Quick Start Guide

Prerequisites

What do you need?

Before going through each and every step in the installation and guide of the RAK811 Breakout Board, make sure to prepare the necessary items listed below:

Hardware Tools

1. **RAK811 Breakout Board**
2. RAKDAP1 Flash and Debug Tool
3. Gateway in Range for Testing
4. Jumper Wires
5. 3.3 V Battery Power Supply
6. A Windows/Mac OS/Linux Computer

Software Tools

1. RAK Serial Port Tool⬈
2. RAK811 Breakout Board Firmware
3. RAK Device Firmware Upgrade (DFU) Tool⬈

> 📝 **NOTE**
>
> The bootloader of the RAK811 Breakout Board is already pre-installed upon manufacturing, so flashing the bootloader is not necessary for you to perform. If you find that the bootloader of your RAK811 Breakout Board damaged, kindly contact our support though our RAKwireless forum⬈. However, if you want to upgrade the firmware of the device, refer to the miscellaneous section of this document.

What's included in the package?

- 1 pc - RAK811 Breakout Board (chipset pre-soldered on the board)
- 1 pc - LoRa Antenna

Product Configuration

Interfacing with RAK811 Breakout Board

RAK811 Breakout Board can be configured using AT commands via UART interface. You need a USB to UART TTL adapter to connect the RAK811 to PC's USB port and a serial terminal tool. It is highly recommended to use RAK Serial Port Tool⬈ so you can easily send AT commands and view the replies from the console output.

> ⚠️ **WARNING**
>
> Before powering the RAK811 Breakout Board, you should install the LoRa antenna first. Not doing so might damage the board.

- Connect your RAK811 Breakout Board with the following diagram below.

- **Figure 1** shows the Pinout Diagram of the Board and **Figure 2** shows how to connect the RAK811 Breakout Board to the RAKDAP1.
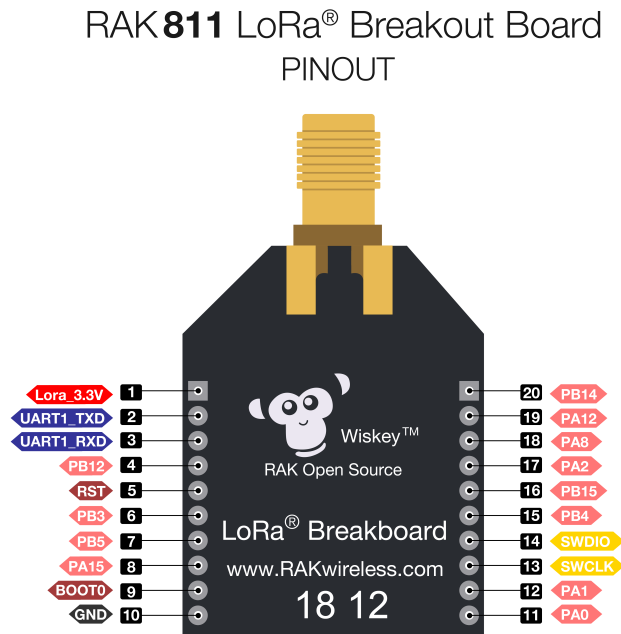

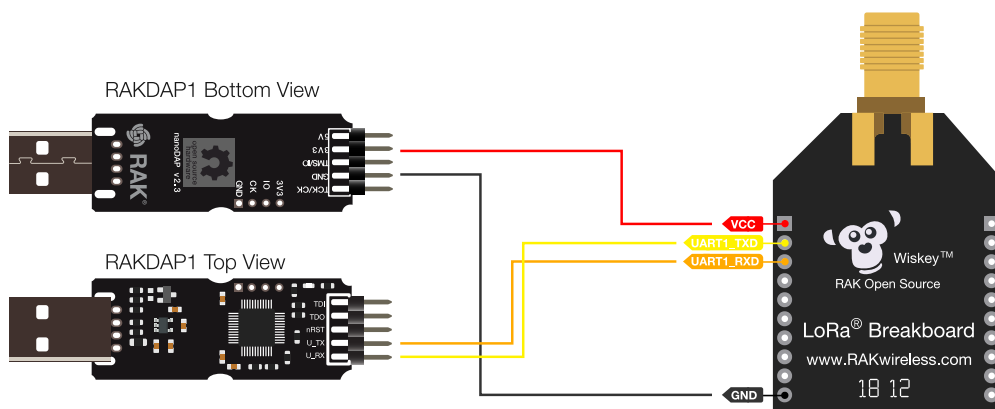**Figure 1:** RAK811(H) Breakout Board Pinout Diagram

Figure 2: RAKDAP1 to RAK811 Breakout Board Connection

- Connect your RAKDAP1 Flash and Debug Tool to your Windows Machine and Open RAK Serial Port Tool:
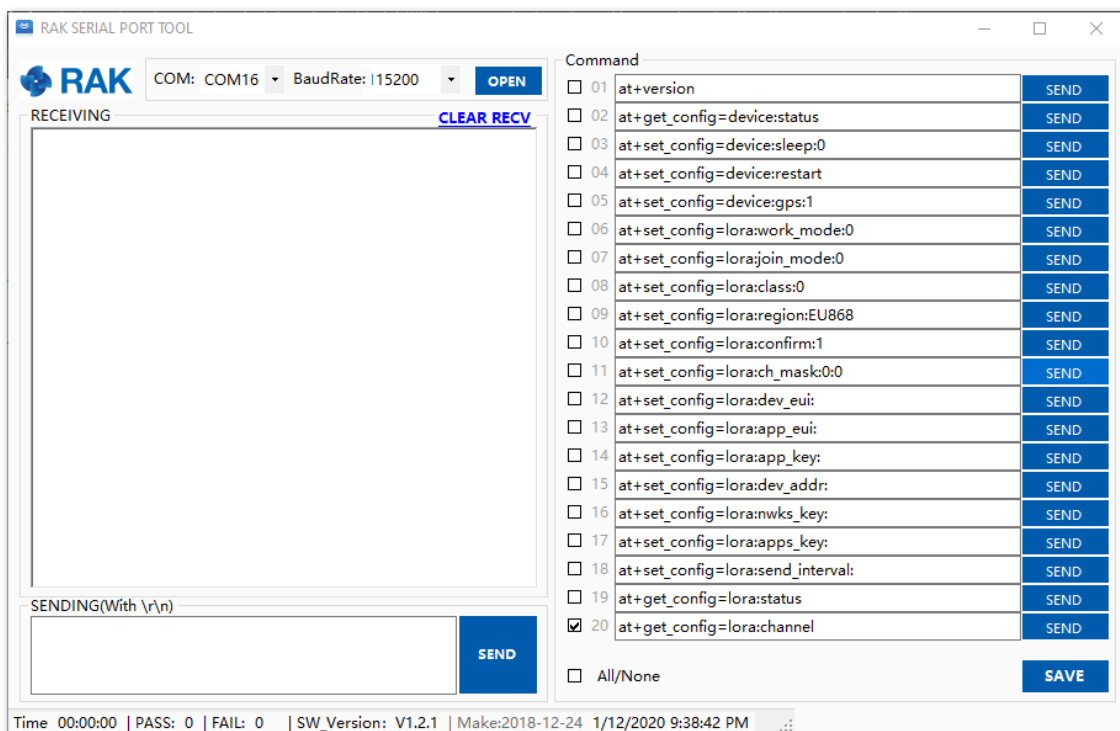

Figure 3: RAK Serial Port Tool

- In choosing the correct COM Port number for your device, go to your Device Manager by pressing **Windows + R** and type `devmgmt.msc` , or search in the Start Menu.
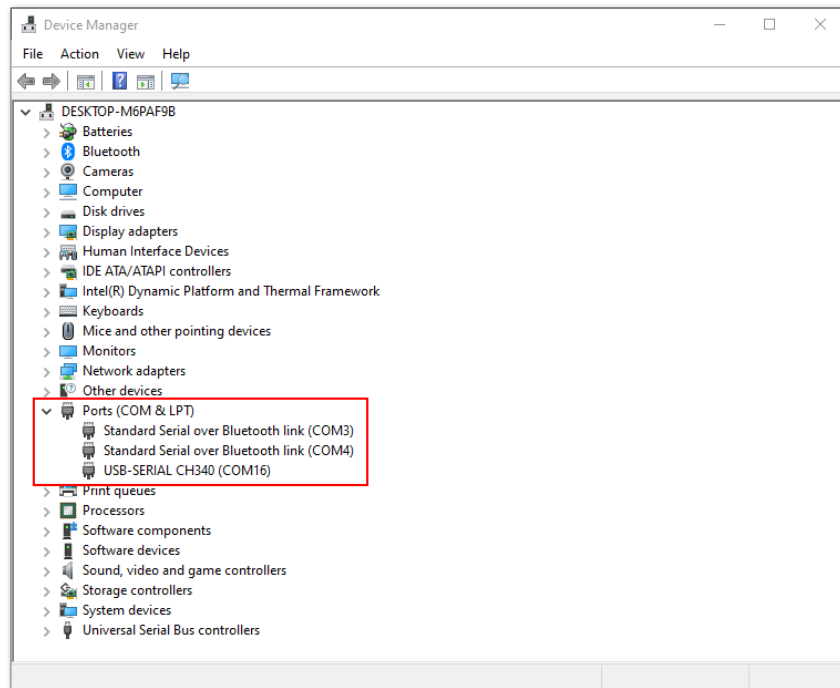

Figure 4: Device Manager

- Look for Ports (COM & LPT). Find the name of of your RAKDAP1 driver and take note of the COM Port Number.
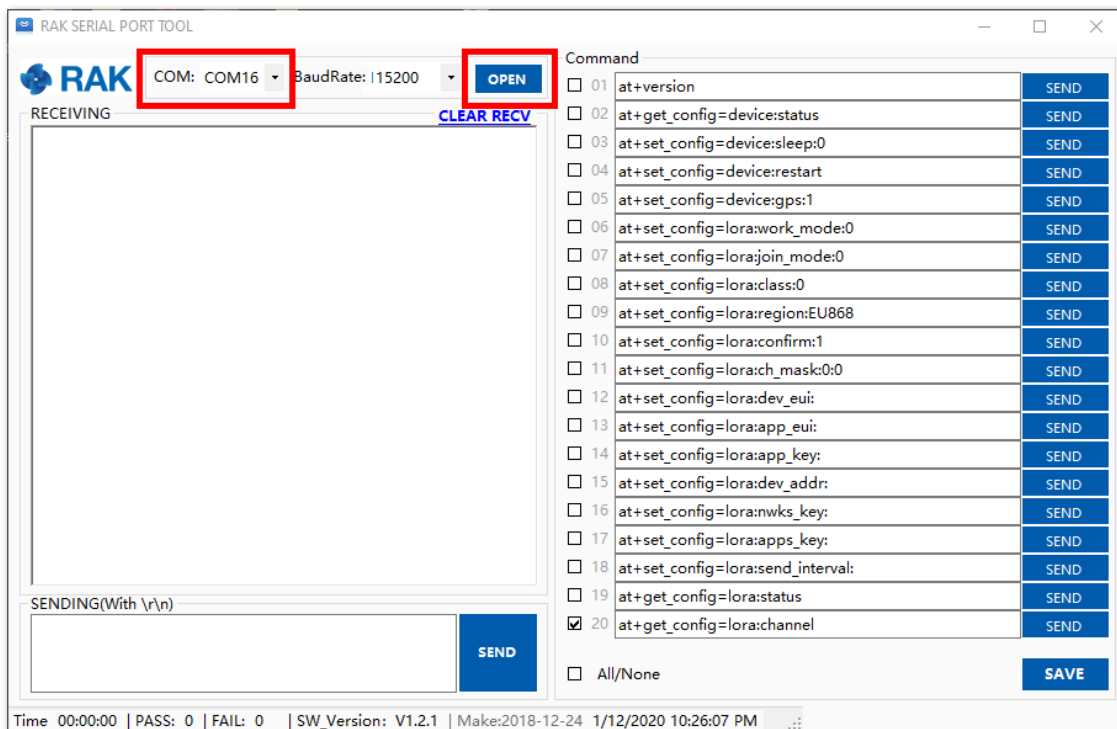

Figure 5: Correct Port Number and Correct Baud rate

Connecting to The Things Network (TTN)

In this section, it shows how to connect the RAK811 Breakout Board to The Things Network (TTN) platform.
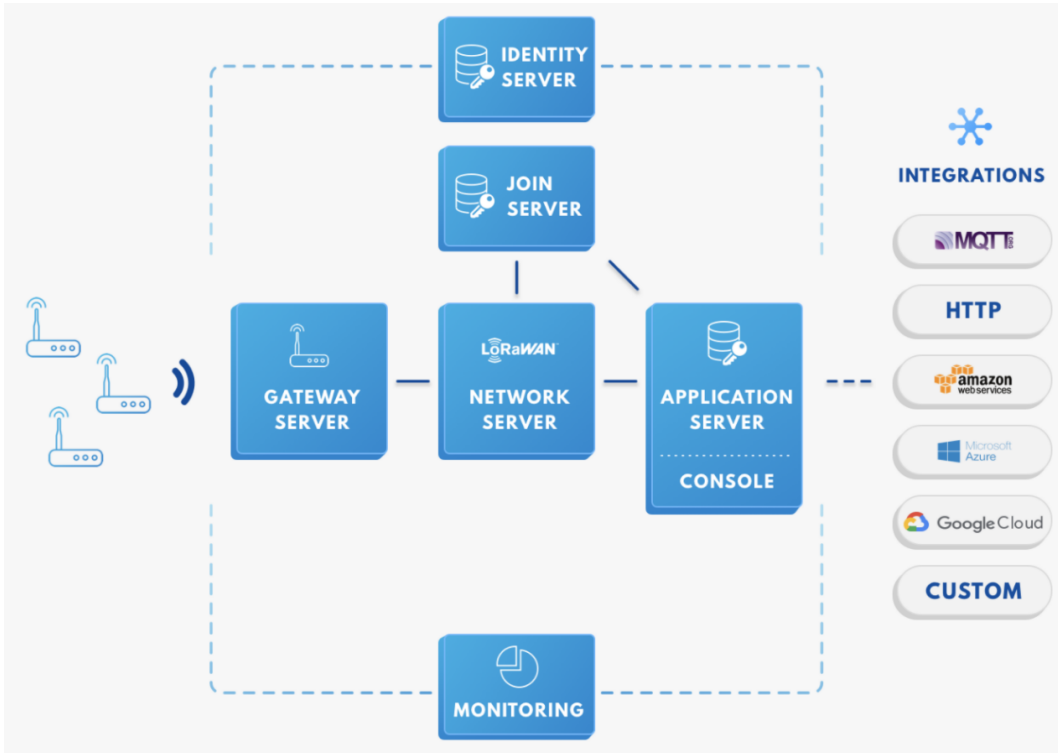
Figure 6: RAK811 Breakout Board in the context of the TTN

As shown in Figure 6, the RAK811 Breakout Board is one of the devices located on the left side. In the context of an IoT solution, the objective is to deploy devices to sense relevant process variables and transmit the data to the backend servers located in the cloud. The data will be processed and integrated as part of a larger solution that ultimately could generate efficiency, traceability and predictability capacity among others.

The RAK811 Breakout Board can be part of this ecosystem, and the objective of this section is to demonstrate how simple it is to send data to the TTN using the LoRaWAN protocol. To achieve this, the RAK811 Breakout Board must be located inside of the coverage of a LoRaWAN gateway.

Sign up and login

If you don't have an account yet, head on to the TTN website and create one. Once done, login to your account and go to the Console.
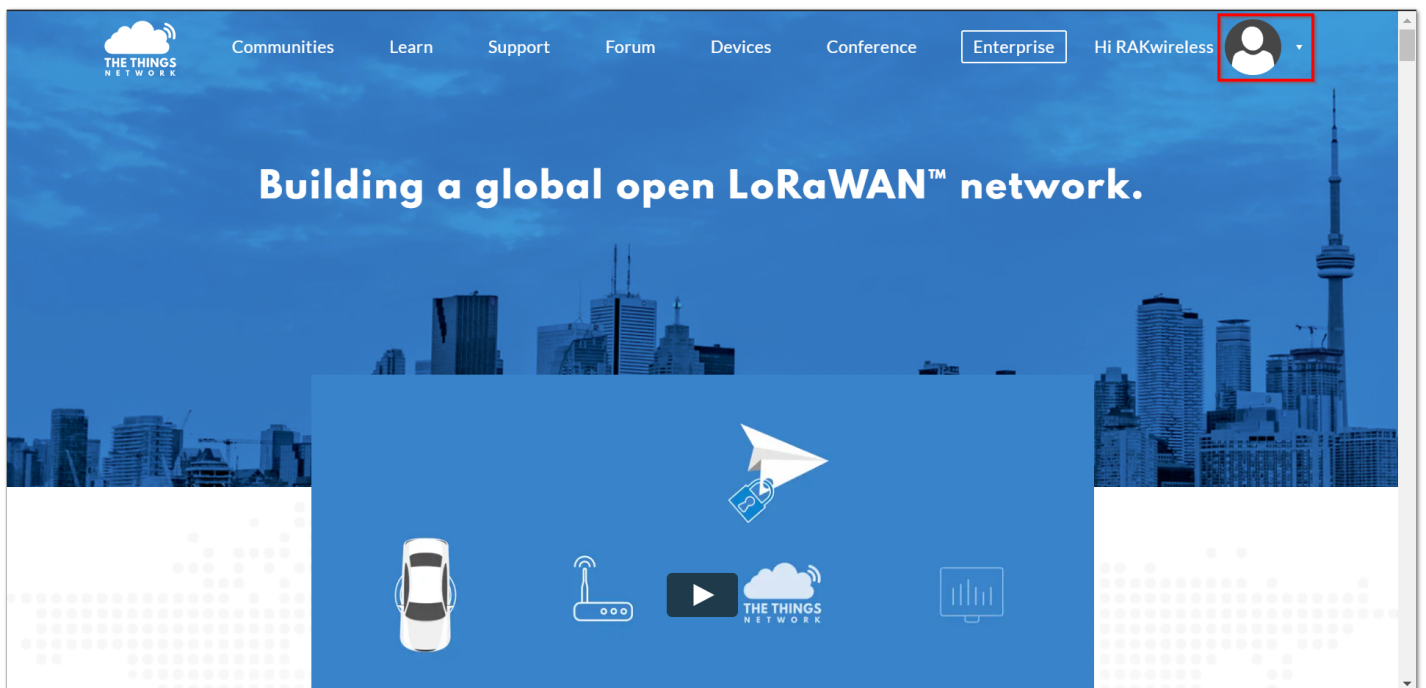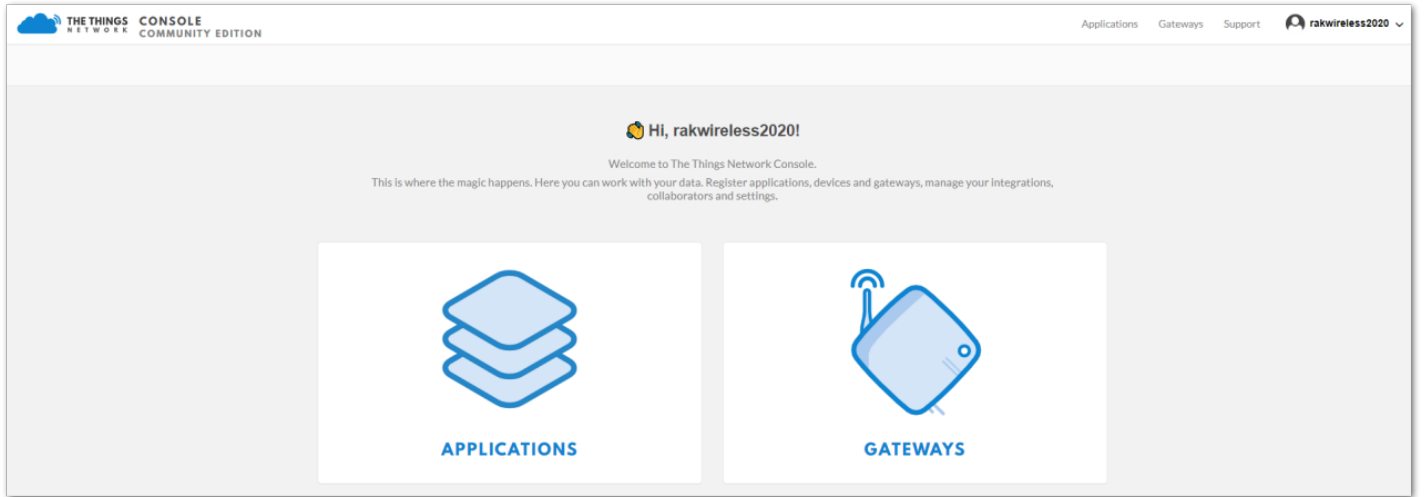

Figure 7: The Things Network Home Page

Figure 8: TTN Console Page

Create a New Application
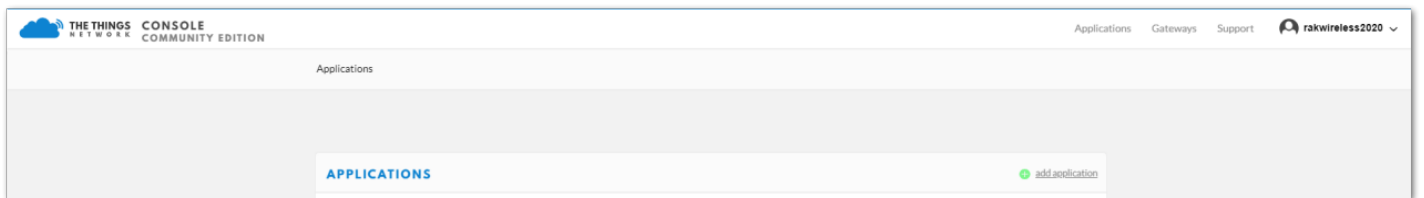
1. Choose the "APPLICATIONS".

Figure 9: Application Section

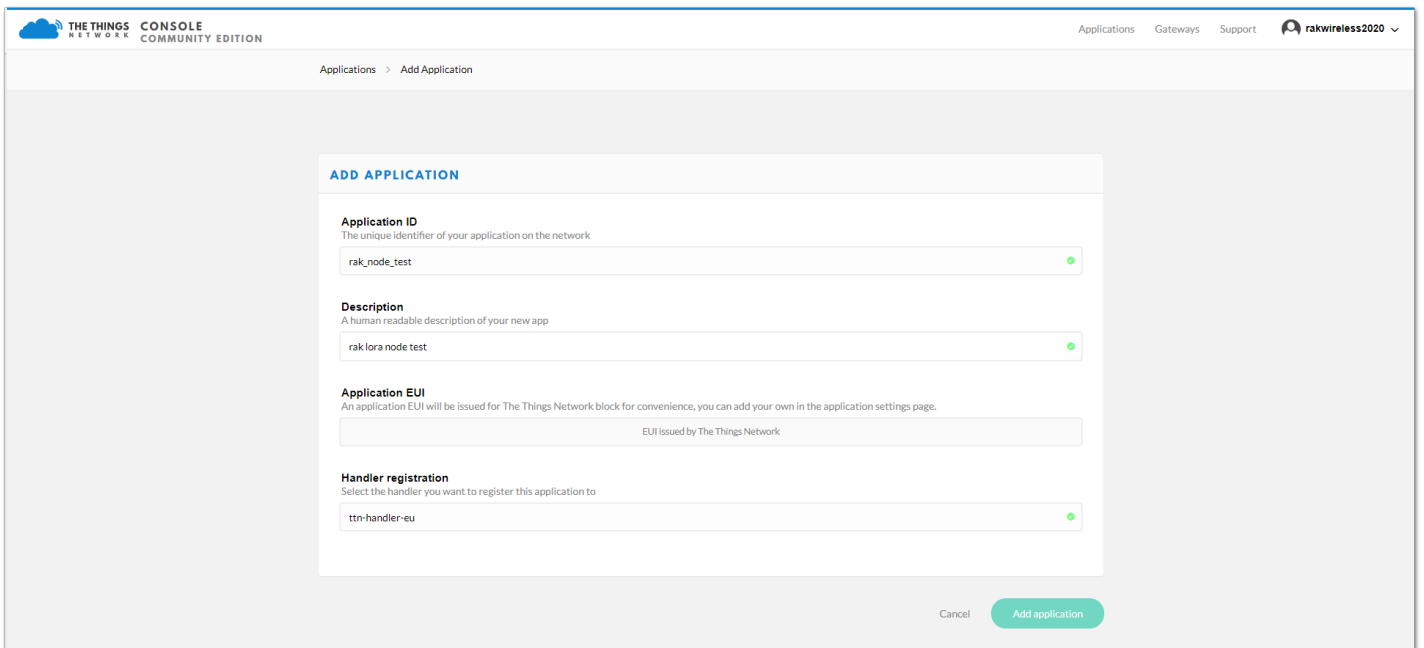2. Click the "**add application**" button.

Figure 10: Adding an Application

- Here are the things that you should take note in adding an application:

  - **Application ID** - this will be the unique id of your application in the Network. Note that the characters should be in lower case, no spaces are allowed.
  - **Description** - this is a short and concise human readable description of your application.
  - **Application EUI** - this will be generated automatically by The Things Network for convenience.
  - **Handler Registration** - handler you want to register this application to.

3. After you fill in the necessary information, press the "**Add application**" button at the bottom of this page. If you see similar page as shown in Figure 11, then you have successfully registered your application.
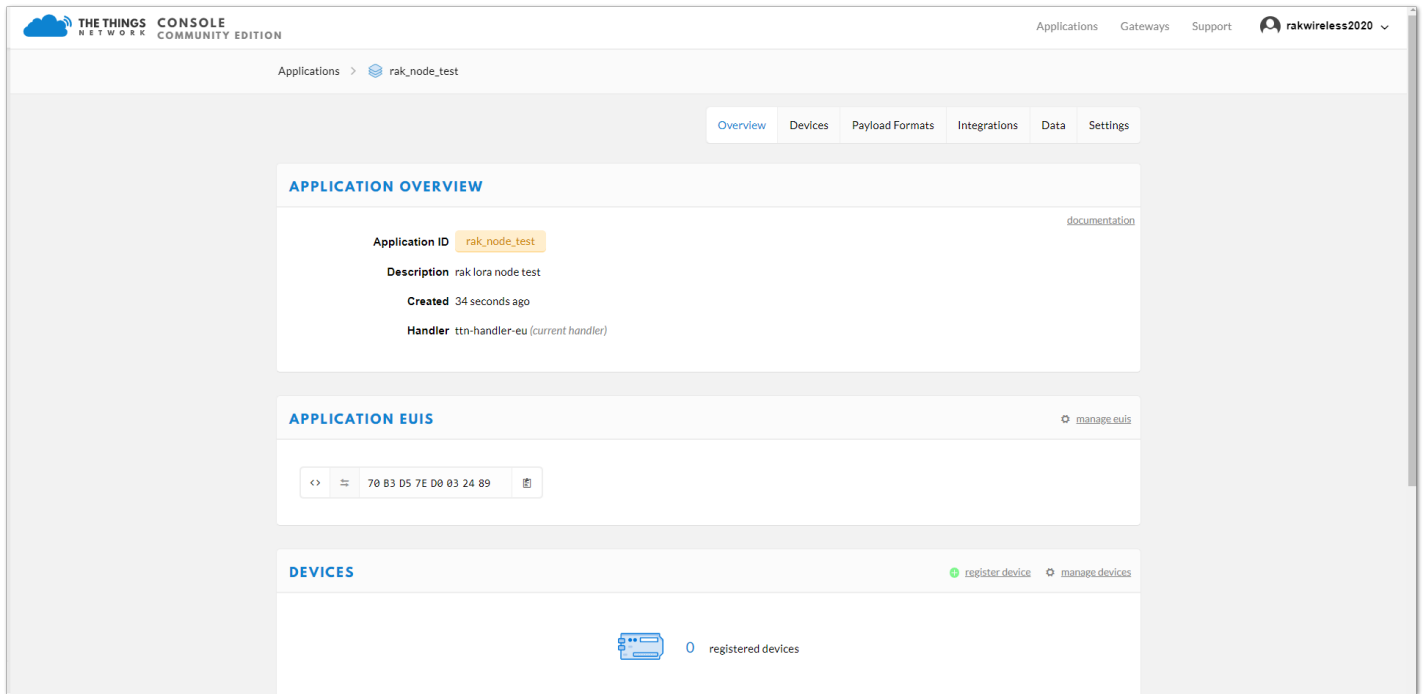
Figure 11: Application Overview

Register a New Device

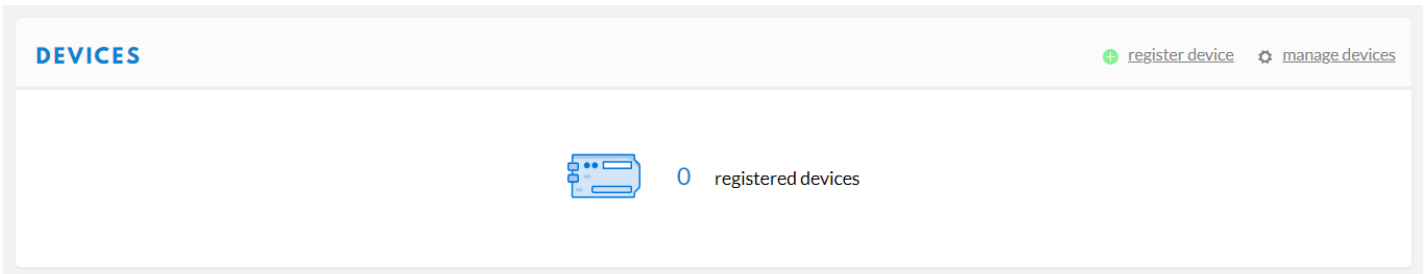1. Scroll down until you see the Devices section. Or, you can click the "**Devices**" button at the top.

Figure 12: Register a New Device

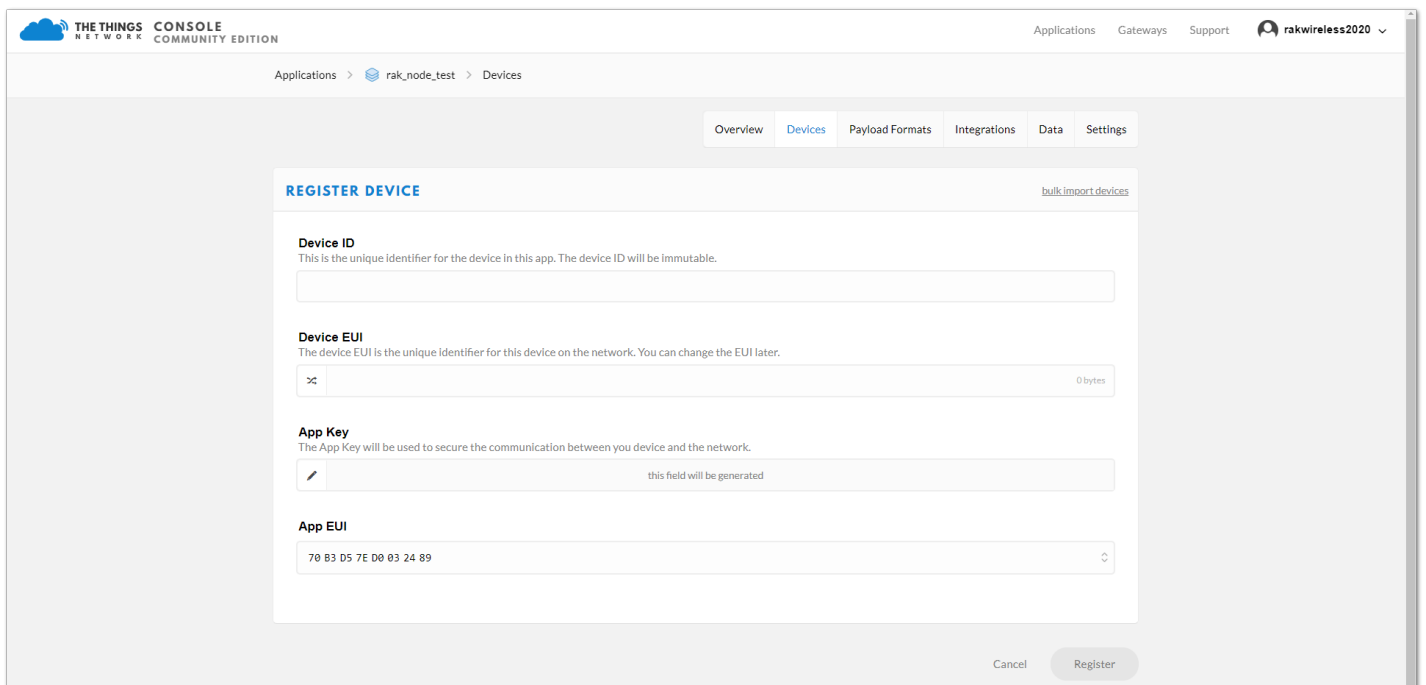2. Then, register a new device by clicking on the "**register devices**".

Figure 13: Add your Device

In this form, the device ID must be unique for the application and must be completed with a lower case, alphanumeric characters. The rest of the parameters in the form are very important for the LoRaWAN protocol:

- **Device EUI**
- **Application Key**

- **Application EUI**

The TTN platform can generate these parameters randomly by leaving those fields empty, or you can enter already existing values.

3. Press the "**Register**" button at the bottom of this page to finish the process.
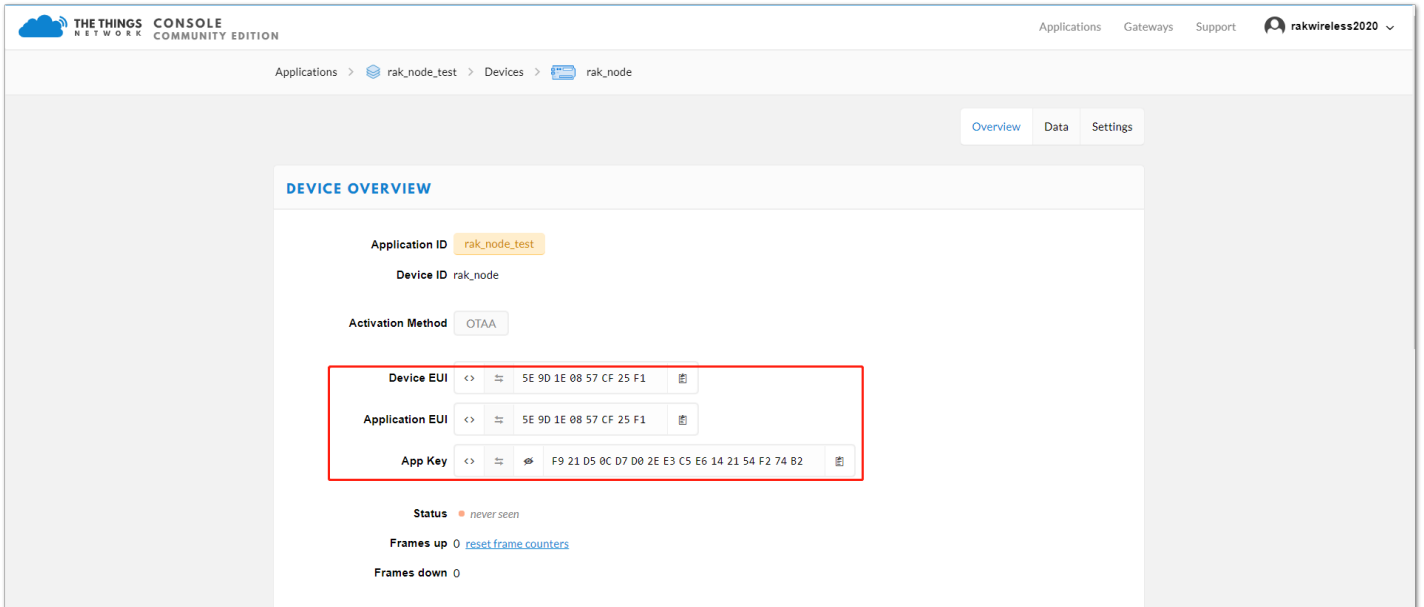

Figure 14: Device Overview

LoRaWAN Join Mode

The LoRaWAN specification defines that to join in a LoRaWAN network, each end-device has to be personalized and activated. Activation can be done either via Over-The-Air-Activation (OTAA) or Activation-By-Personalization (ABP). In OTAA, the previously personalized end-device is activated when is deployed or reset. On the other hand, in ABP, the personalization and activation are done as a single step.

Hence, this is referred to as the "**Join Mode**". LoRaWAN allows the OTAA mode and the ABP mode. In this section, the configuration process of these two modes is explained, both on the platform side and the node side.

OTAA Mode

Configure the OTAA Mode on the Platform

As shown in the Figure 14, the default activation mode in TTN is the OTAA mode. Therefore, no further actions are required in the platform side.

Configure the OTAA Mode on the RAK811 Breakout Board

The RAK811 Breakout Board supports a series of AT commands to configure its internal parameters and control the functionalities of the module. Physically, the module exposes a serial interface through the USB connector.

To set up the RAK811 Breakout Board to join the TTN using OTAA, start by connecting the RAK811 Breakout Board to the Computer (see Figure 1) and open the RAK Serial Port Tool. Wait for the communication to start. It is recommended to test the serial communication and verify the current configuration by sending either of these two AT commands:

```
at+set_config=device:restart
```
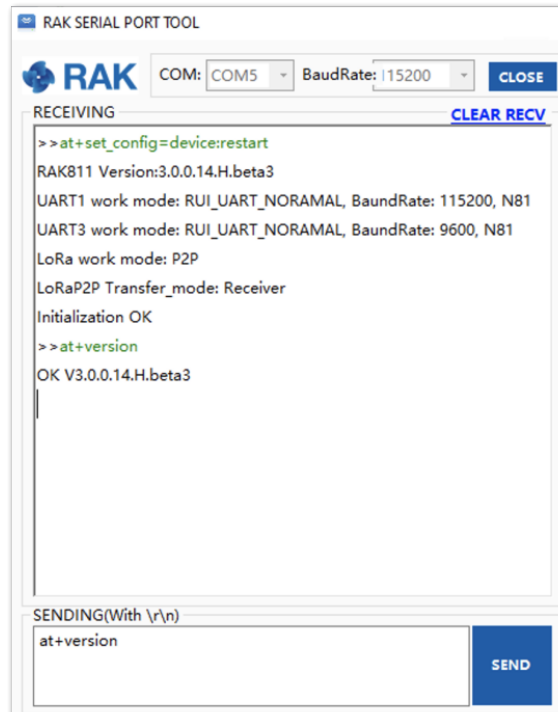
```
at+version
```


Figure 15: at+version command response

As an example, these are the list of the parameters you need to configure in RAK811 Breakout Board:

- LoRa join mode: **OTAA**
- LoRa class: **Class A**
- LoRa region: **EU868**
- Device EUI: **5e9d1e0857cf25f1**
- Application EUI: **5e9d1e0857cf25f1**
- Application Key: **f921d50cd7d02ee3c5e6142154f274b2**

1. Set the LoRa join mode to OTAA.

```
at+set_config=lora:join_mode:0
```

2. Set the LoRa class to Class A.

```
at+set_config=lora:class:0
```

3. Set the frequency/region to EU868.

- Refer in the RAK811 Breakout Board Datasheet for the list of supported frequencies.

```
at+set_config=lora:region:EU868
```

4. Set the Device EUI.

```
at+set_config=lora:dev_eui:5e9d1e0857cf25f1
```

5. Set the Application EUI.

```
at+set_config=lora:app_eui:5e9d1e0857cf25f1
```

6. Set the Application Key.

```
at+set_config=lora:app_key:f921d50cd7d02ee3c5e6142154f274b2
```
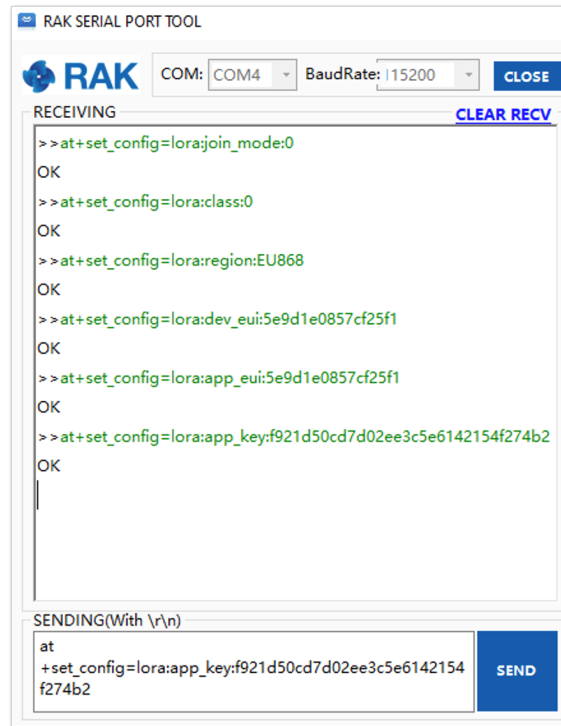

Figure 16: Configuring LoRa Parameters

> 📝 **NOTE:**
>
> After configuring all the parameters, you need to reset your RAK811 Breakout Board to save the parameters.

7. After resetting, join in OTAA mode.

```
at+join
```

After 5 or 6 seconds, if the request was successfully received by a LoRa gateway, then you should see the messages shown in Figure 17.

8. Try to send a message from the RAK811 Breakout Board.

```
at+send:lora:2:1234567890
```

Figure 17: OTAA Test Sample Data Sent via RAK Serial Port Tool

You can see the data sent by the RAK811 Breakout Board on the TTN platform as shown in Figure 18.
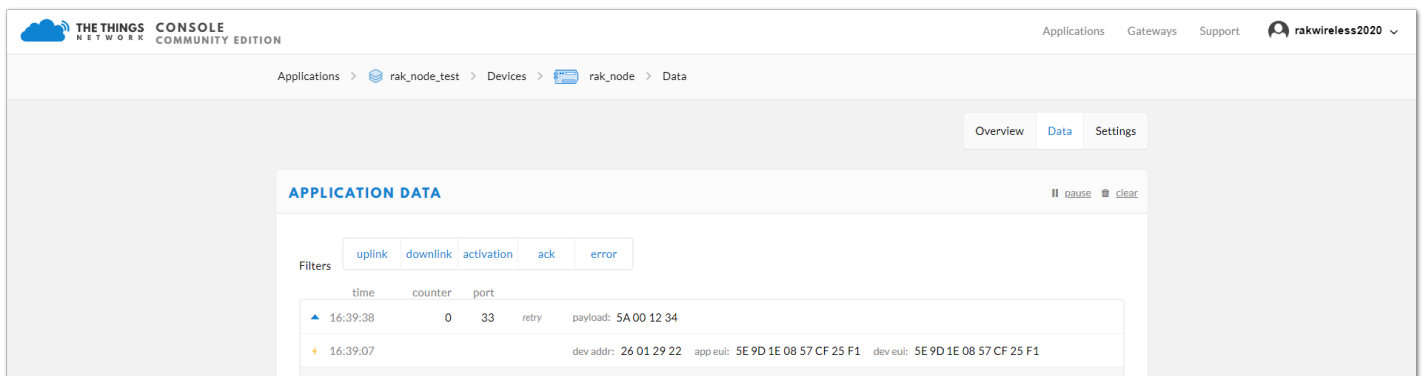

Figure 18: OTAA Test Sample Data Sent Viewed in TTN

ABP Mode

Configure the ABP mode on the Platform

If the ABP mode is preferred, then the TTN platform needs to be configured first accordingly. At TTN, once a device is created, you can select the "**SETTINGS**" section of the "**DEVICE**" and switch the "**Activation Method**".
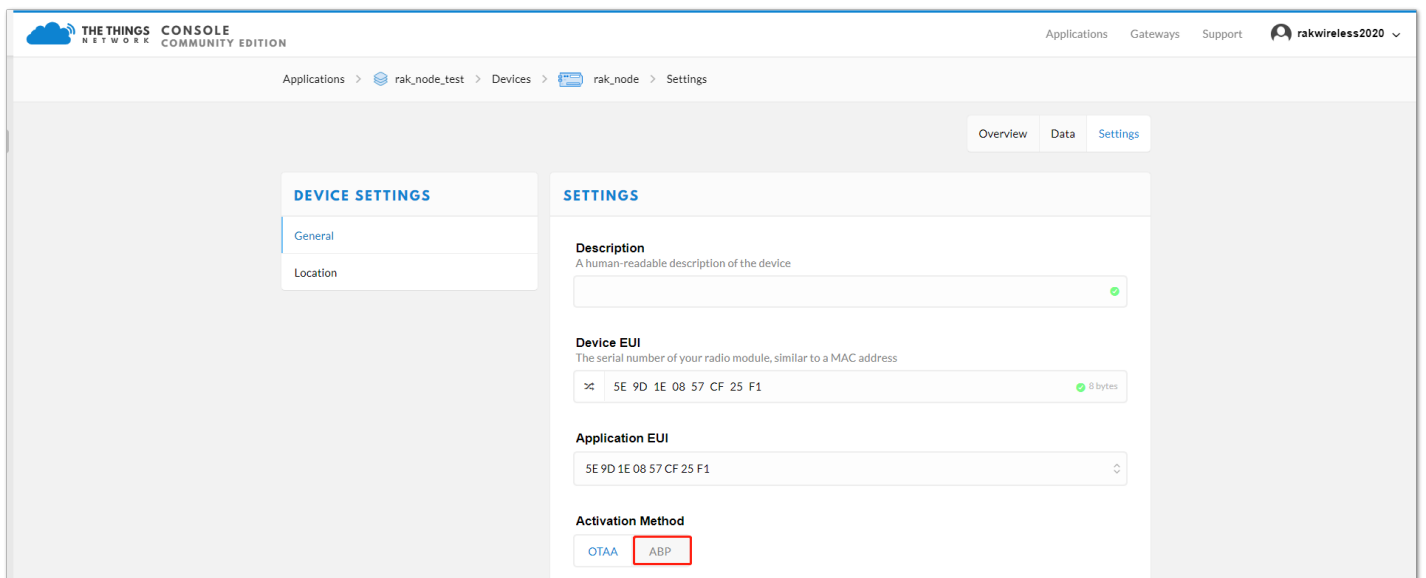

Figure 19: ABP Activation in TTN

- For ABP mode, the TTN parameters needed are the following:

- **Device Address**
- **Network Session Key**
- **App Session Key**

> 📝 **NOTE:**
>
> These fields can be left empty in the form and TTN will complete them with random values. In other cases, you can complete them with specific values.
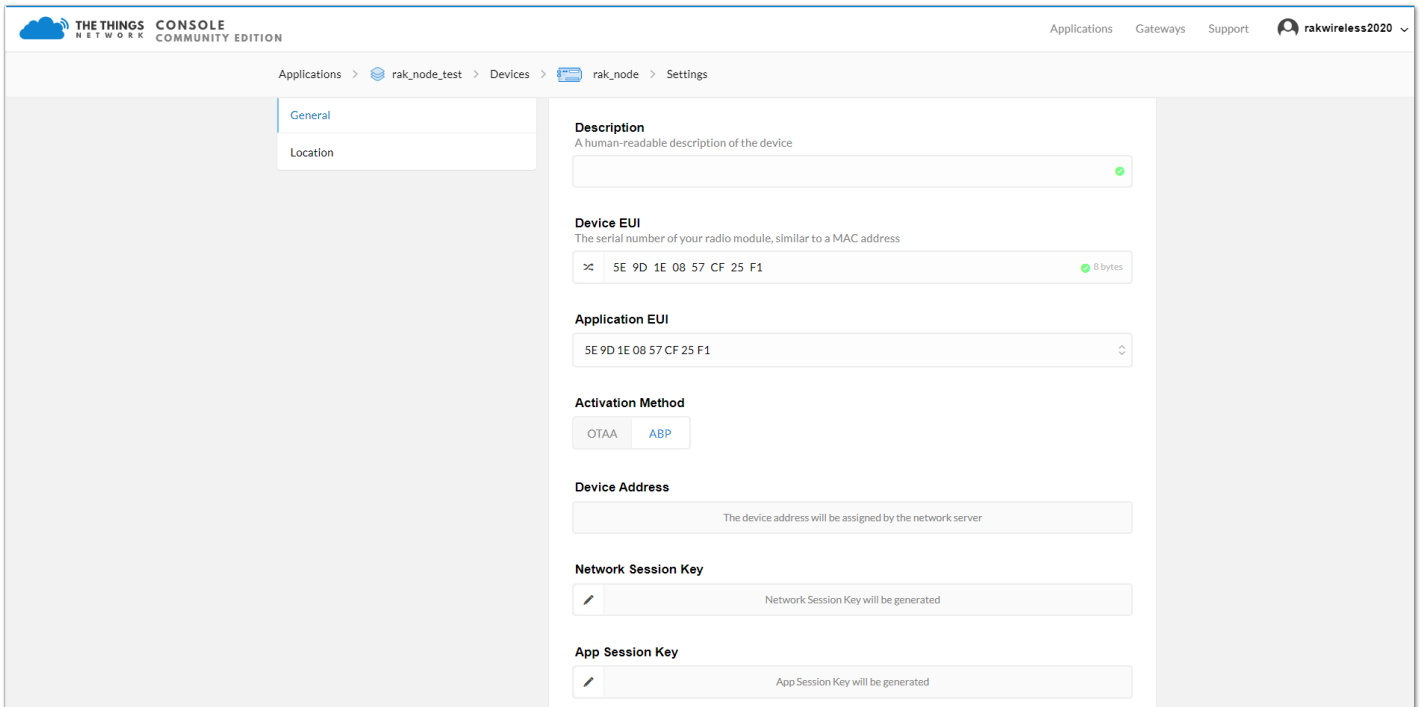

Figure 20: ABP Mode Parameters

The same as the OTAA form, you can leave these fields empty to allow TTN to generate random values or input the specific values that you want.
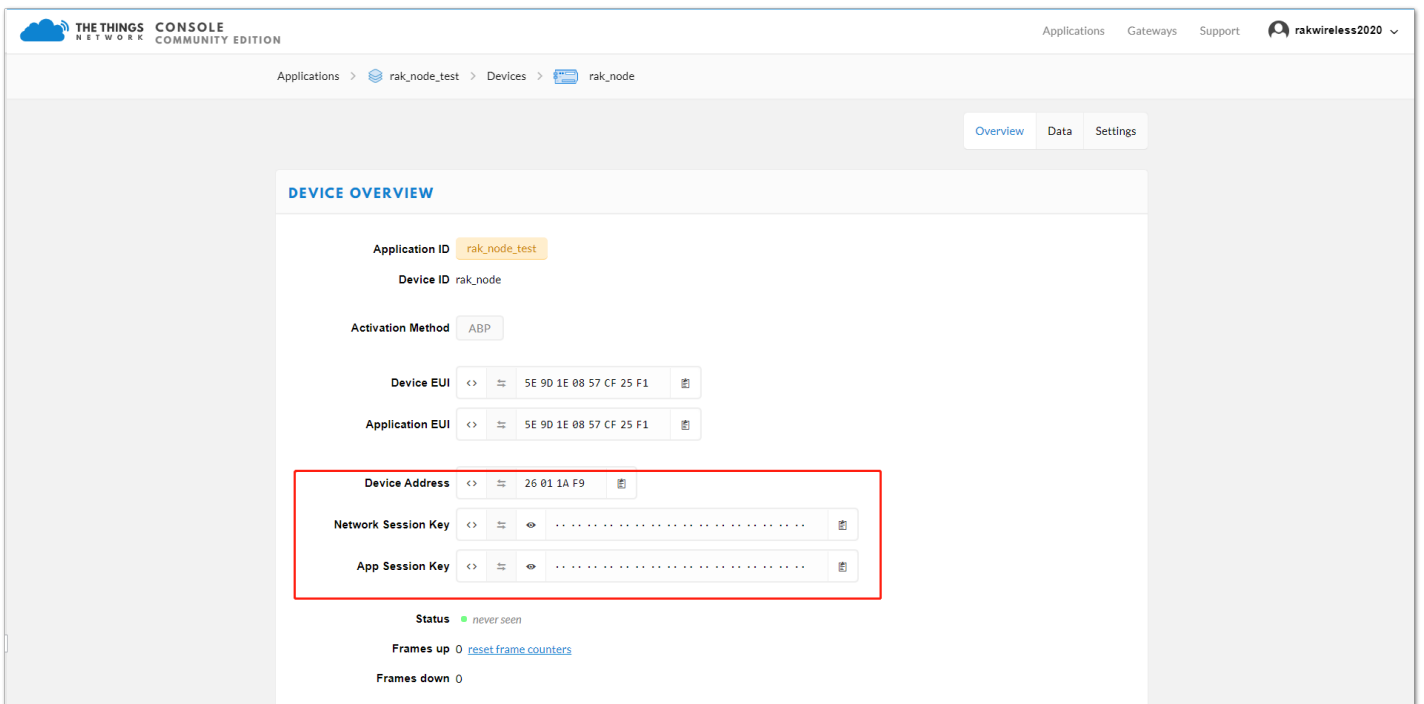

Figure 21: ABP Mode Parameters

Configure the ABP mode on the RAK811

To set up the RAK811 Breakout Board to join the TTN using ABP, start by connecting the RAK811 board to the Computer via a USB to UART converter (see Figure 2) and open the RAK Serial Port Tool. Wait for the

communication to start. It is recommended to test the serial communication by sending either of these two AT commands:

```
at+set_config=device:restart
```

```
at+version
```


Figure 22: at+version command response

As an example, these are the list of the parameters you need to configure in RAK811:

- LoRa join mode: **ABP**
- LoRa class: **Class A**
- LoRa region: **EU868**
- Device address: **26011af9**
- Network Session Key: **c280cb8d1df688bc18601a97025c5488**
- Application Session Key: **4d42ec5caf97f03d833cdaf5003f69e1**

1. Set the LoRa join mode to ABP.

```
at+set_config=lora:join_mode:1
```

2. Set the LoRa class to Class A.

```
at+set_config=lora:class:0
```

3. Set the frequency/region to EU868.

- Refer in the RAK811 Breakout Board Datasheet for the list of supported frequencies.

```
at+set_config=lora:region:EU868
```

4. Set the Device Address.

```
at+set_config=lora:dev_addr:26011af9
```

5. Set the LoRa Network Session Key.

```
at+set_config=lora:nwks_key:c280cb8d1df688bc18601a97025c5488
```

6. Set the LoRa Application Session Key.

```
at+set_config=lora:apps_key:4d42ec5caf97f03d833cdaf5003f69e1
```
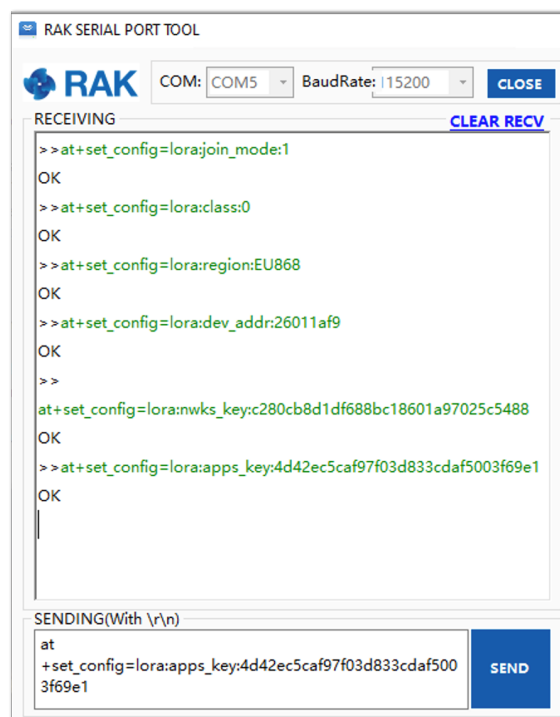

Figure 23: AT Command for ABP LoRa parameters via RAK Serial Port Tool

📝 **NOTE:**

After configuring all the parameters, you need to reset your RAK811 Breakout Board to save the parameters.

7. After resetting, join in ABP mode.

```
at+join
```

> 📝 **NOTE:**
>
> By using the ABP mode in LoRaWAN, it doesn't require to join a network before sending a LoRaWAN package. But to keep the consistency of internal states of the firmware of the RAK811 Breakout Board, it is still required to send `at+join` command in the ABP mode. This time, the firmware should reply almost immediately with an "OK".

8. Try to send a data from the RAK811 Breakout Board to TTN in ABP mode.

```
at+send:lora:2:1234567890
```


Figure 24: ABP Test Sample Data Sent via RAK Serial Port Tool

Then, go to the TTN Console to confirm that the message was properly received.

Connecting to ChirpStack

The ChirpStack or previously known as LoRaServer project provides open-source components for building LoRaWAN networks. To learn more about ChirpStack, visit their **website**⧉ .

You can use RAK811 Breakout Board to connect with ChirpStack according to the following steps:

> 📝 **NOTE:**
>
> In this document, it is assumed that you are using RAK Gateway and its built-in ChirpStack or RAK cloud testing ChirpStack. Also, the RAK Gateway with Chirpstack must be configured successfully.

1. Open the web page of the ChirpStack which you want to connect with and login.

2. By default, there is already one or more items in this page. You can either use it or create a new item, but for this, create a new item by clicking the "**CREATE**" button.
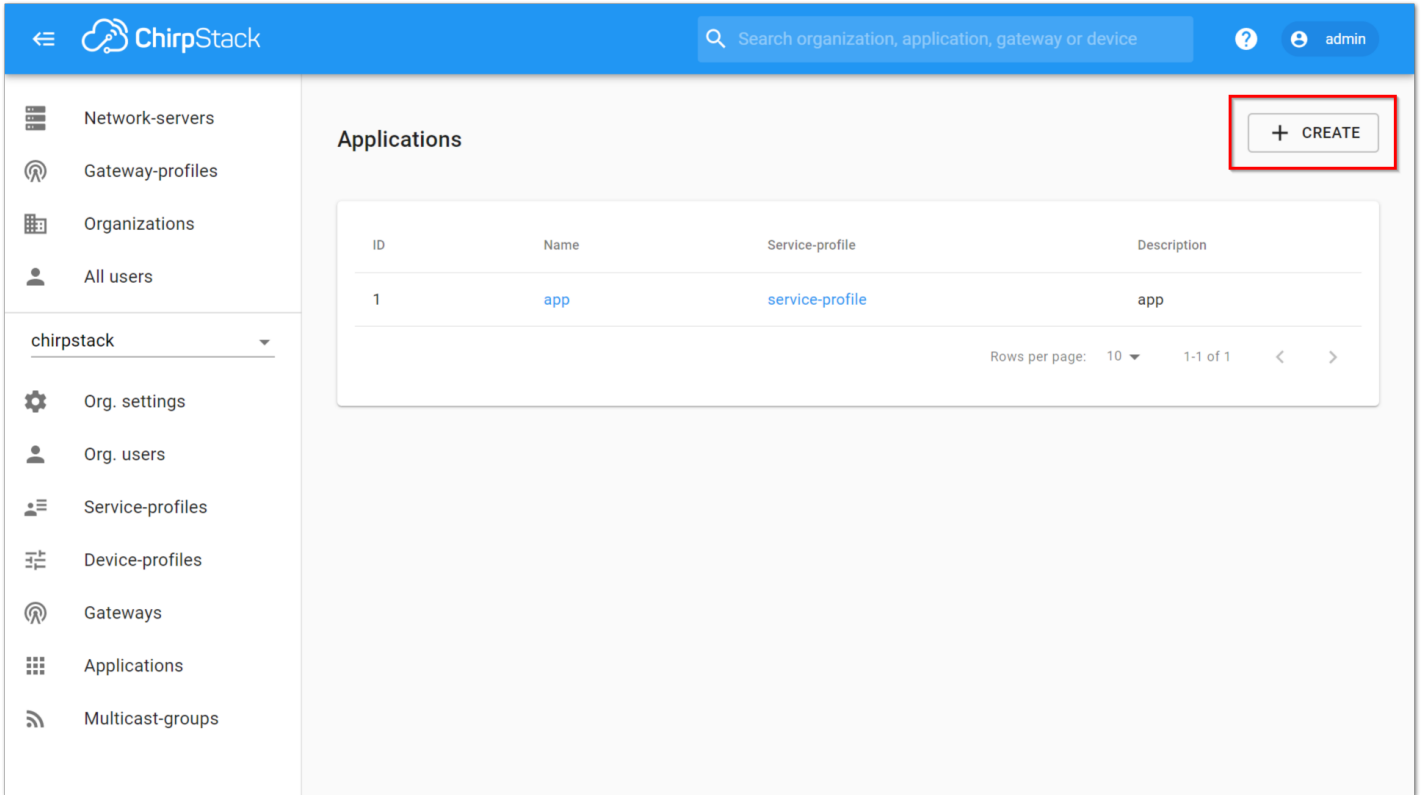
Figure 25: ChirpStack Applications

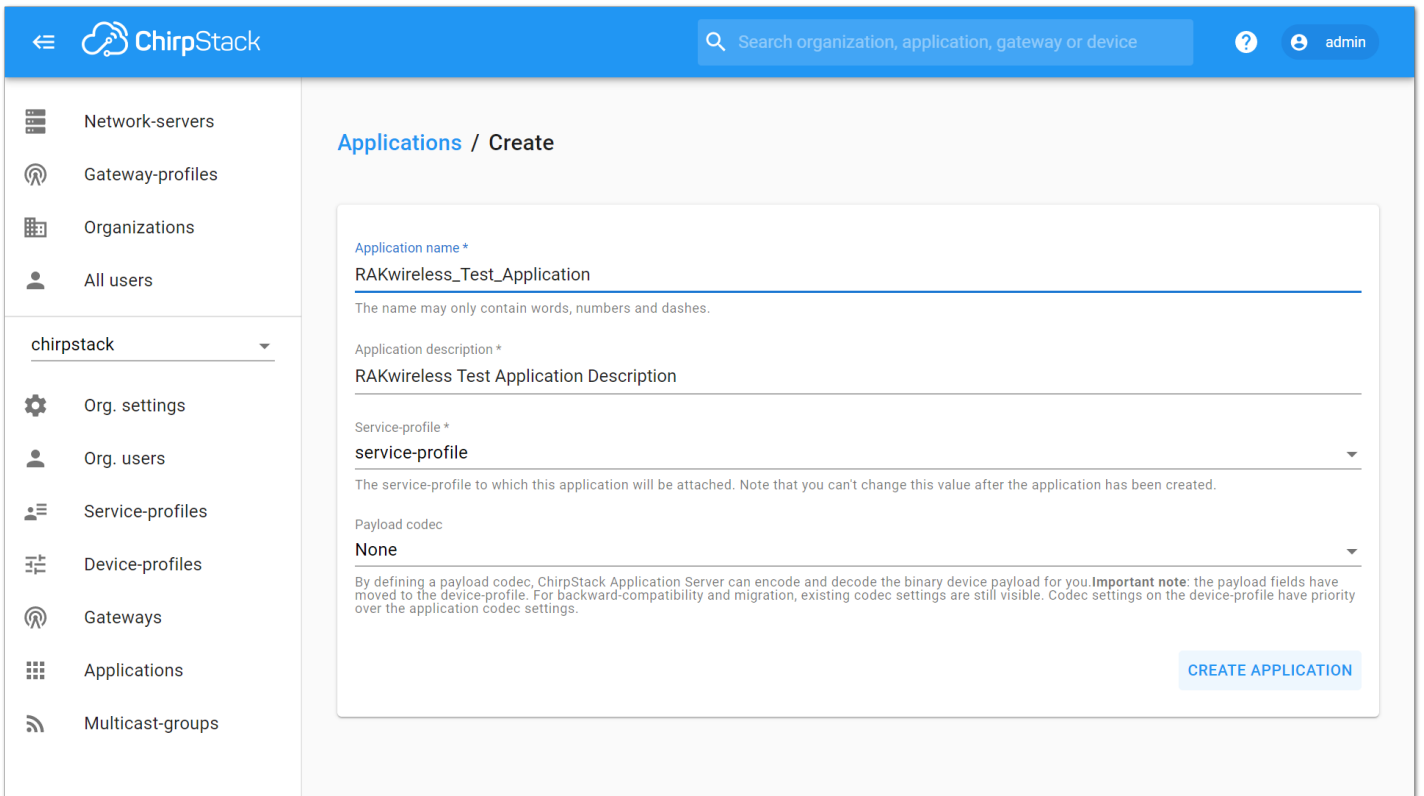3. Fill up the necessary information then Click "**CREATE APPLICATION**".

Figure 26: Creating the Application

4. Click the new item name "**RAKwireless_Test_Application**":
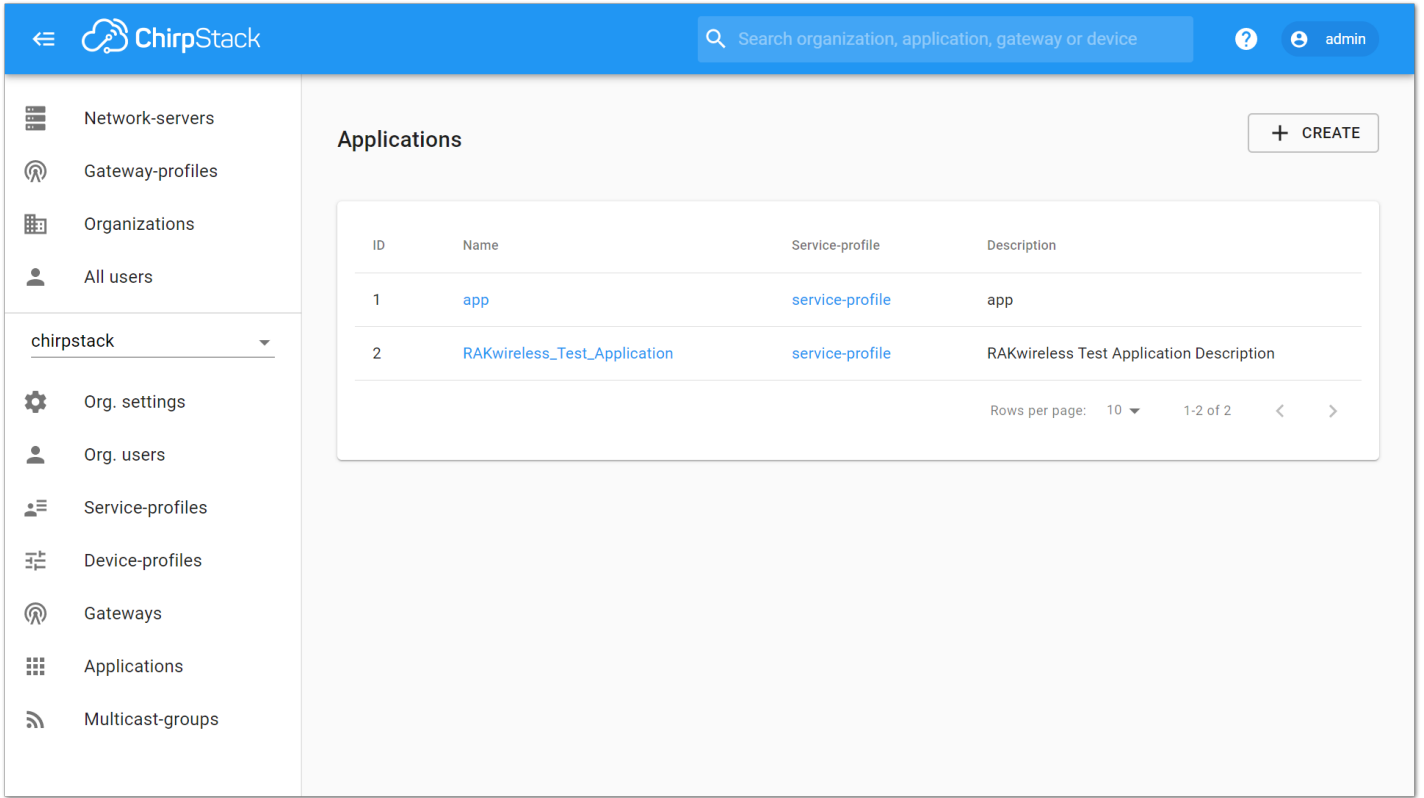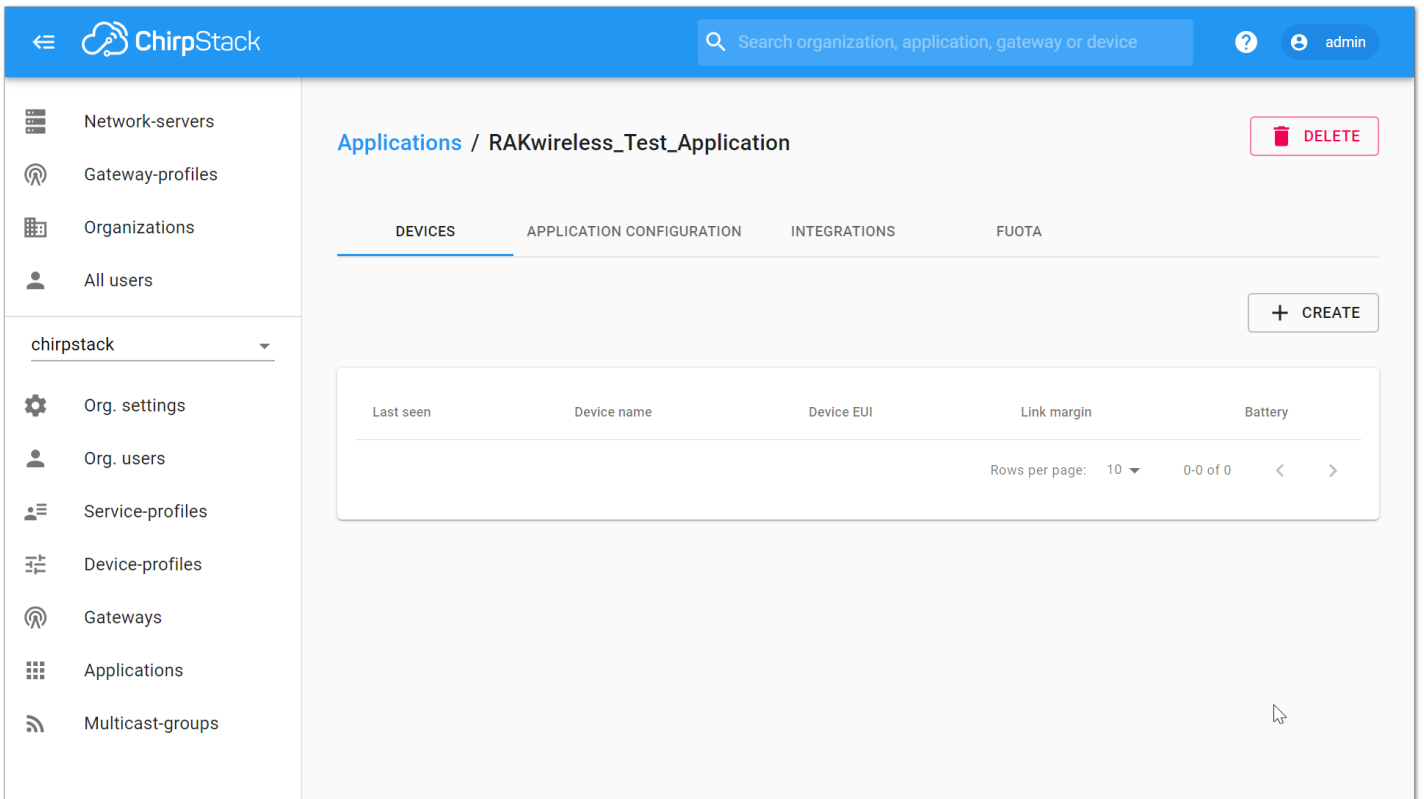
Figure 27: Applications page in ChirpStack

Figure 28: RAK811 Breakout Board Application

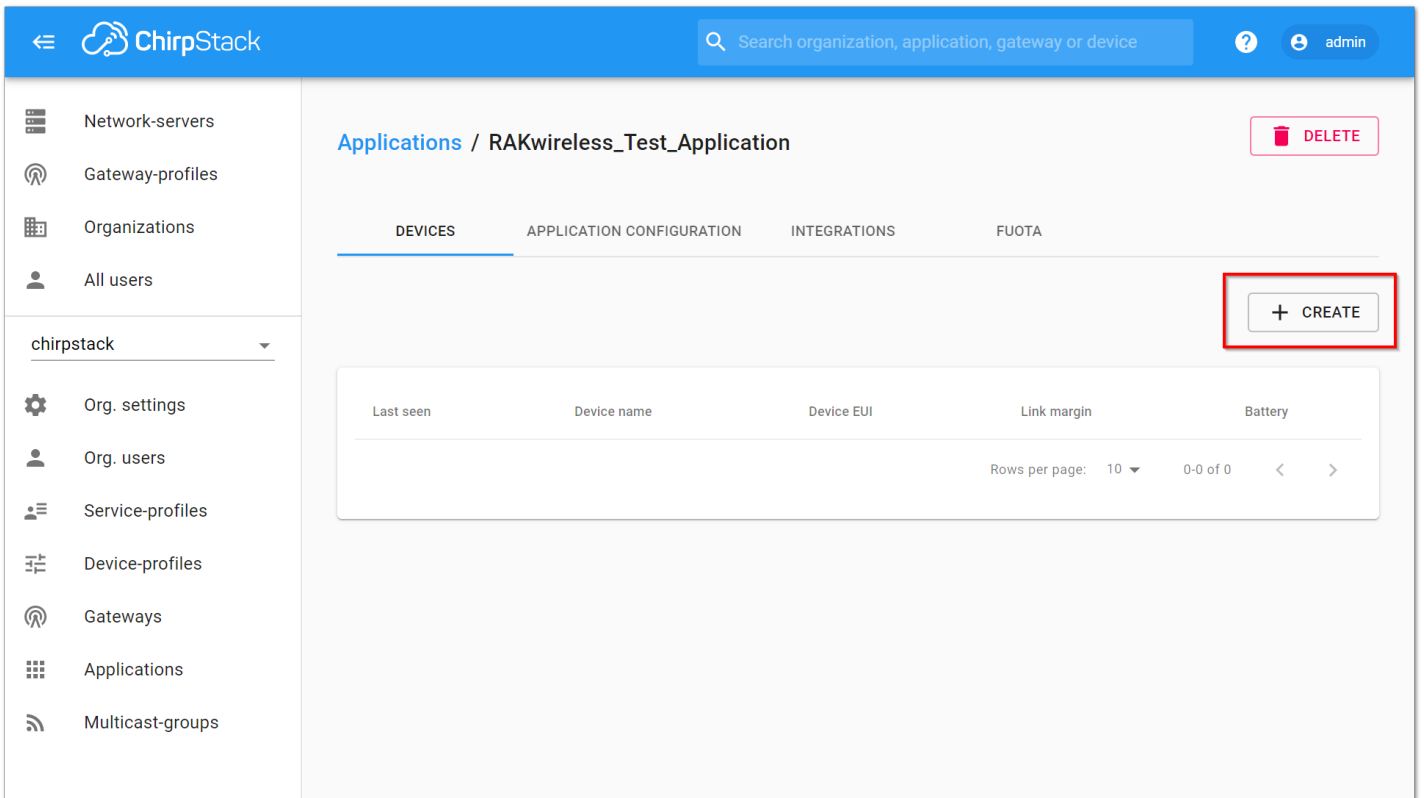5. **Add** a Node device into ChirpStack by clicking the "**CREATE**" button.

Figure 29: Adding a Node Device

6. Fill them in. You can generate a **Device EUI** automatically by clicking the Device EUI icon, or you can write the correct Device EUI in the edit box.
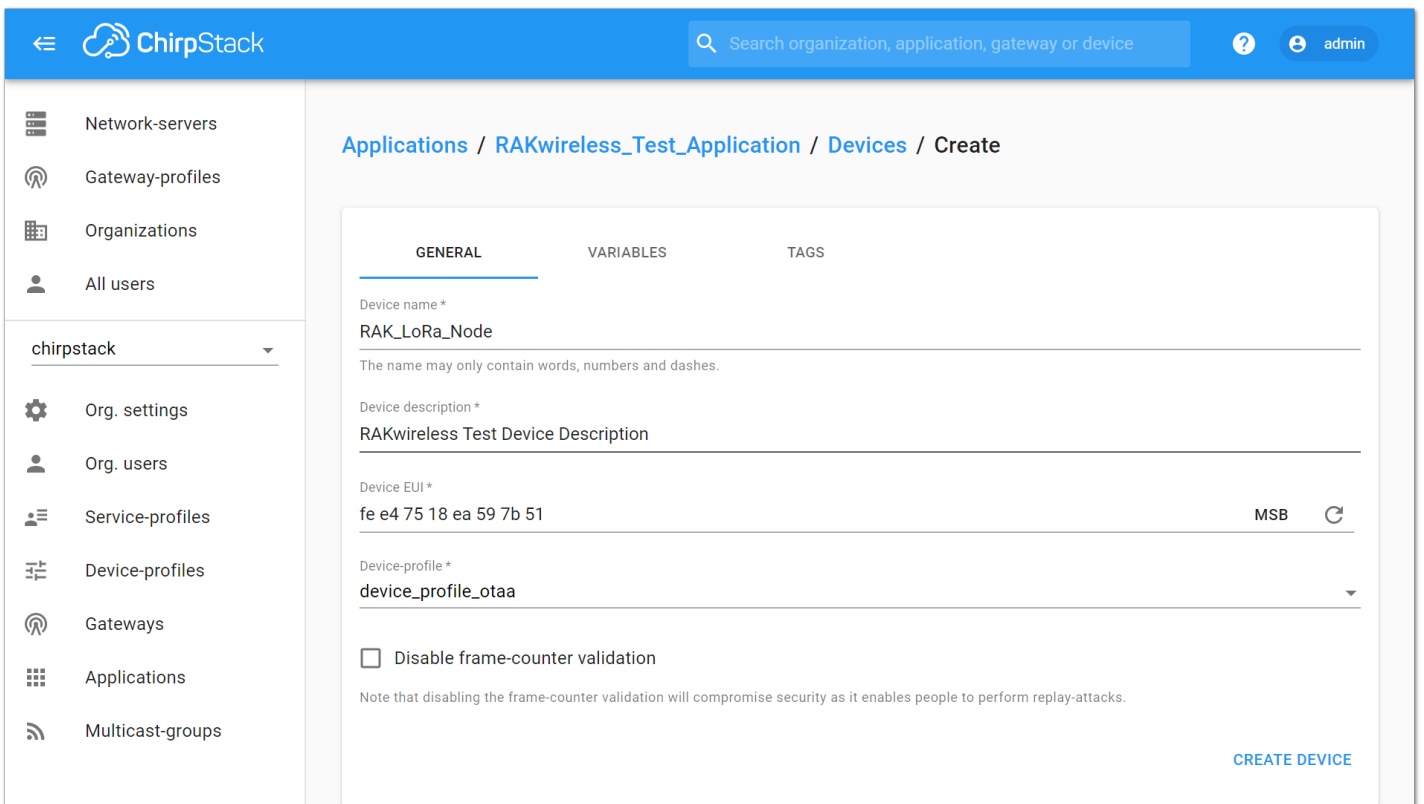

Figure 30: Filling the Device Parameters

📝 **NOTE**

- If you want to join in OTAA mode, select "**DeviceProfile_OTAA**" in the "Device-profile" item.
- If you want to join in ABP mode and CN470 frequency, select "**DeviceProfile_ABP_CN470**" in the "Device-Profile" item.
- If you want to join in ABP mode and other frequencies except AS923 and CN470, select "**DeviceProfile_ABP**" in the "Device-profile" item.

OTAA Mode

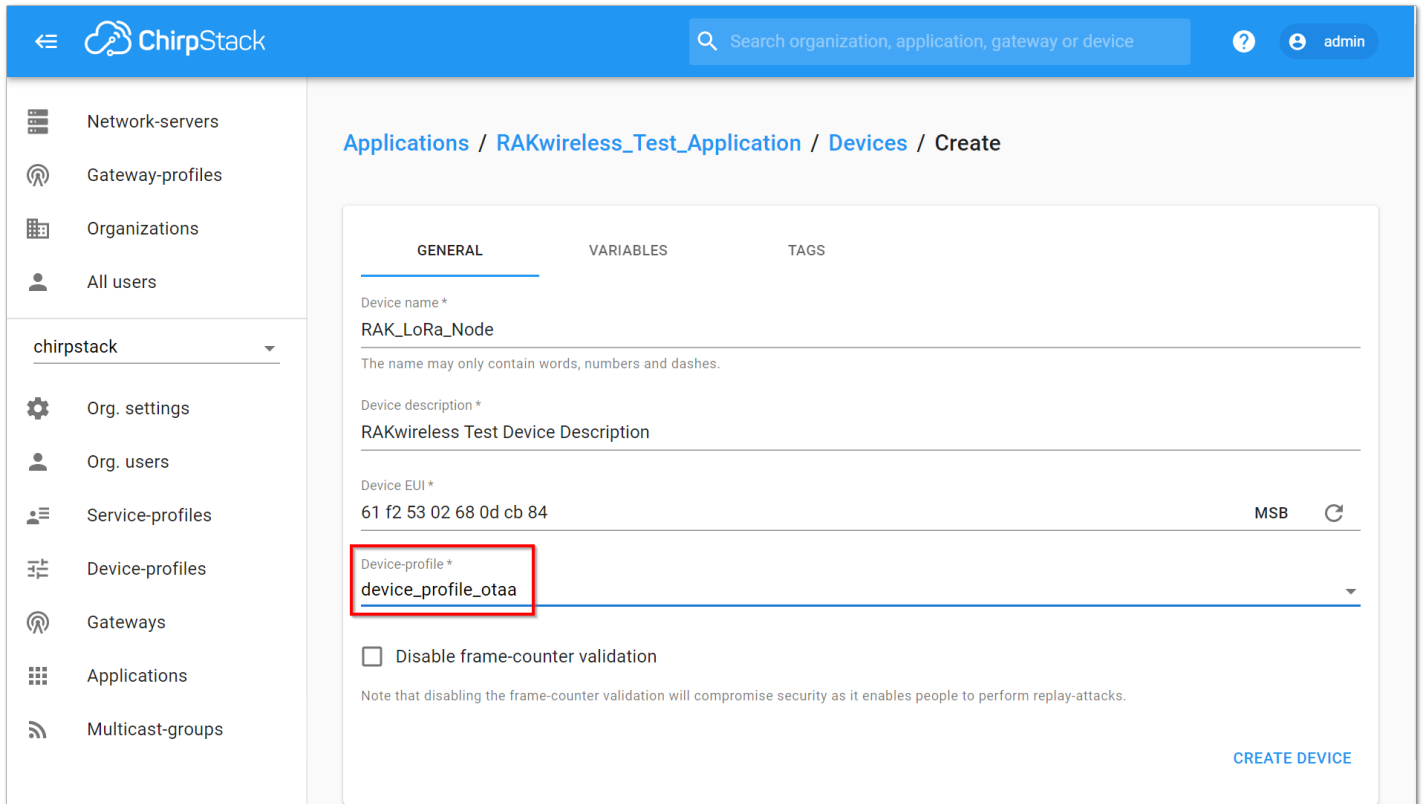1. To join ChirpStack in OTAA mode, select "**DeviceProfile_OTAA**".

Figure 31: Selecting OTAA Activation Mode in ChirpStack

2. Press "**CREATE DEVICE**" button. You may write the application key by yourself or generate it automatically by clicking the icon highlighted in Figure 32.
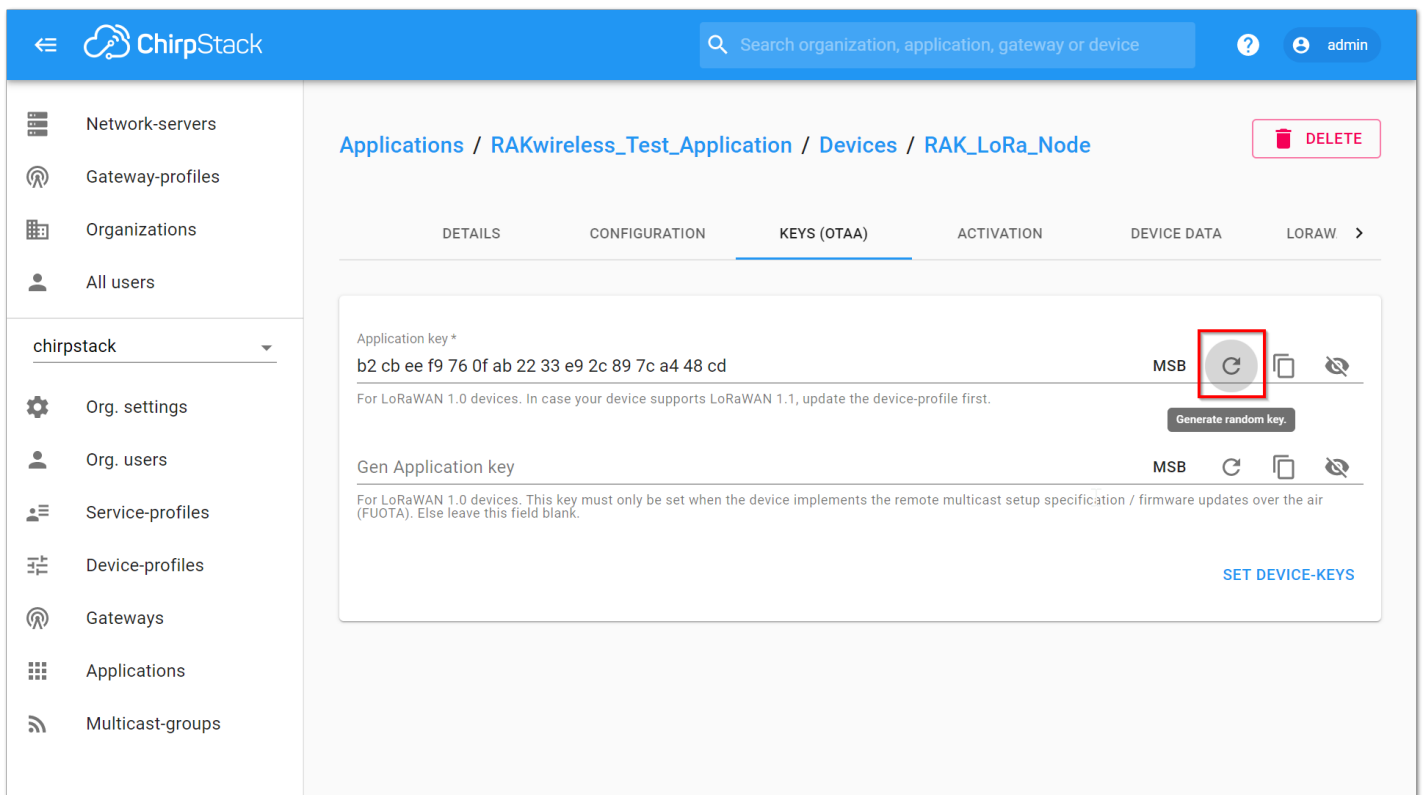

Figure 32: Application Key Generation

3. Click "**SET DEVICE KEYS**" button. Now, you've completed the configuration on ChirpStack.

- The Device EUI, which was set in the previous section to your RAK811 Breakout Board as "dev_eui" is the same as highlighted in Figure 33.
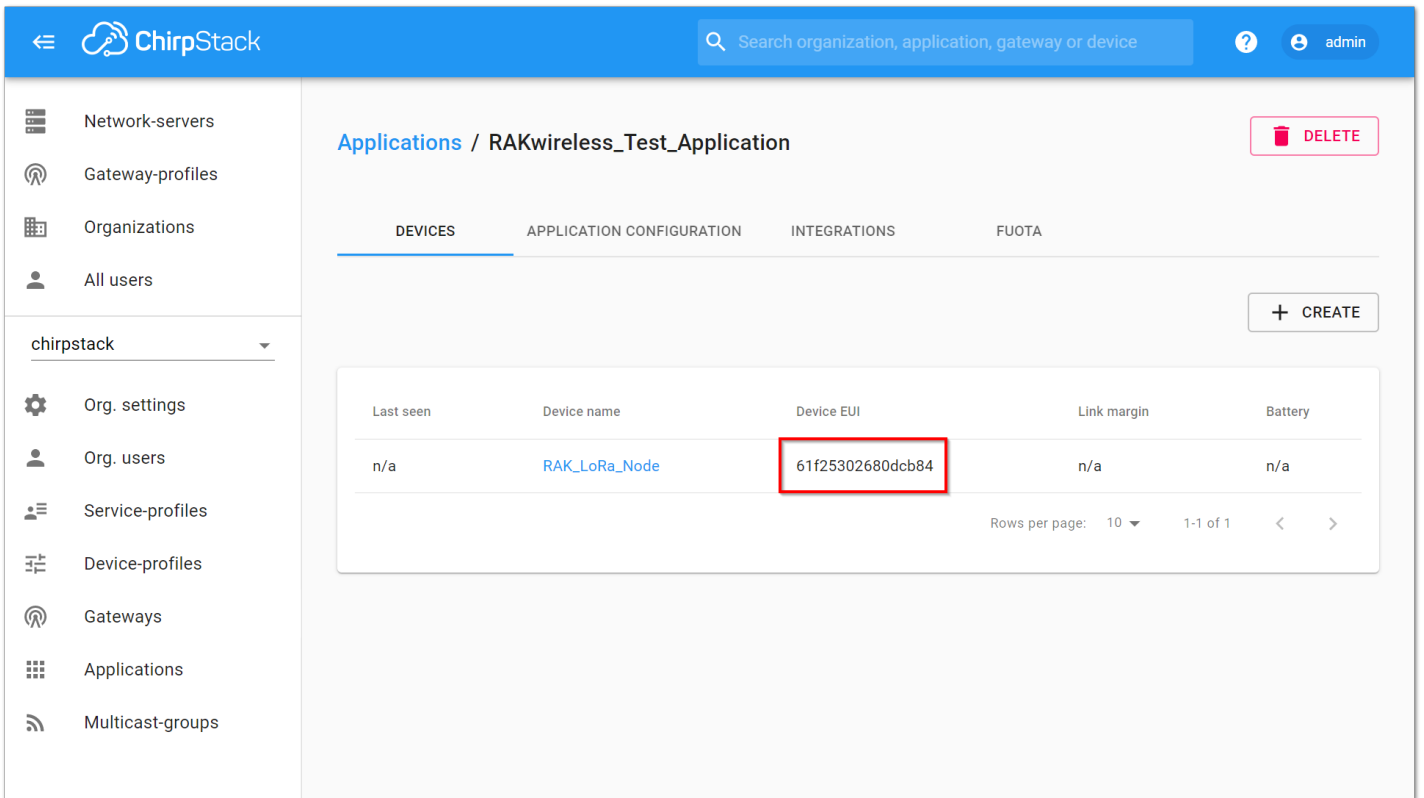
Figure 33: Device EUI Code

- The same with the Application Key, it was also set in the previous section as "app_key", and it should be the same as highlighted in Figure 34.
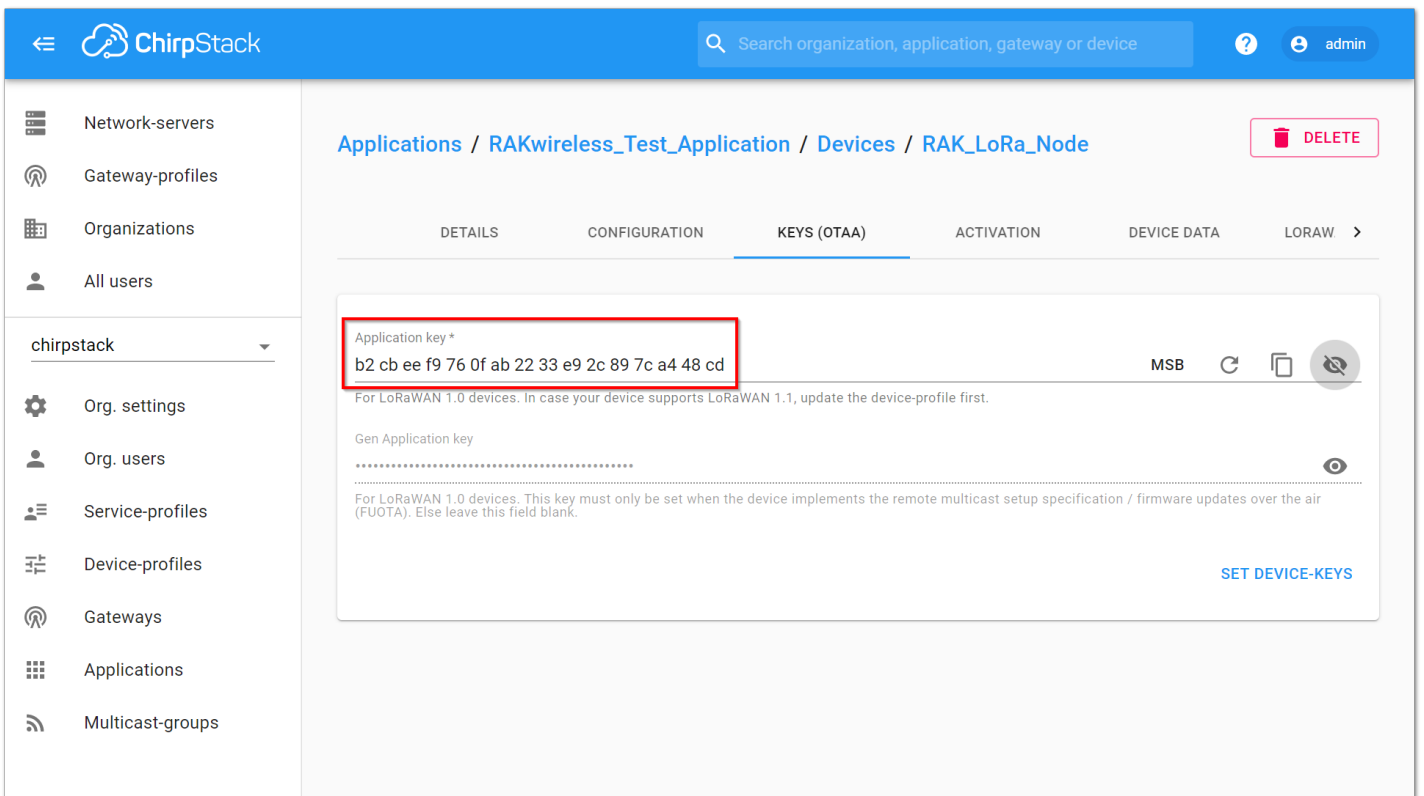

Figure 34: Application Key LoRaWAN

> 📝 **NOTE**
>
> The Application EUI which was into RAK811 Breakout Board as "**app_eui**" is not needed for ChirpStack.

4. Next, **configure** RAK811 Breakout Board by using **AT commands**. To do this, connect your RAK811 Breakout Board to a PC, power it on and open **RAK Serial Port Tool** on your computer.

```sh
at+version
```

Figure 35: RAK Serial Port Tool

- Now, join your RAK811 Breakout Board using the OTAA activation mode.

5. If the join mode is not in OTAA, just set the LoRa join mode to **OTAA** and LoRa class to **Class A** by typing the AT commands shown in Figure 36.

```sh
at+set_config=lora:join_mode:0
```

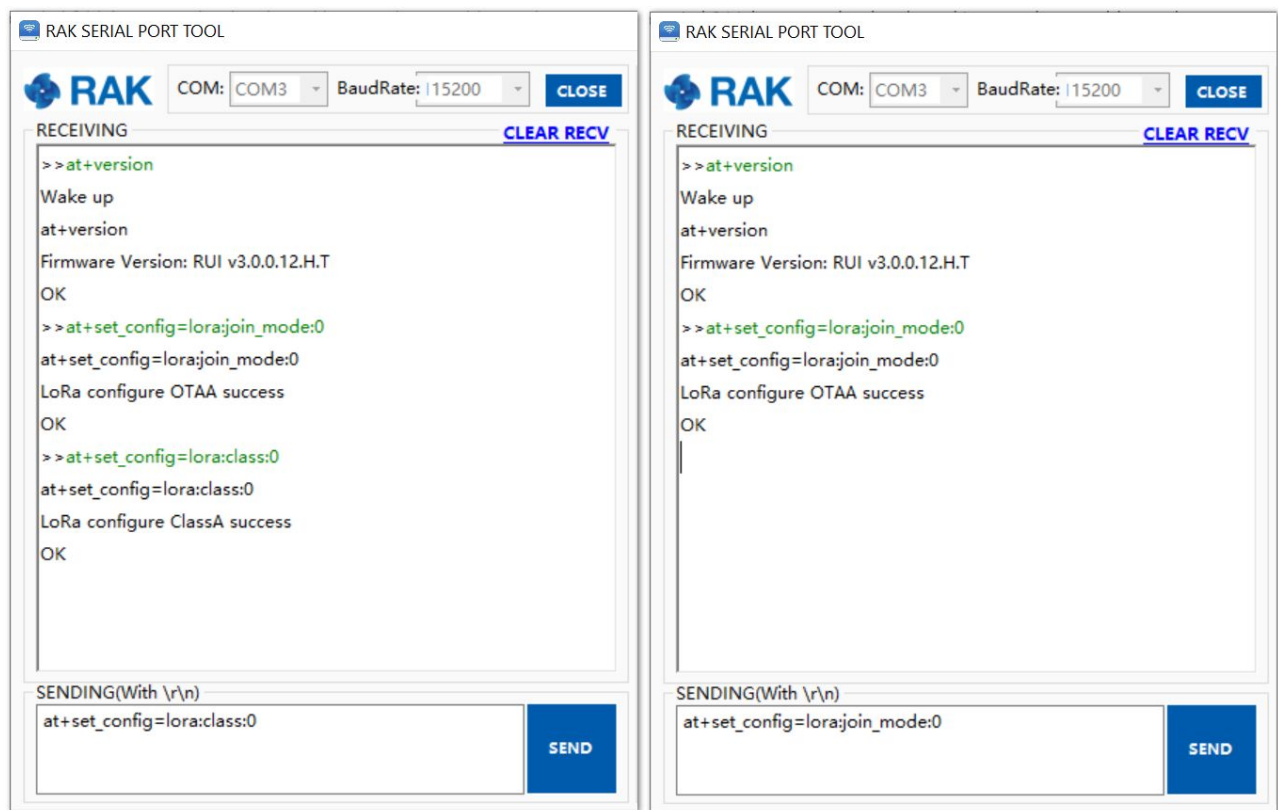```sh
at+set_config-lora:class:0
```

**Figure 36:** Setting of LoRaWAN mode and class

6. Type the following AT command to set the **Frequency/Region**, **Device EUI**, **Application EUI**, and **Application Key**. Remember to replace "**XXX**" and "**XXXX**" with the parameters set in the previous steps.

```sh
at+set_config=lora:region:EU868
```

```sh
at+set_config=lora:dev_eui:XXXX
```

```sh
at+set_config=lora:app_eui:XXXX
```
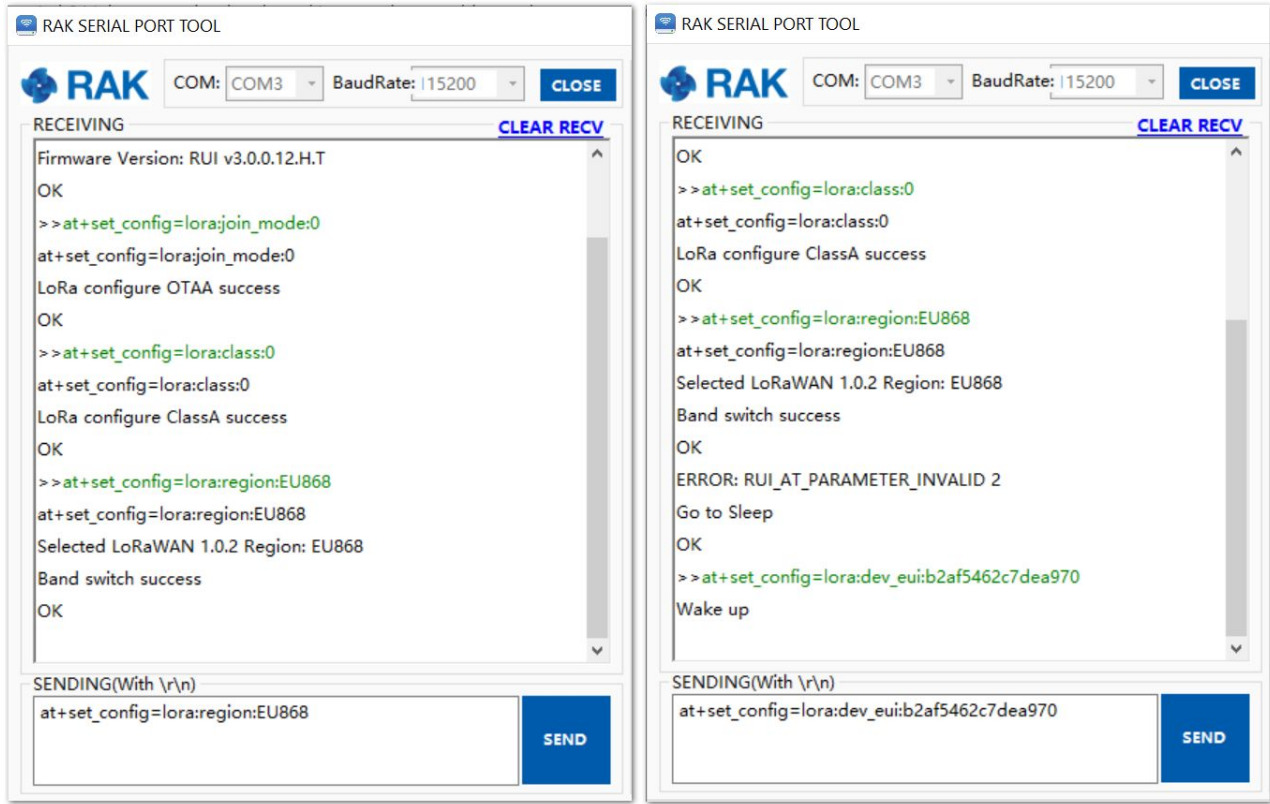
```sh
at+set_config=lora:app_key:XXXX
```

Figure 37: Setting of Frequency and Device EUI
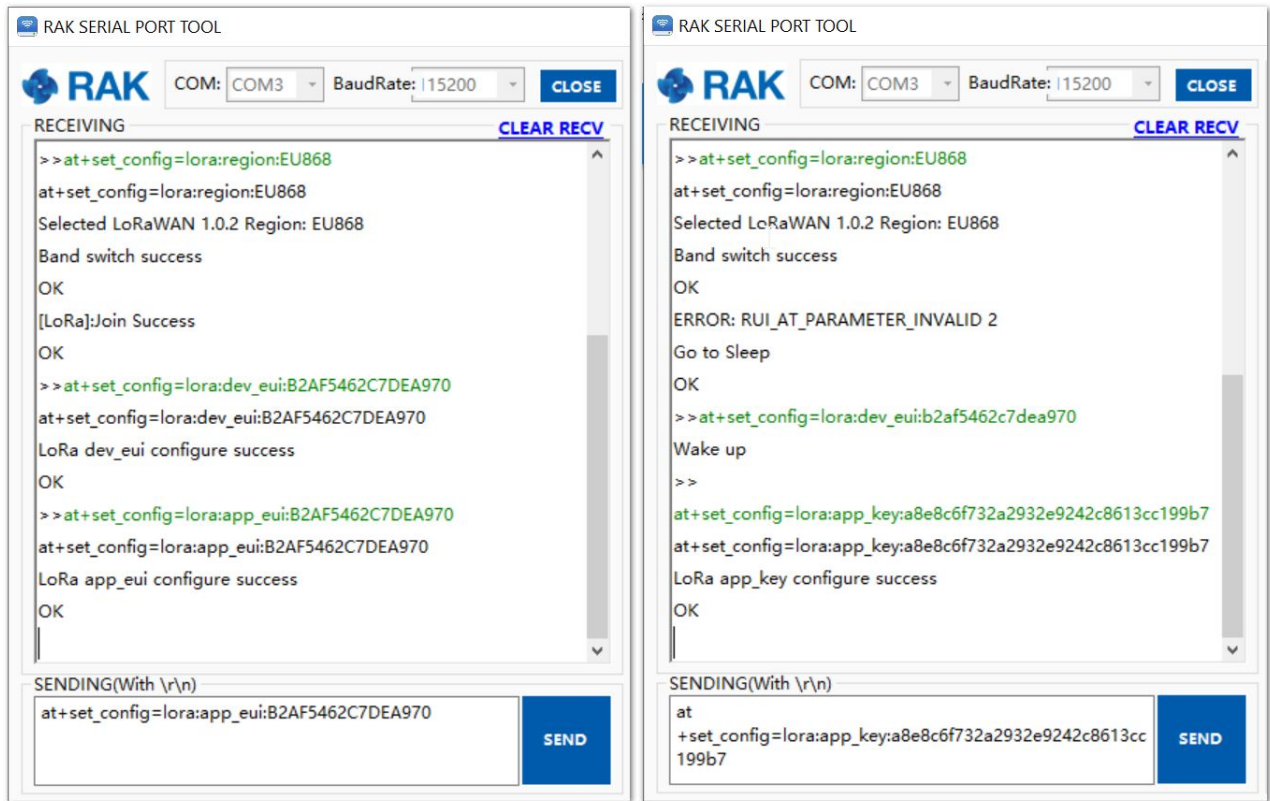

Figure 38: Setting of Application EUI and Key
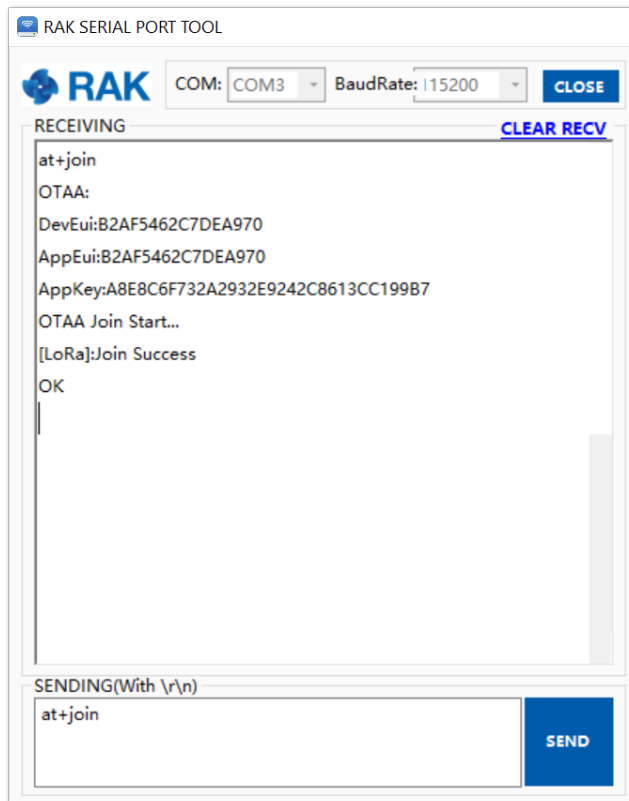
7. Then, **join** in OTAA mode.

```sh
at+join
```

Figure 39: Joining in OTAA

- **Joined Successfully!**

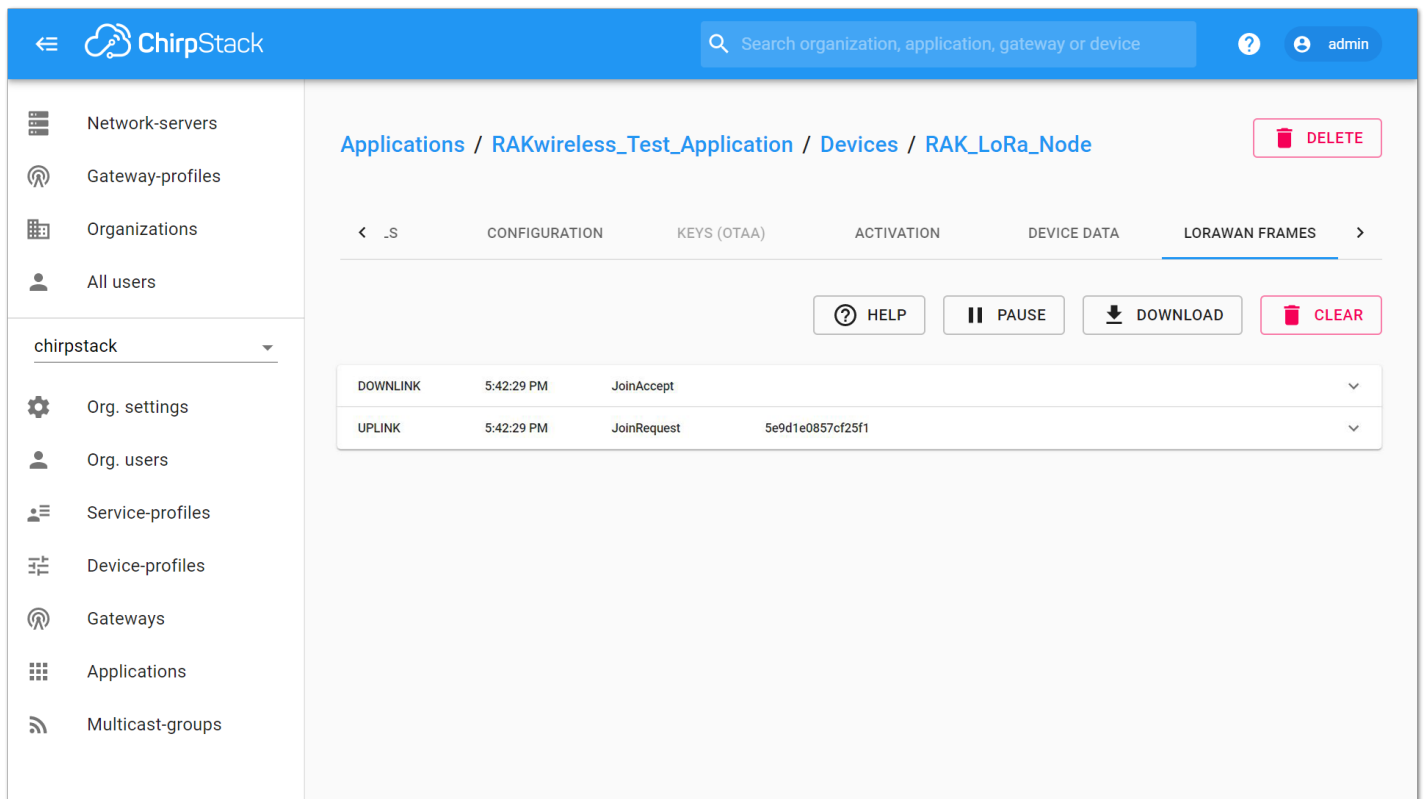8. You can view the "**JoinRequest**" and "**JoinAccept**" on the ChirpStack page.

Figure 40: Join Request of the Device in the ChirpStack

9. Try sending data from the RAK811 Breakout Board to the ChirpStack by typing the command below in the serial port.
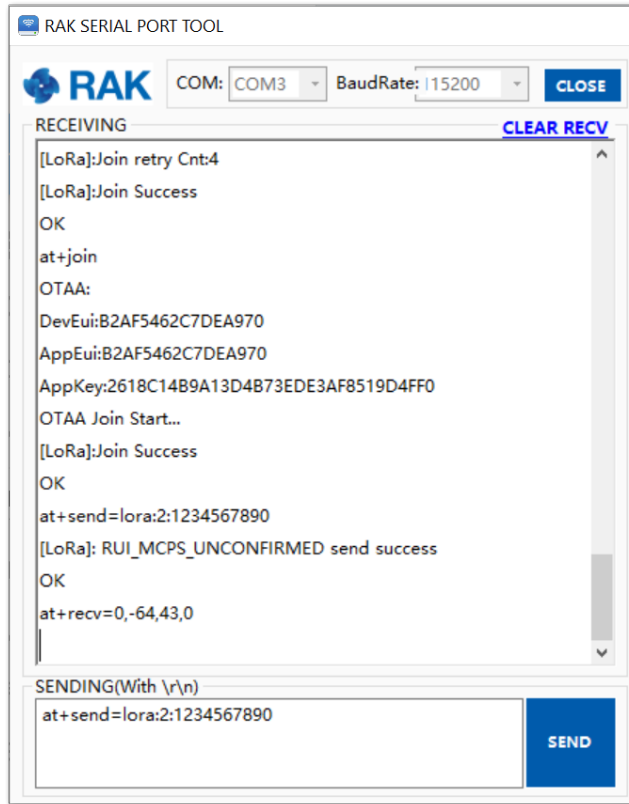
```sh
at+send=lora:2:1234567890
```

Figure 41: Sending Data to ChirpStack

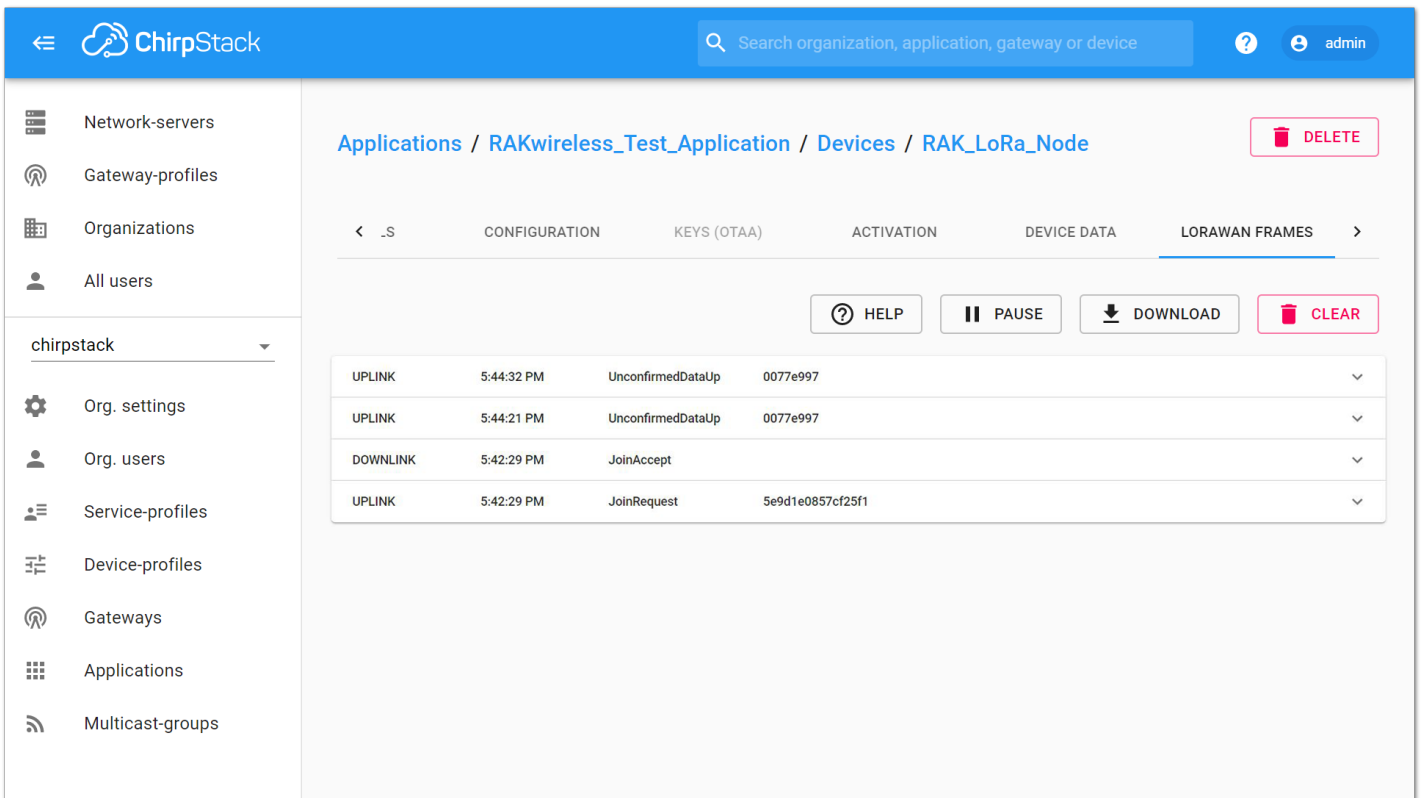You can see the message on ChirpStack page as shown in Figure 42.

Figure 42: Message Received in ChirpStack

ABP Mode

1. If you select "**DeviceProfile_ABP**" or "**DeviceProfile_ABP_CN470**", it means you want to join ChirpStack in
   ABP mode.

⚠️ **WARNING**

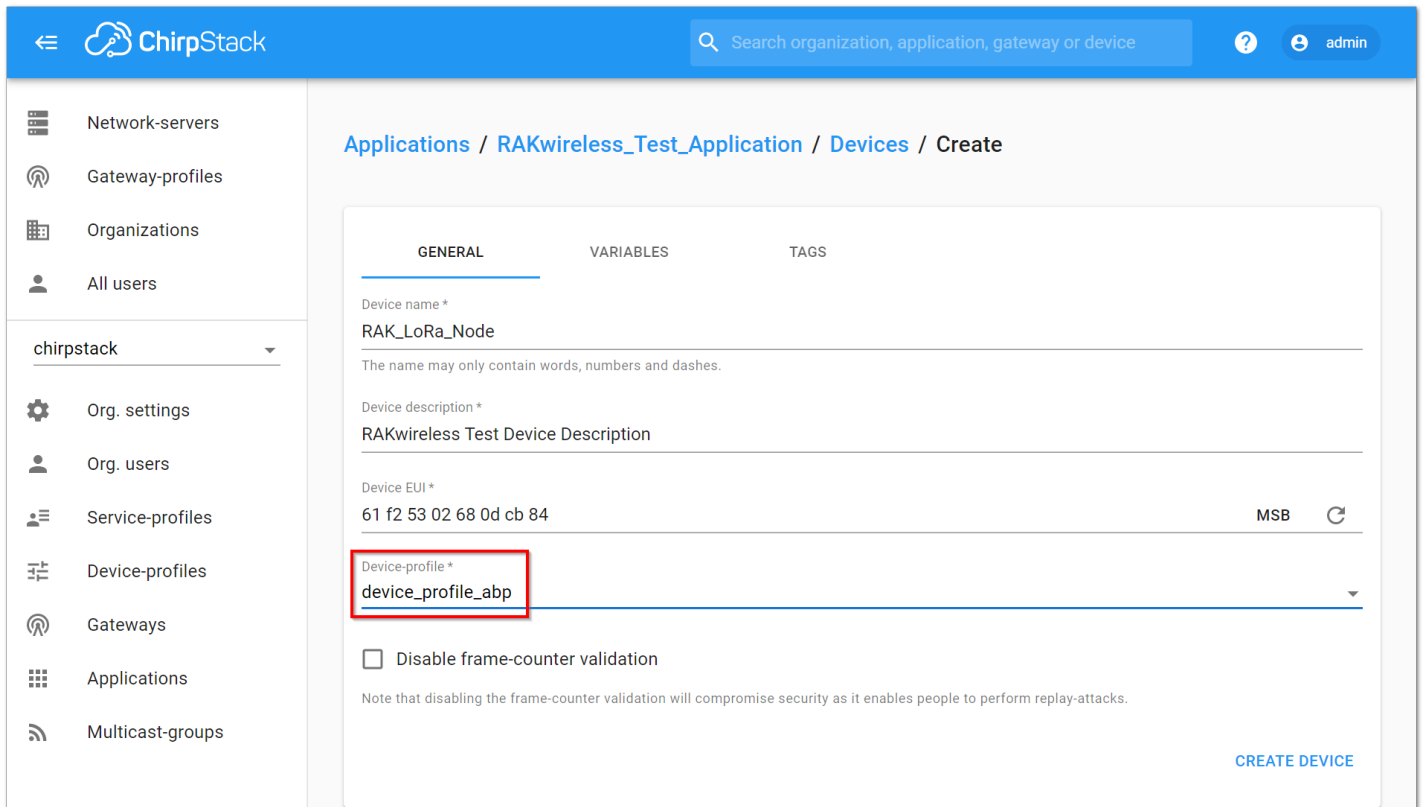Frequency AS923 in ABP Mode is not supported in Chirpstack.

Figure 43: Chirpstack ABP Activation

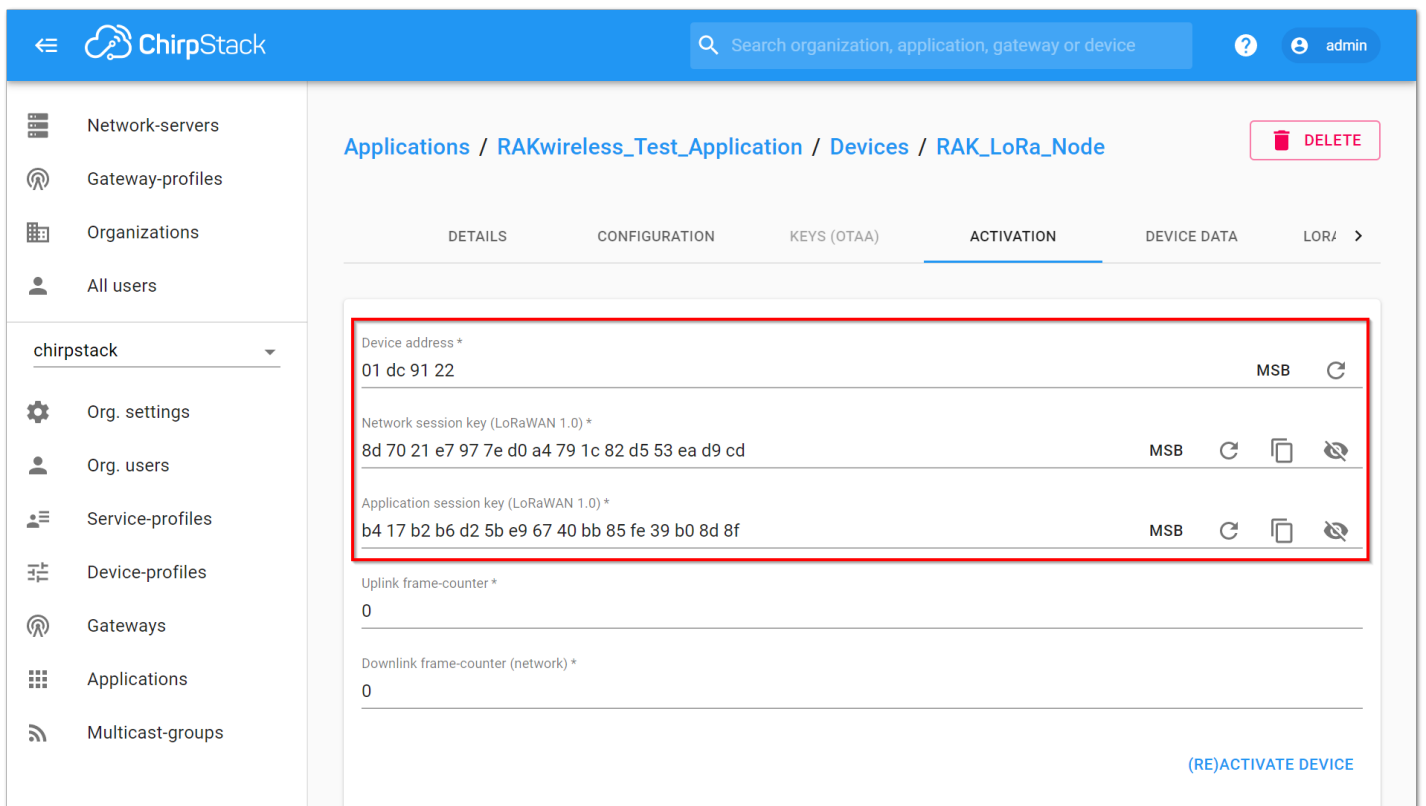2. Then, you can see that there are some parameters for ABP in the "**ACTIVATION**" item.

Figure 44: Chirpstack ABP Activation Parameters Needed

3. Use these parameters to set RAK811 Breakout Board by using AT command. To set **LoRa join** mode to **ABP**, type the following command:

```sh
at+set_config=lora:join_mode:1
```

Figure 45: Chirpstack ABP Join Mode via RAK Serial Port Tool

4. Set LoRa class to **Class A**.

```sh
at+set_config=lora:class:0
```
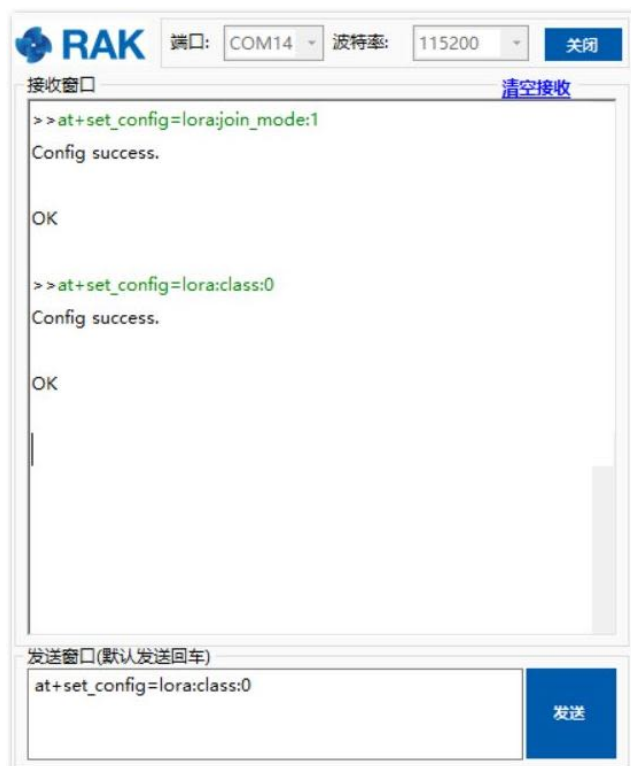

Figure 46: Chirpstack ABP Set Class via RAK Serial Port Tool

5. Set the frequency/region to **EU868**.

```sh
at+set_config=lora:region:EU868
```

Figure 47: Chirpstack ABP Set Region/Frequency via RAK Serial Port Tool

6. Set the **Device Address**.

```sh
at+set_config=lora:dev_addr:XXXX
```
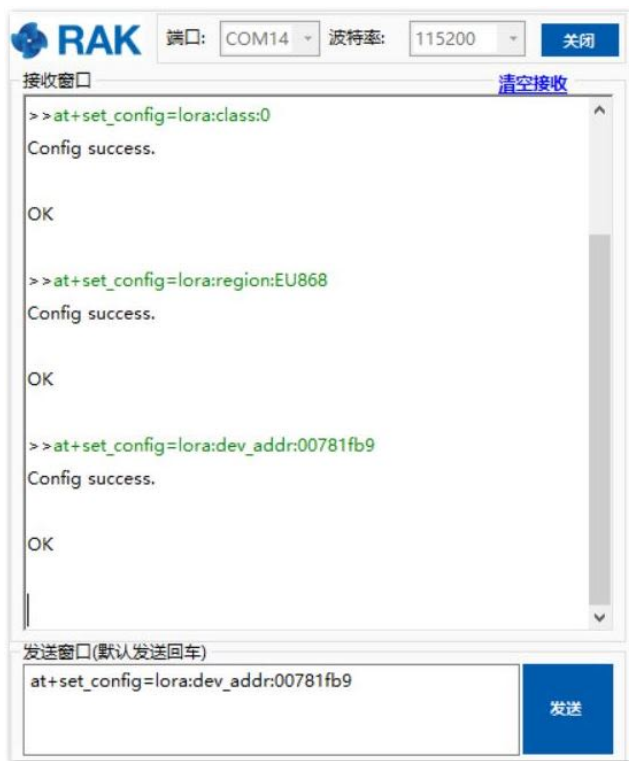

Figure 48: Chirpstack ABP Set Device Address via RAK Serial Port Tool

7. Set the **Network Session Key**.

```sh
at+set_config=lora:nwks_key:XXXX
```

Figure 49: Chirpstack ABP Set Network Session Key via RAK Serial Port Tool

8. Set the **Application Session Key**.

```sh
at+set_config=lora:apps_key:XXXX
```


Figure 50: Chirpstack ABP Set Application Session Key via RAK Serial Port Tool

📝 **NOTE**

After configuring all the parameters, you need to reset your RAK811 Breakout Board to save the parameters.

9. After resetting RAK811 Breakout Board, join in ABP mode.

```sh
at+join
```


Figure 51: Chirpstack ABP Join via RAK Serial Port Tool

> 📝 **NOTE**
>
> Actually, it is not needed to join in ABP mode, but you still need to set this AT command to validate the
> parameters you just set for ABP mode.

10. Try to send a data from RAK811 Breakout Board to ChirpStack.

```sh
at+send=lora:2:1234567890
```
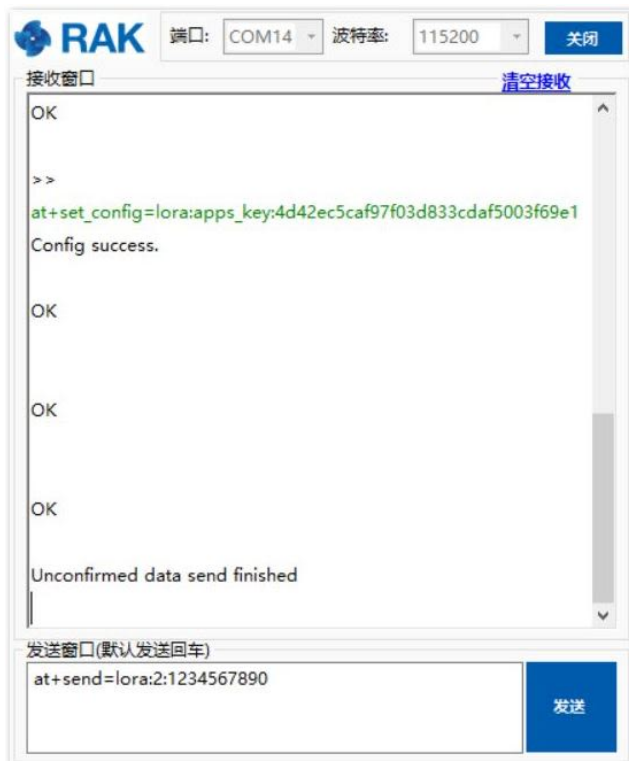

Figure 52: Chirpstack Sample Data Sent via RAK Serial Port Tool

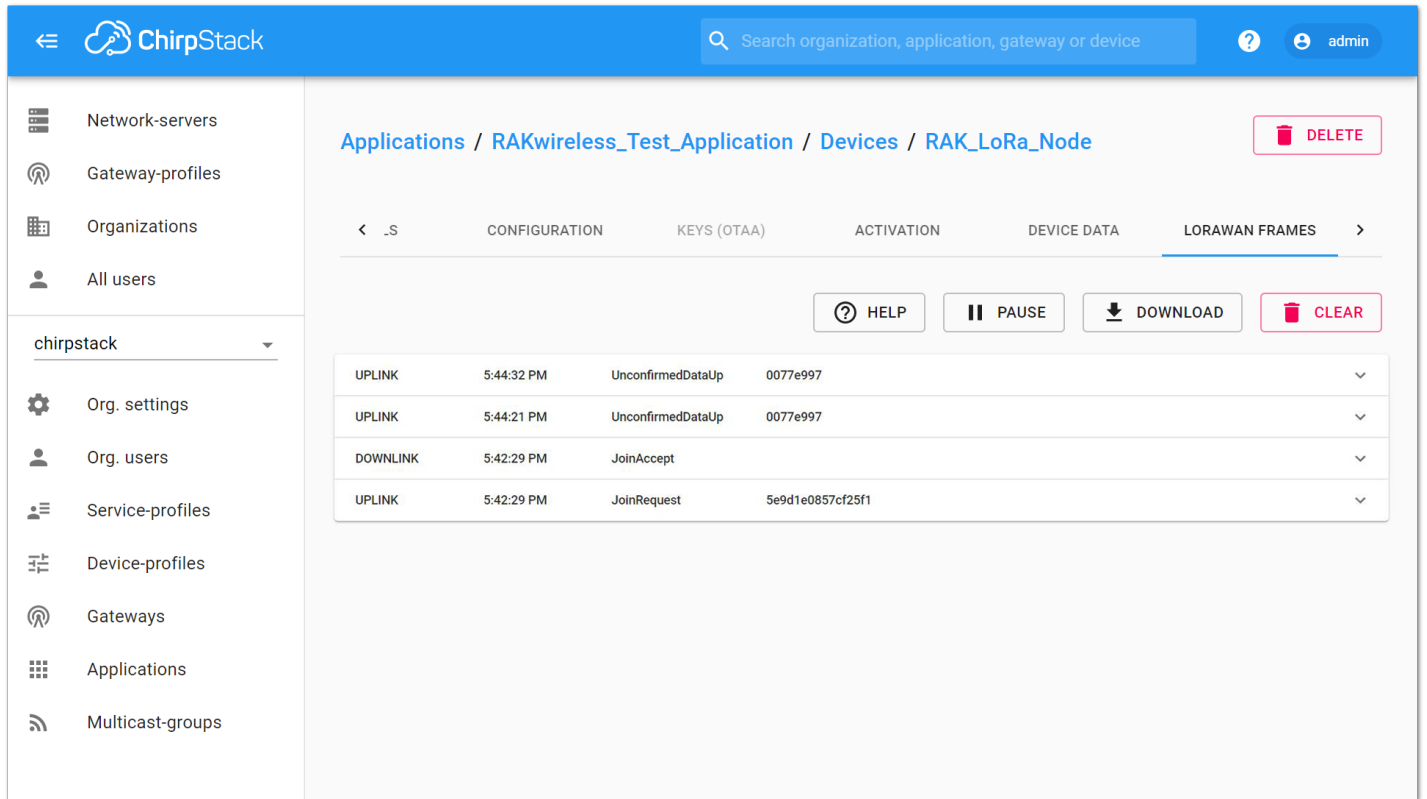- You can then see the data which is just sent from RAK811 Breakout Board on ChirpStack page:

Figure 53: Chirpstack Data Received Preview

LoRa P2P Mode

This section shows how to use LoRa P2P mode. You will be using EU868 as the frequency, although it is applicable to other standard bands.

1. First, find two RAK811 Breakout Board which can work on EU868 frequency and make sure their firmware version isn't less than V3.0.0.1.

2. Next, connect these two RAK811 Breakout Board with PC through UART, and open two serial port tool on PC.

3. Now, configure them to both work in LoRaP2P mode as follow:

```sh
at+set_config=lora:work_mode:1
```

Figure 54: P2P Initialization

4. Then, configure LoRaP2P parameters for both of them.

```sh
at+set_config=lorap2p:869525000:7:0:1:5:5
```
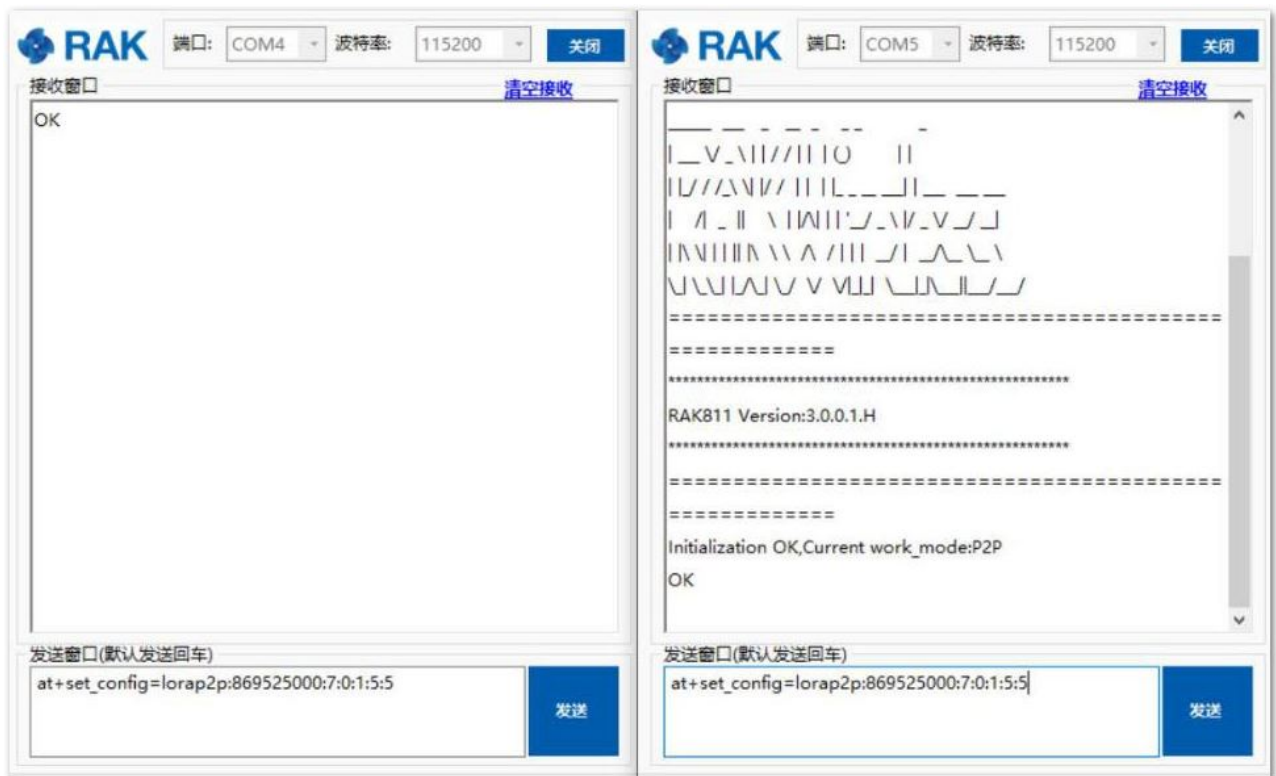

Figure 55: Configuring P2P in both RAK811 Breakout Board Nodes

5. Try to send a message from RAK811 Breakout Board 2 (the right one) to RAK811 Breakout Board 1 (the left one):
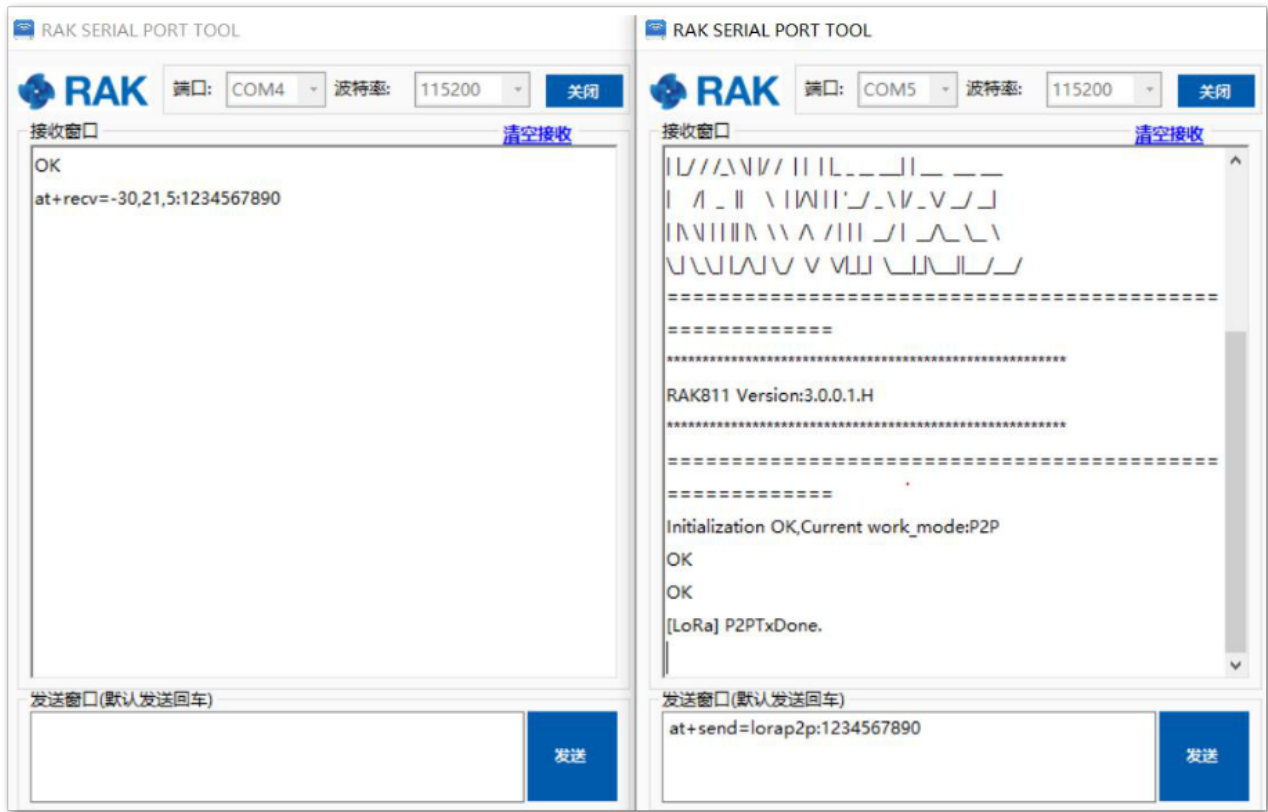
```sh
at+send=lorap2p:1234567890
```

Figure 56: Message sent and received status in the two Nodes

6. You can send more messages.

```sh
at+send=lorap2p:12345678901234567890
```
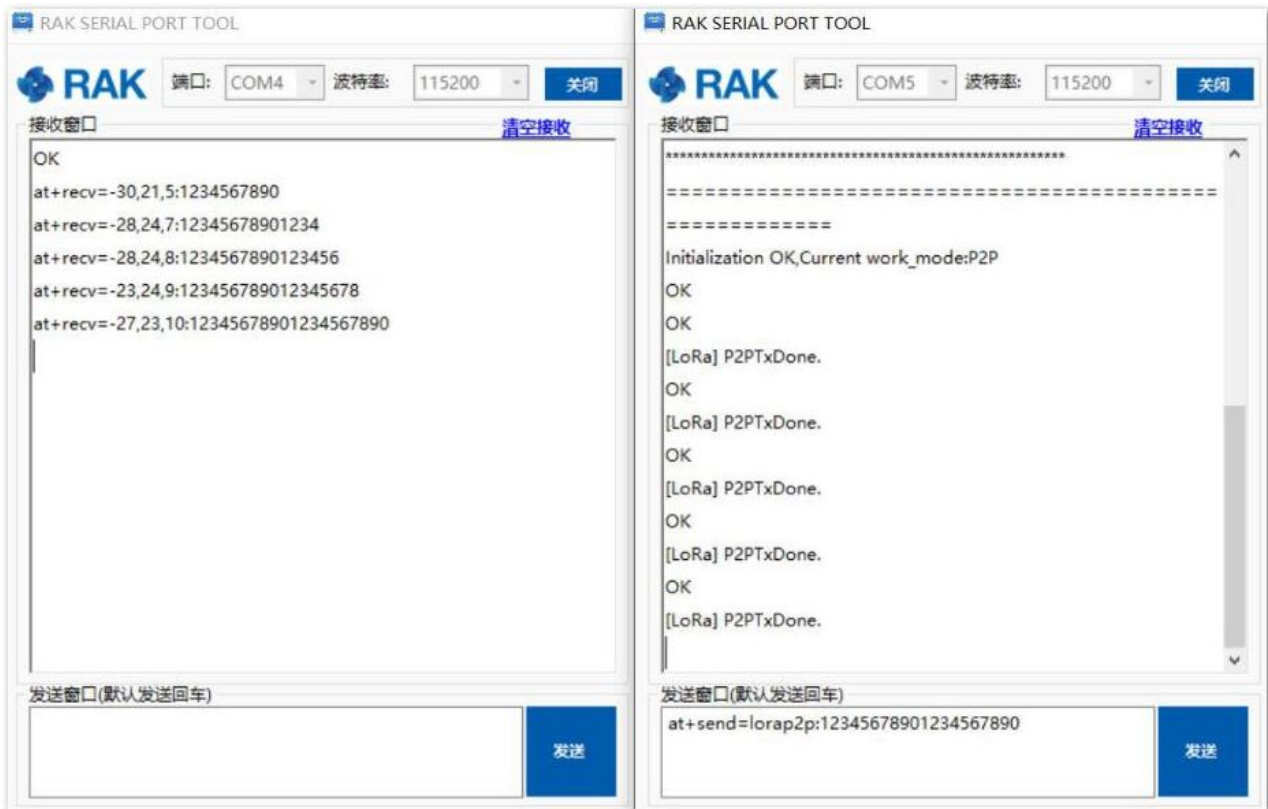

Figure 57: Succeeding Messages sent to the other Node

You have successfully finished your RAK811 Breakout Board set up.

Miscellaneous

Upgrading the Firmware

If the firmware version of your **RAK811 Breakout Board** is newer than V3.0.0.0 or you have just burned the bootloader into the RAK811 Breakout Board according to the **Burning Bootloader into the Device** section, then proceed to Step 2.

1. In case you have not just burned the bootloader, as instructed in the previous section, you need to go into **boot mode**. Connect your board via the USB interface and enter the following **AT command** after you have connected via the proper COM port.

```sh
at+set_config=device:boot
```
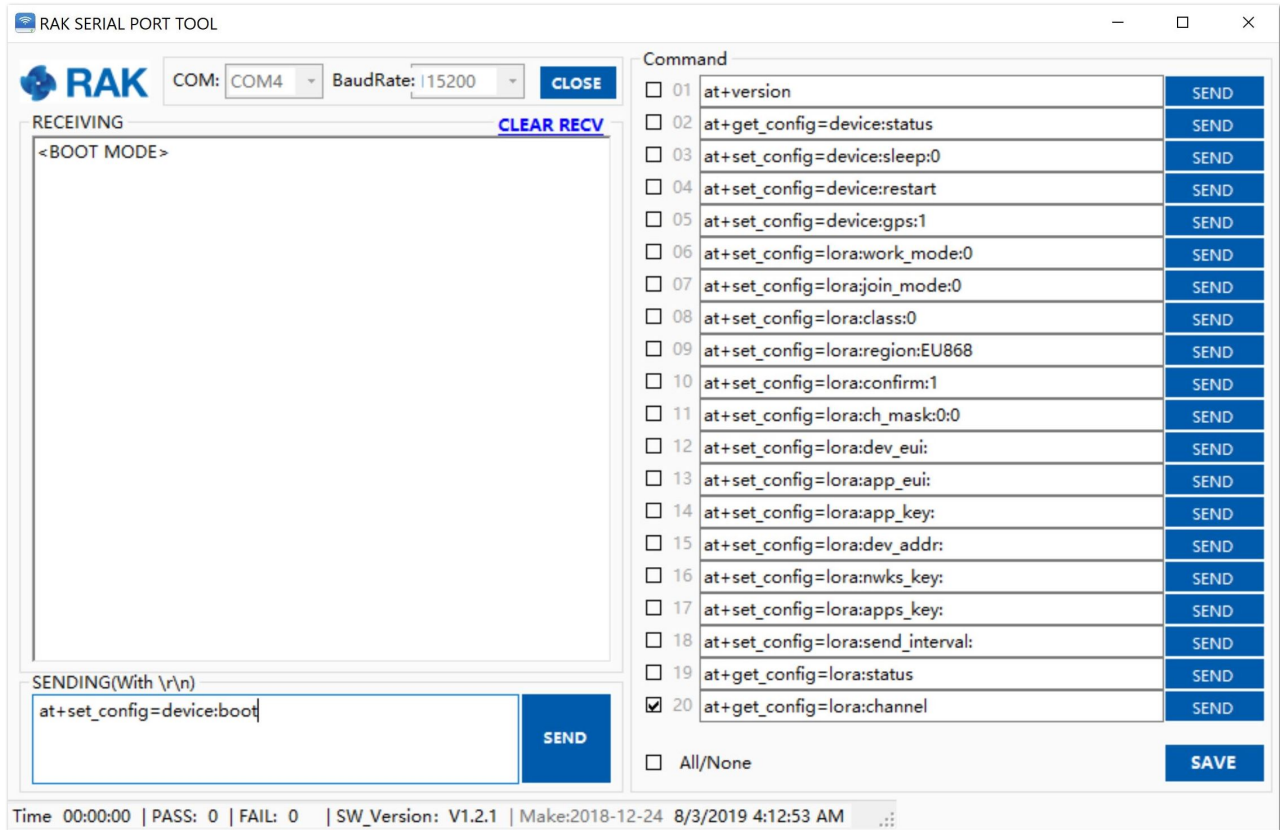

Figure 58: Entering Boot Mode

2. Download and open the RAK Device Firmware Upgrade (DFU) tool.
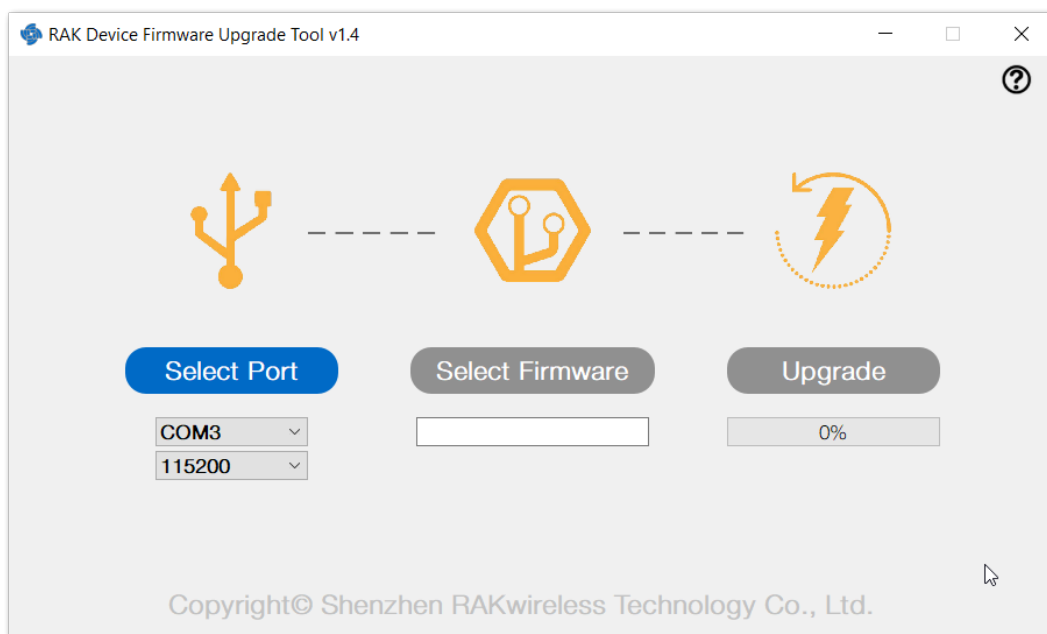   - RAK Device Firmware Upgrade (DFU) Tool↗

Figure 59: RAK Upgrade Tool

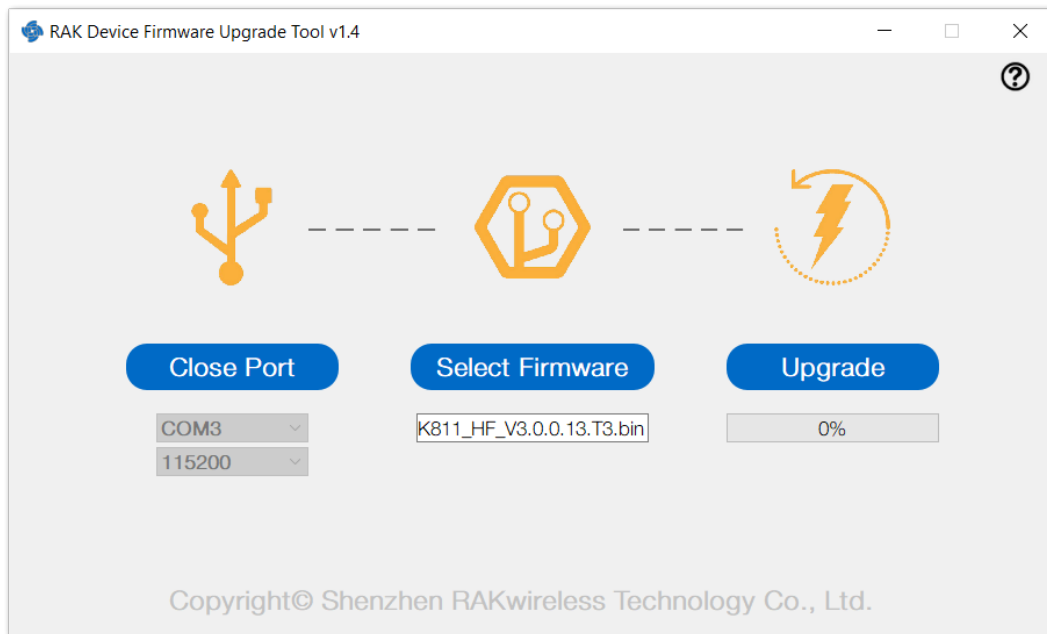3. Click "**Choose File**" and choose the firmware you have downloaded for your desired frequency band.

Figure 60: Choosing the Correct Upgrade file

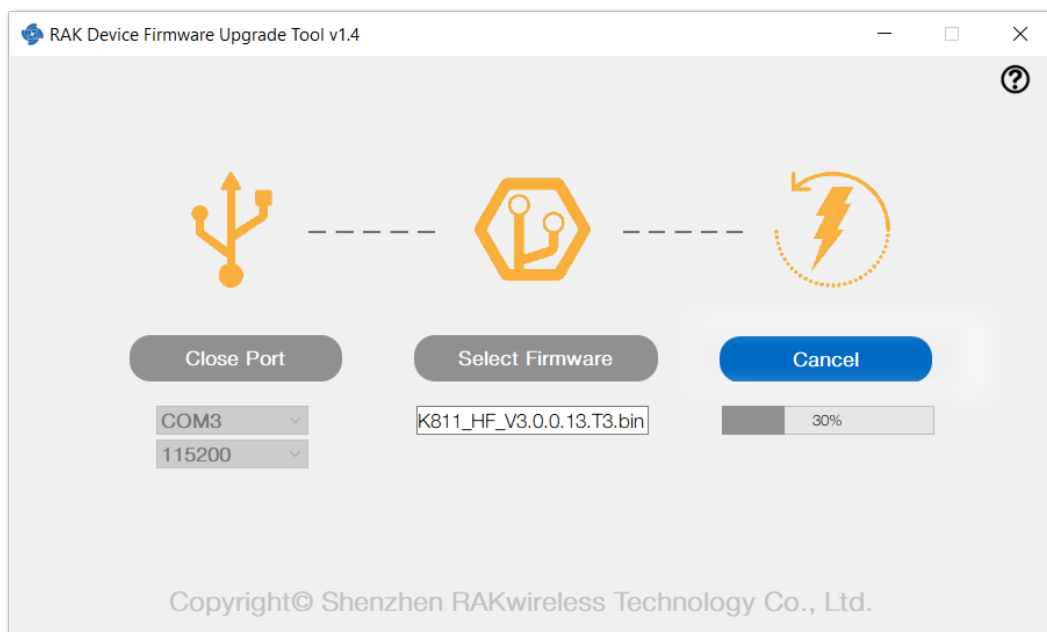4. Click "**Start**" to upgrade. This may take a minute.

Figure 61: Firmware Upgrading in Process

5. You should see the same pop-window as shown in Figure 62 if everything went well.
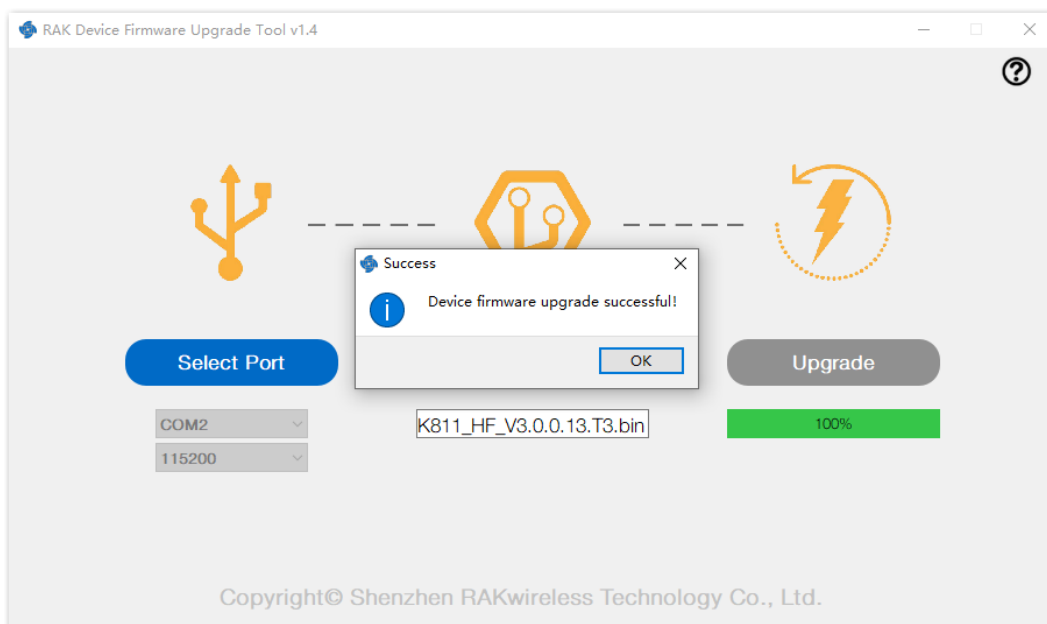

Figure 62: Successfully Upgraded Firmware

6. Now, **CLOSE** the upgrade tool and **OPEN** the serial port too, again.

- It is recommend to use RAK serial port tool since there are some ready AT commands in this tool which very useful for you. You can get it from RAK website available for free at this RAK directory ⧉.

7. Choose the correct **COM port** and set the baud rate to **115200**. Then, open the serial port and enter the AT command shown below to restart. Another option is to press the **RST** button on the RAK811 Breakout Board.

```sh
at+set_config=device:restart
```

If you want to configure your RAK811 Breakout Board using the available **AT commands**, check the AT Commands for RAK811 Breakout Board.

Last Updated: 1/14/2021, 3:54:20 AM