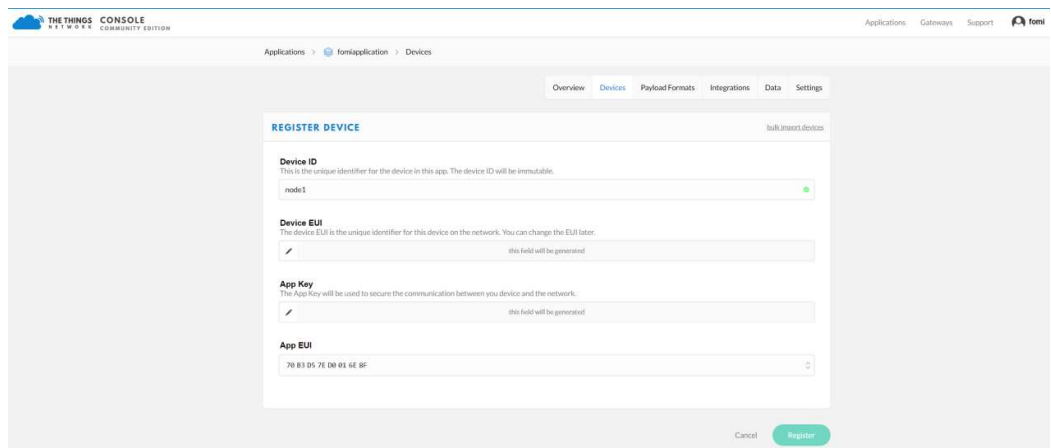
5) Click “register device”:



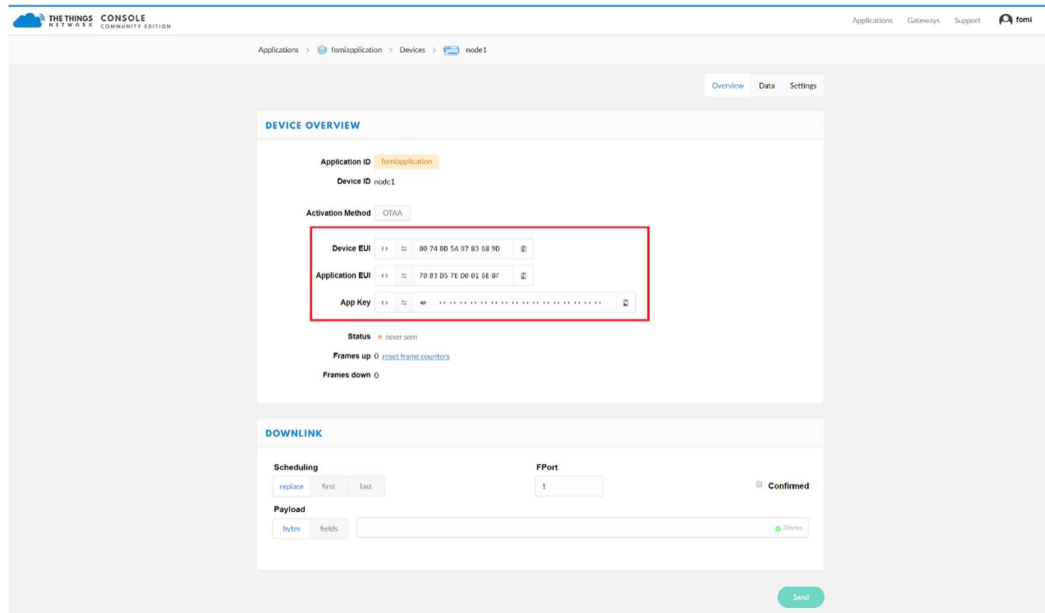
6) Fill in them:



Note: You can generate a Device EUI automatically by click  .



7) After clicking “Register”, you will see the following page. Please remember “Device EUI”, “Application EUI”, and “App Key”, because you will use them to configure your LoRa node in the step 3.



Step 3: Configure the LoRa node to join

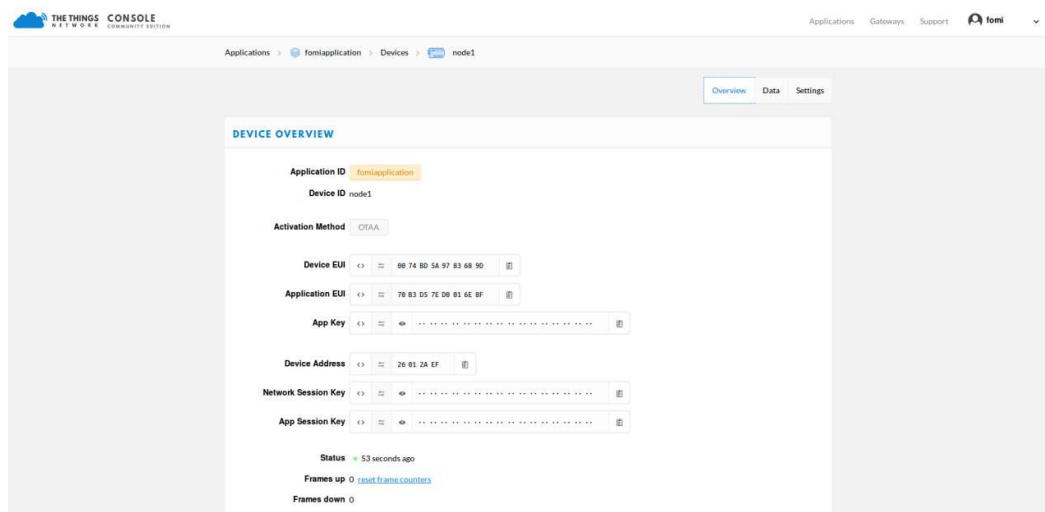
- 1) Configure the LoRa node through AT command:

“at+set_config=dev_eui:xxxxxxxxxxxxxxxx”

“at+set_config=app_eui:xxxxxxxxxxxxxxxx”

“at+set_config=app_key:xxxxxxxxxxxxxxxx”

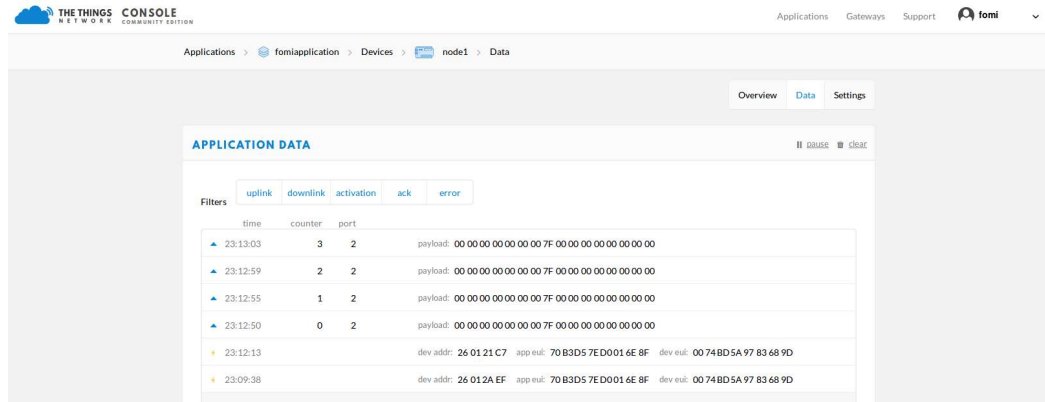
- 2) The “Status” indicates that the LoRa node has joined successfully:



- 3) Send some data from LoRa node to TTN:

at+send=0,2,00000000000007F0000000000000

You will see the data on TTN as follow:



The screenshot shows the 'Data' tab in the The Things Console for a specific node. The 'APPLICATION DATA' section is active, displaying a table of data points. The table has columns for time, counter, port, and payload. The data points show a sequence of uplink and downlink messages with their respective counters and ports. The payload for the uplink messages is shown as a series of zeros, indicating a test message. The downlink messages include device addresses and application addresses.

time	counter	port	payload
23:13:03	3	2	payload: 00 00 00 00 00 00 00 7F 00 00 00 00 00 00 00
23:12:59	2	2	payload: 00 00 00 00 00 00 00 7F 00 00 00 00 00 00 00
23:12:55	1	2	payload: 00 00 00 00 00 00 00 7F 00 00 00 00 00 00 00
23:12:50	0	2	payload: 00 00 00 00 00 00 00 7F 00 00 00 00 00 00 00
23:12:13			dev addr: 26 01 21 C7 app eui: 70 B3D5 7E D001 6E 8F dev eui: 00 74 BD SA 97 83 68 9D
23:09:38			dev addr: 26 01 2A EF app eui: 70 B3D5 7E D001 6E 8F dev eui: 00 74 BD SA 97 83 68 9D

Postscript Note

This tutorial is simplest for LoRa beginners, and the default OS of the LoRa gateway is LoRa gateway OS which is based on Yocto.

If you want to use Raspbian OS on the LoRa gateway, please see the next tutorial, **From zero to build a LoRa gateway using RAK2243, Raspberry Pi, and Raspbian OS**. It is an advanced tutorial for the RAK LoRa Develop Kit.

Special Announcement

The LoRa server and the LoRa application server of the RAK LoRa Develop Kit are both based on a great open source project which is made by Orne Brocaar.

You can find more about it in the lorasever official website:

<https://www.lorasever.io/>.

You can find the open source project on Github here:

<https://github.com/brocaar?tab=repositories>

