LoRaWAN® TUTORIAL

SETTING AND OPERATION METHOD

2ND DEC. 2020

MCP-AA-20-0131

MCU DEVICE SOLUTION BUSINESS DIVISION ,
IOT AND INFRASTRUCTURE BUSINESS UNIT
RENESAS ELECTRONICS CORPORATION

Notes on using the RF transceiver:
The use of wireless receivers and transmitters is restricted by international standards and domestic regulations. Wireless receivers and transmitters must therefore be used in accordance with the applicable laws and regulations of the country in which they are being used.

CONTENTS

LoRaWAN® FEATURES

- You can build network with the LoRaWAN ecosystem.
- You can send data to the cloud with AT commands using the LoRaWAN End node Renesas software.
- You can realize IoT devices with LoRaWAN.

REQUIRED EQUIPMENT

- RL78/G14 Fast Prototyping Board (RTK5RLG140C00000BJ) (https://www.renesas.com/rl78g14-fast-prototyping-board)
- Semtech SX1261 Shield (https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1261) or
  Semtech SX1262 Shield (https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1262)
- Digilent Pmod USBUART (https://reference.digilentinc.com/reference/pmod/pmodusbuart/start)
- Kerlink Wirnet iFemtoCell (https://www.kerlink.com/product/wirnet-ifemtocell)
- Micro USB(USB A-Micro B) Cable. (**When using SX1262, you need two USB cables**.)
- Pin header(2 pins) and Short pin for standalone operation

ORDERING REFERENCE

SEMTECH SX1261/SX1262 SHIELD AND LORA GATEWAY'S KERLINK WIRNET IFEMTOCELL

- **Semtech SX1261 Shield or Semtech SX1262 Shield**

Region	Parts number	Description
EU	**SX1261MB2BAS**	SX1261 @868MHZ MBED SHIELD ; +14dBm, XTAL
US	**SX1262MB2CAS**	SX1262 @915MHZ MBED SHIELD ; +22dBm, XTAL

- **Others region:** SX1261 can transmit up to +15 dBm. SX1262 can transmit up to +22 dBm. First, please select by your local transmission power limit. If you are not sure, it is better to select SX1261 for demonstration purposes.

- **Gateway's Kerlink Wirnet iFemtoCell**

Reference	Description	ISM-Frequencies
PDTIOT-IFE00	**Wirnet iFemtoCell 868 MHz**	863-874.4MHz
PDTIOT-IFE01	**Wirnet iFemtoCell 915 MHz**	902-928MHz
PDTIOT-IFE02	**Wirnet iFemtoCell 923 MHz**	915-928MHz

Information:
https://lora-alliance.org/sites/default/files/showcase-documents/Commercial_Leaflet_Wirnet_iFemtocell_2019.pdf

Certification

868	915	923
• Europe • Turkey • India	• USA • Canada	• Australia • New-Zealand • Singapore • Argentina • Brazil • Taiwan • South Korea • Japan • Hong-Kong • Malaysia • Indonesia • Vietnam • Thaïland • Philippines

LORIOT NETWORK SERVER

https://loriot.io/index.html#loriot-network-server

LORIOT Network Server has three plans. The tutorial uses a community public network server.

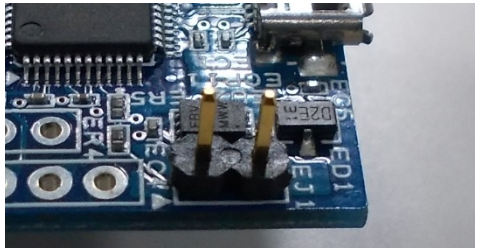
	COMMUNITY PUBLIC NETWORK SERVER 13 Worldwide Community Public Servers Public LoRaWAN® servers on-demand including **FREE connectivity**. Ideal for Academic/Development/Proof-of-concept/Small-scale/non-critical.	PROFESSIONAL PUBLIC SERVER Professional Network Server for production services Professional LoRaWAN® network servers with 99.9% SLA and built-in redundancy. Guaranteed network infrastructure to deploy PoC and commercial services.	PRIVATE NETWORK SERVER Full-featured enterprise-grade Network Server Private cloud or on-premise network server deployment. Carrier-grade solution for network operator and large-scale production services.
Unlimited User Accounts	Exclusive	Inclusive	Inclusive
Unlimited Applications	Exclusive	Inclusive	Inclusive
Unlimited gateways	Exclusive	Inclusive	Inclusive
Unlimited Messages	Inclusive	Inclusive	Inclusive
Multitenancy	Exclusive	Inclusive	Inclusive
Included Gateways	1 Gateway FREE	Unlimited	Unlimited
Included Devices	10 Devices FREE	Device connectivity packages available	**Contact us**
Service Level Agreement	Exclusive	99.9%	Inclusive
Cloud Deployment	Worldwide - 13 Regional Servers	Worldwide Professional Servers	Available Worldwide
On-Premise Deployment	—	Exclusive	Inclusive
LoRaWAN® Network Operator	Exclusive	Exclusive	Inclusive
White Label + Custom Domain	—	—	Inclusive
Technical support	Basic	Inclusive	Inclusive
Test Server	—	—	Inclusive
Pricing	**FREE**	**See the plans**	**Contact us**

SETUP LoRaWAN® END NODE

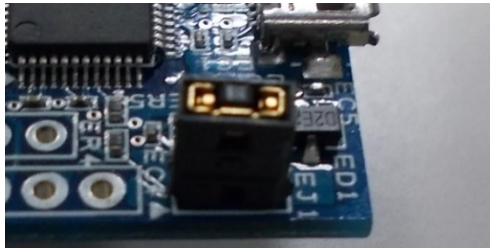
SETUP LoRaWAN END NODE(1)

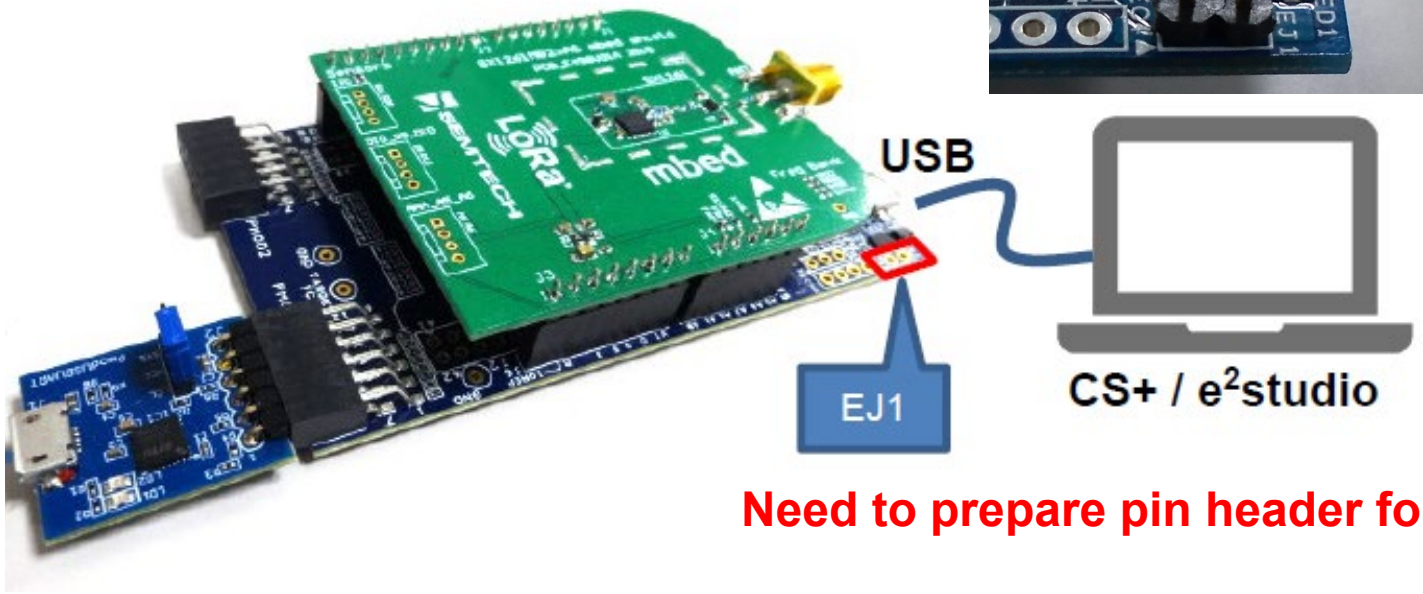
- Connect as shown below

EJ1(OPEN)



EJ1(SHORT)





Need to prepare pin header for standalone operation.

- For flash programming(Renesas Flash Programmer) or debugging with IDE(CS+/e2studio), EJ1 pin header should be OPEN. After completion of flash programming, “short EJ1” enables standalone operation without IDE.
- Pmod USBUART(USB-Serial Converter) should be connected to the PMOD1 connector’s upper.

SETUP LoRaWAN END NODE(2)

- **Download LoRa-based Wireless Software Package**

  LoRa®-based Wireless Software Package

  https://www.renesas.com/document/scd/lora-based-wireless-software-package-v220

- **Flash programming to RL78/G14 Fast Prototyping Board**
  - For flash programming, EJ1 pin header should be OPEN.
  - Download Renesas Flash Programmer (RFP).

    RFP V3.05 or higher required. RFP site: https://www.renesas.com/rfp
  - Execute flash programming by RFP.

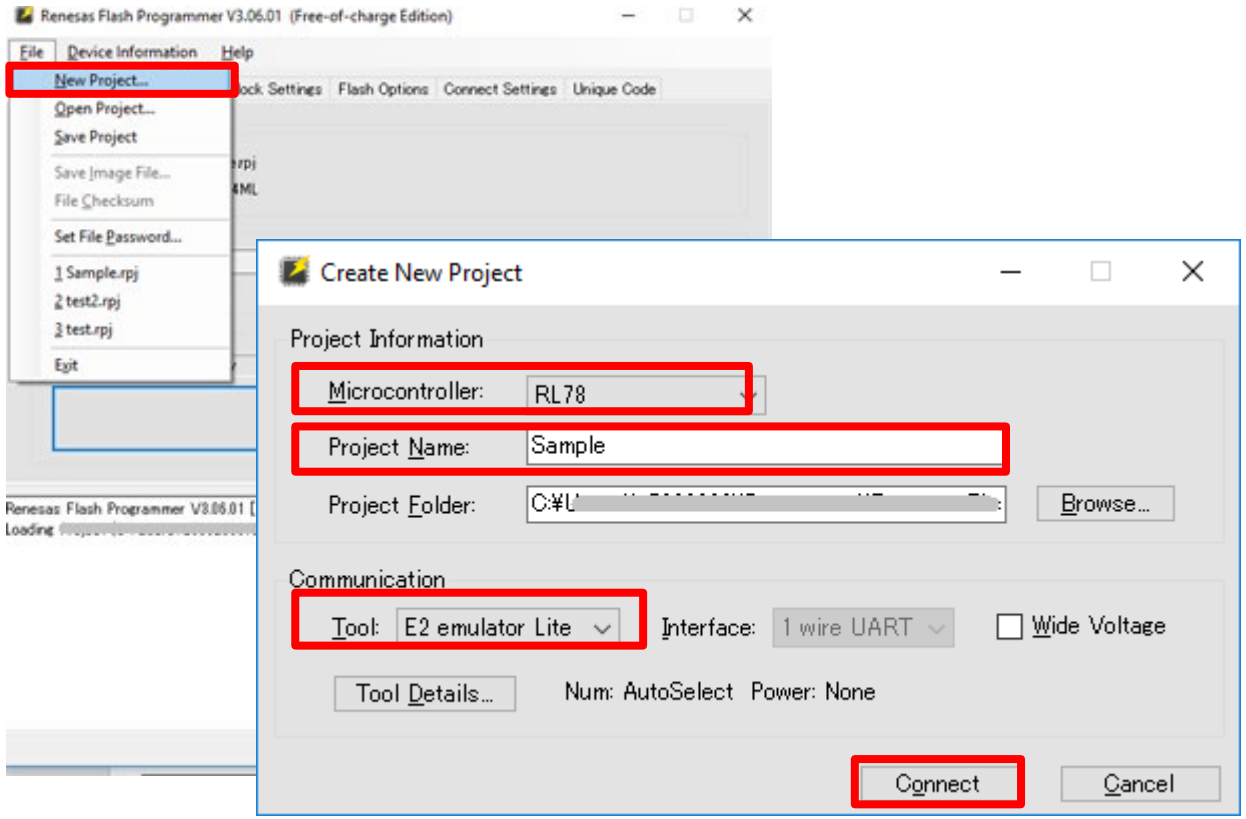
    Write the following file. to RL78/G14 Fast Prototyping Board

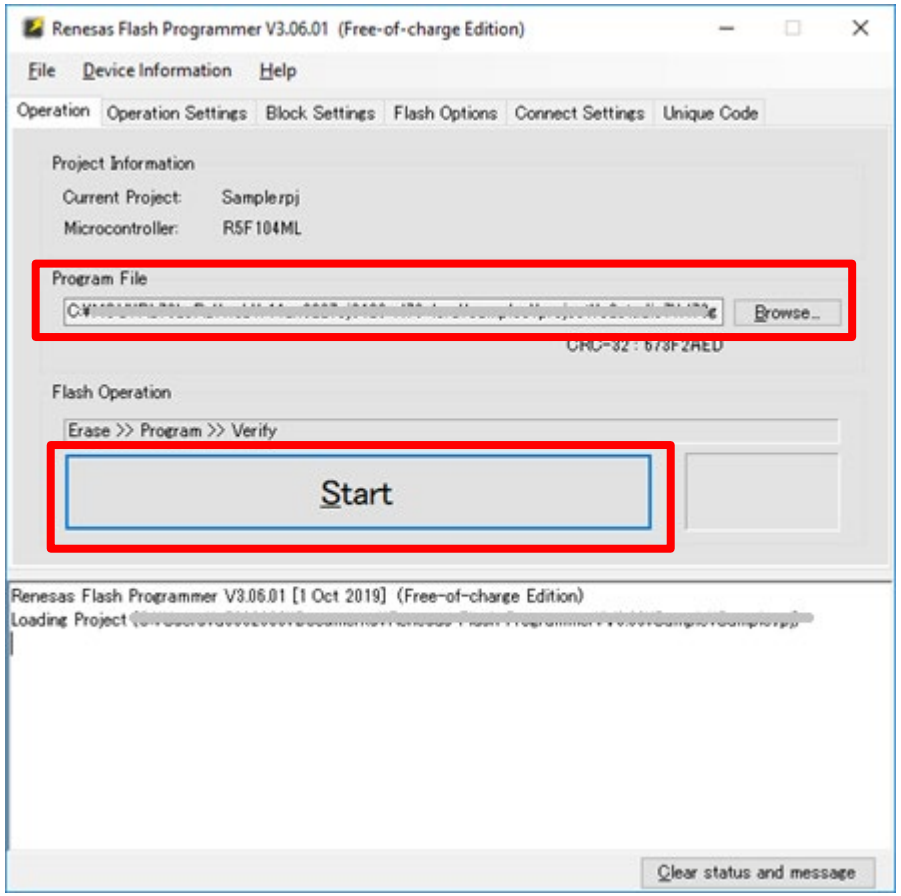
    samples¥project¥e2studio7¥rl78g14fpb_sx126x¥LoRaSample¥DefaultBuild¥LoRaSample.mot

- **After completion of flash programming, “short EJ1” enables standalone operation.**

HOW TO USE RENESAS FLASH PROGRAMMER

- Select **New Project**.
- Select **RL78** in Microcontroller. Enter **Project Name**. Select **E2 emulator Lite** in Tool. Click **Connect**.
- Select file in **Program file** of Main Window.
- Click **Start**.

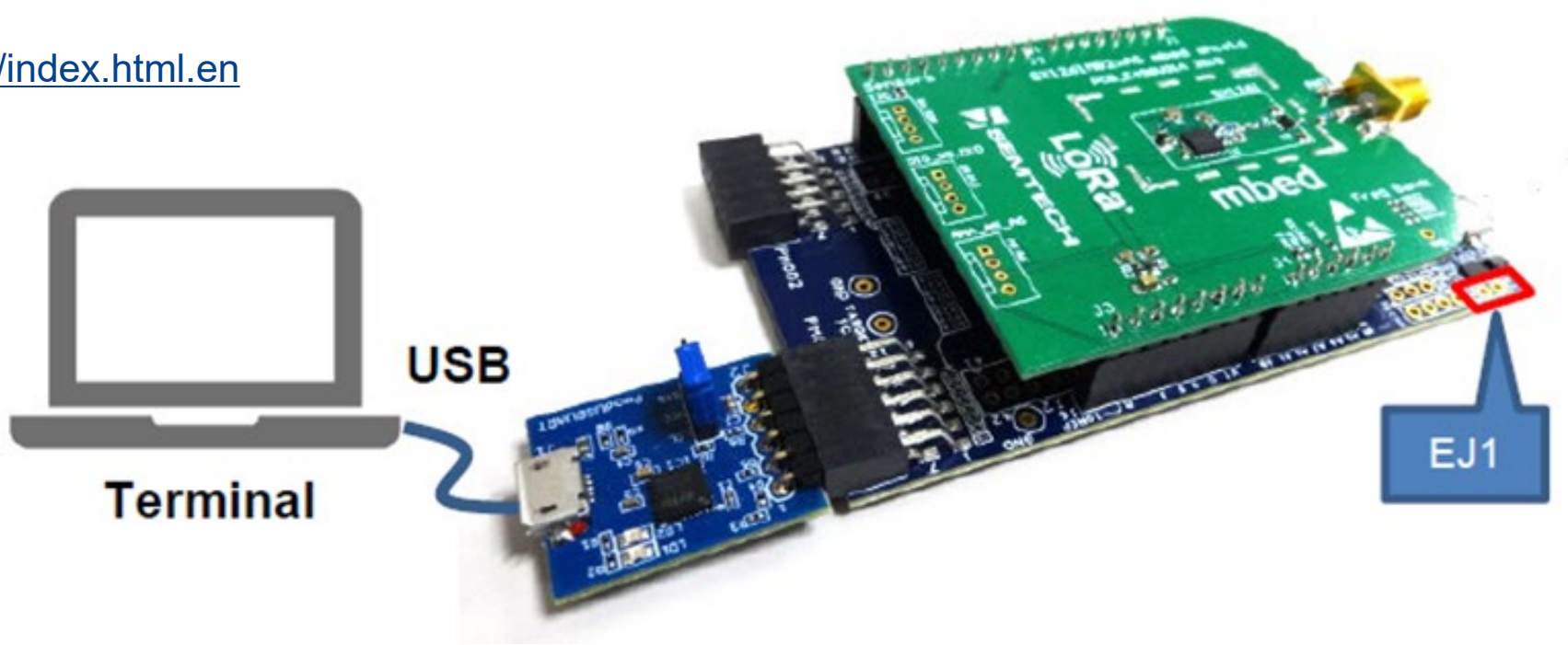




SETUP LoRaWAN END NODE(3)

You can control End node by the AT command from Terminal software of PC .
If you do not have any terminal software on your PC, please install a terminal software.

Example:
Tera Term https://ttssh2.osdn.jp/index.html.en



Terminal setting

Configuration Items	Value
Baud rate	115,200 bps
Data bit	8 bits
Parity bit	None
Stop bit	1 bit
Flow control	None
Local echo back	No
Line terminator	Transmission: CR+LF Reception: CR+LF

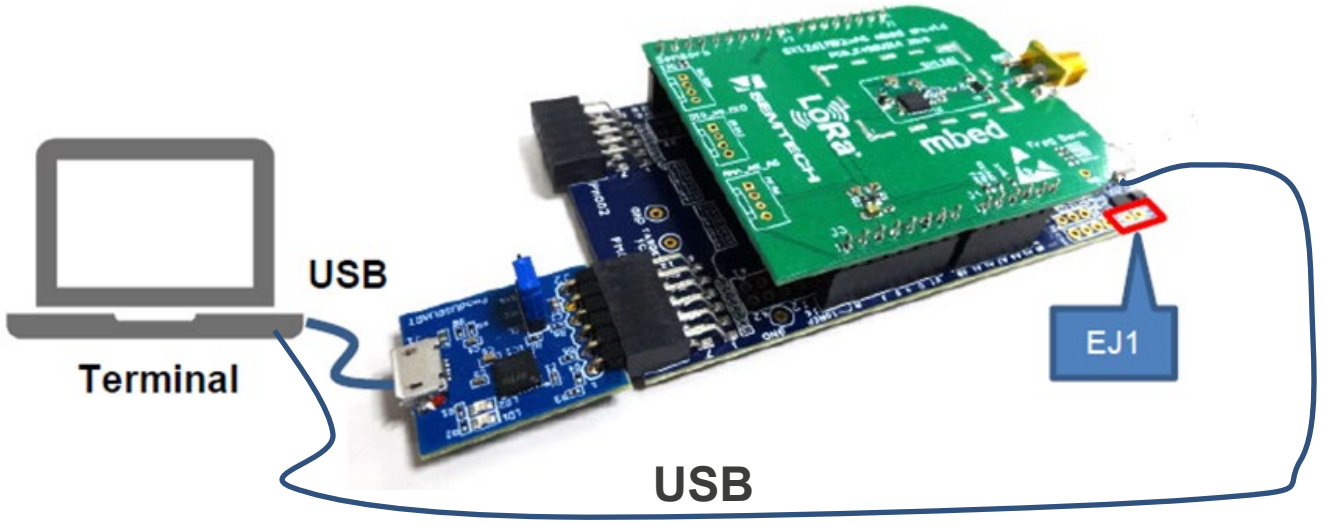
WHEN USING SX1262

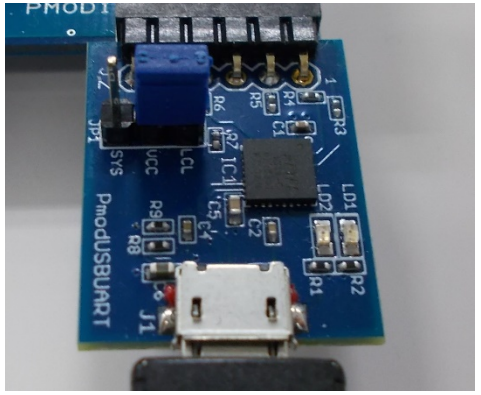
If you use SX1262, power supply capability of Digilent Pmod USBUART is not enough.

Please supply power from the USB port of the RL78/G14 Fast Prototyping Board.

You need two USB cables.

In this case, **please change the jumper pin on Digilent Pmod USBUART**
as the right pictures.





VCC-LCL

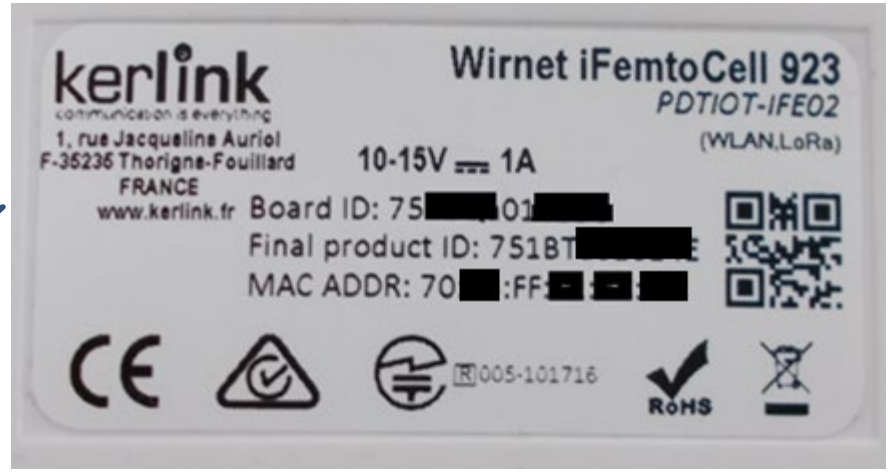
SETUP LoRaWAN® GATEWAY AND LoRaWAN® NETWORK SERVER

SETUP LoRaWAN GATEWAY

KERLINK GATEWAY BY TERMINAL SOFTWARE(SSH)

You need Gateway information for setup.
Individual information of iFemtoCell is as follows.

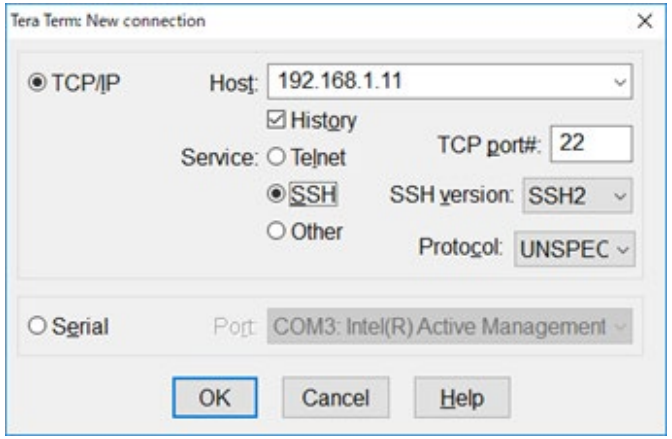
Board ID	75xxxx**012345**
Host name	klk-wifc-**012345**
MAC ADDR	70:76:FF:xx:xx:xx
Default password Username: root	pdmk-**012345** (Last 6 digits of Board ID)



Gateway rear label

Gateway must be connected to the network to connect to the Network Server.

- Connect iFemtoCell to the LAN environment
- It is necessary to know the IP address assigned by the DHCP server in order to set up with SSH. Please Execute" arp –a" command from Windows command prompt. You identify iFemtoCell from the MAC address. Then check the IP address.
- Next, login via SSH to the confirmed IP address (Example: 192.168.1.11) using Tera Term.
- Use "root" to login with the default password.



Similar information

- https://www.thethingsnetwork.org/docs/gateways/kerlink/ifemtocell/

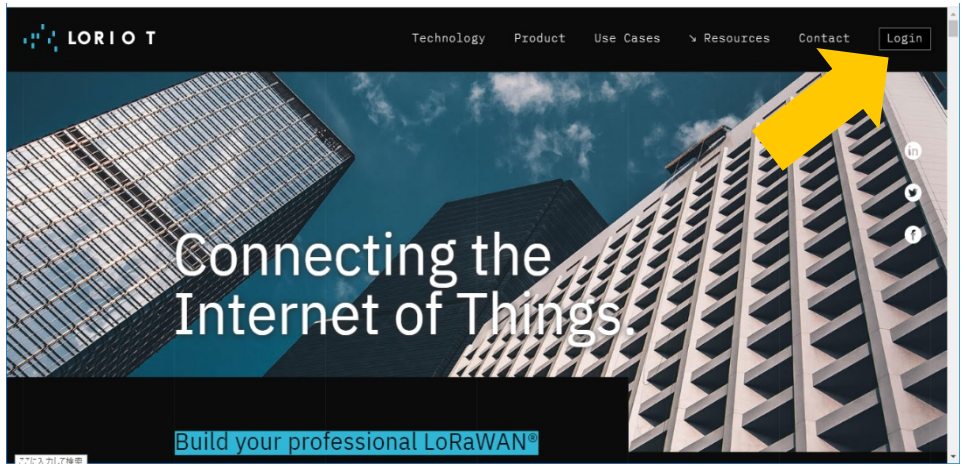
SETUP LoRaWAN NETWORK SERVER(1)
WEB BROWSER(LORIOT)

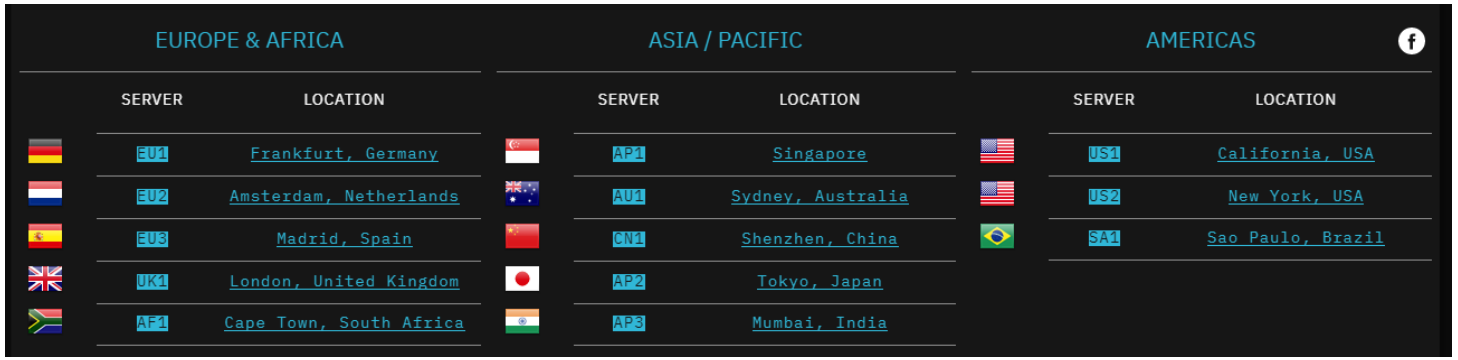
Please use Google Chrome, Firefox or Microsoft Edge

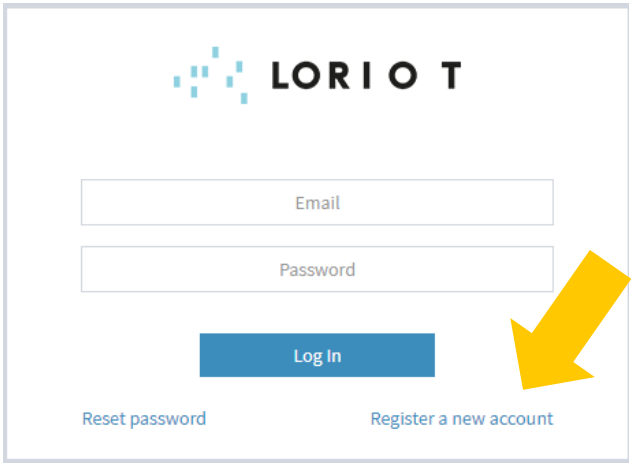
Create LORIOT account

- https://www.loriot.io/login.html
- Select SERVER close to your location
- Click Register a new account

https://www.loriot.io/

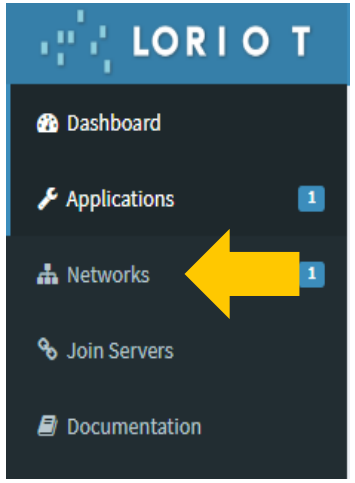




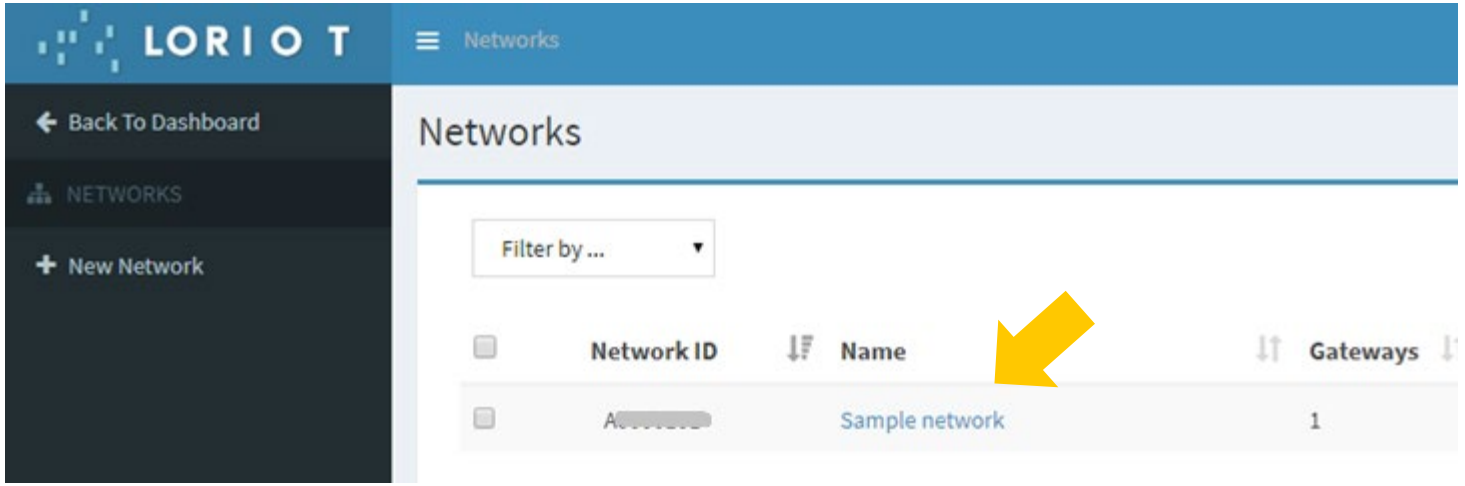


SETUP LoRaWAN NETWORK SERVER(2)
WEB BROWSER(LORIOT)

- **Add Gateway**
  - Click Dashboard→ Networks

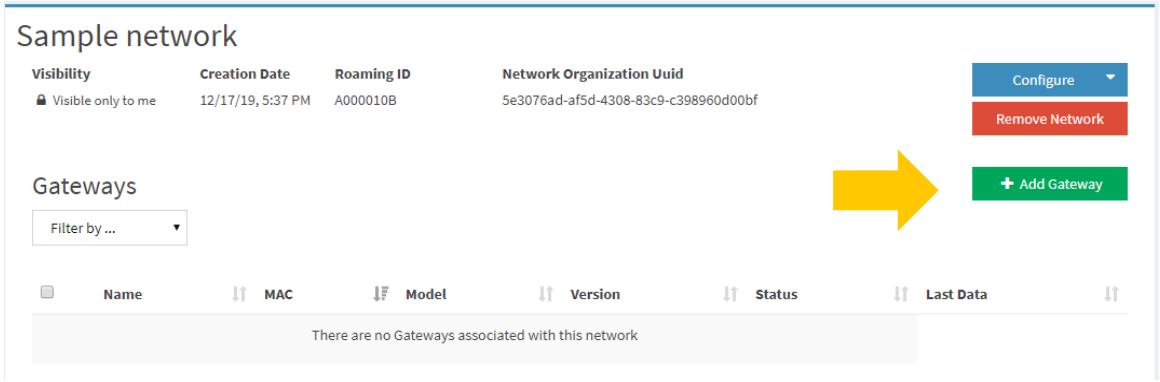


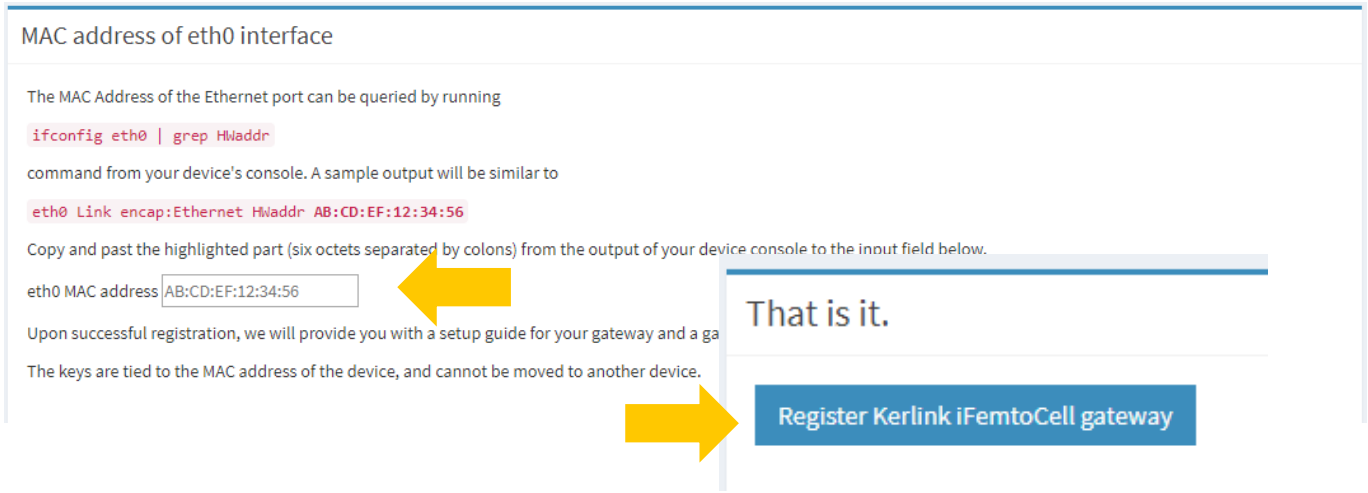
  - Click Dashboard→ Networks → Sample network



SETUP LoRaWAN NETWORK SERVER(3)
WEB BROWSER(LORIOT)

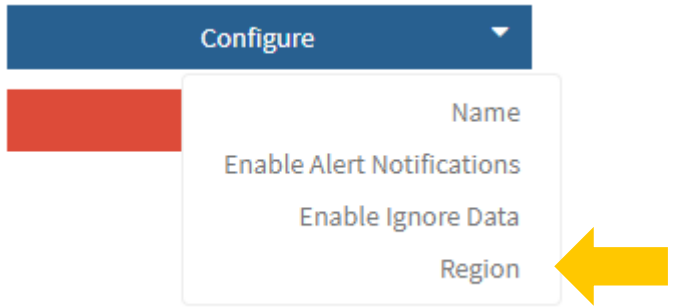
- Click “+Add Gateway”
- **Gateway Registration**
  - Select “**Kerlink iFemotoCell**”
  - Set Gateway MAC ADDR to MAC address of eth0 interface
  - Set Gateway Location Form
  - Click “Register Kerlink iFemotoCell Gateway”





SETUP LoRaWAN NETWORK SERVER(4)
WEB BROWSER(LORIOT)

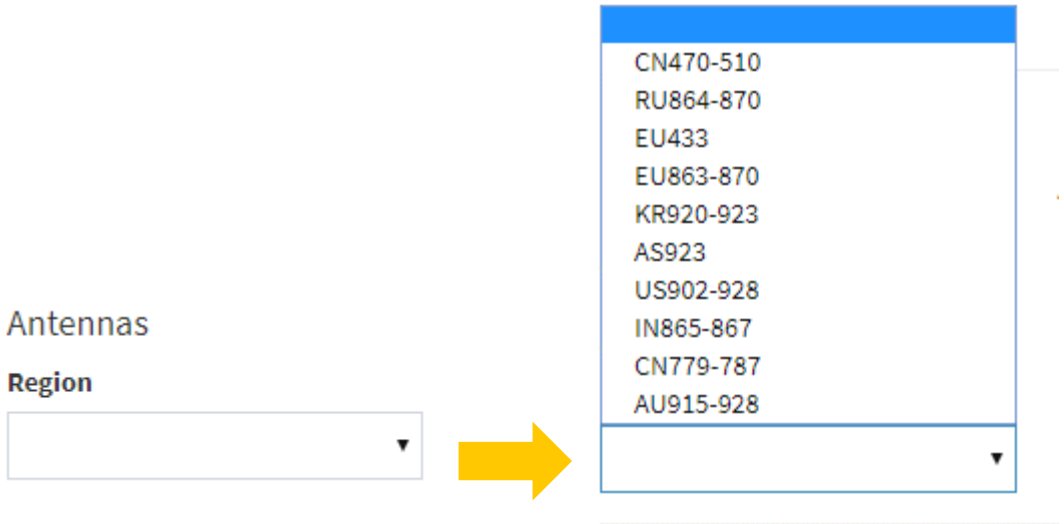
- **Click Region of Configure**



- **Select Region Code**

  Example:

  - Europe: EU863-870
  - US: US902-928
  - JAPAN:AS923

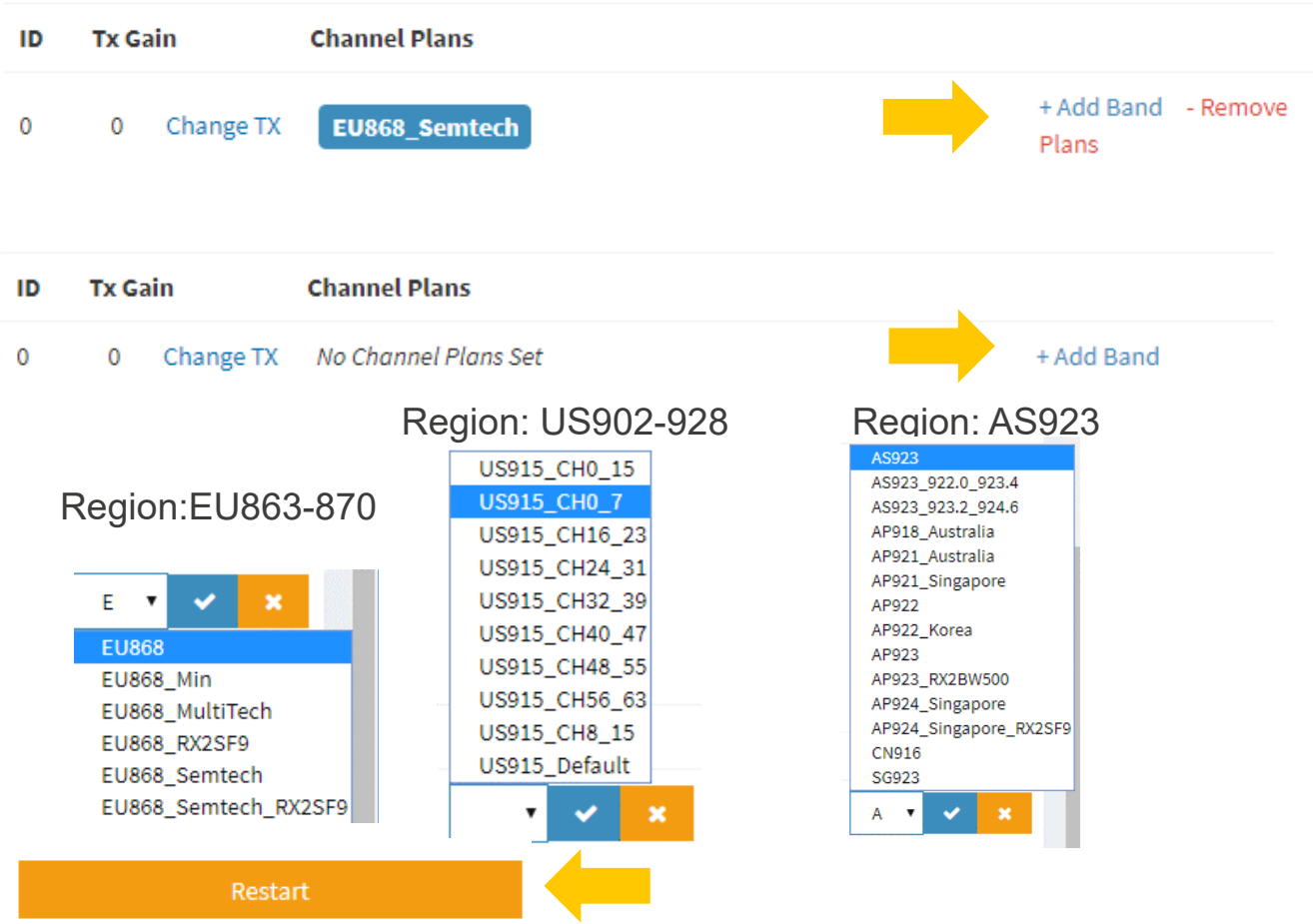


Regarding Region Code, see below for other regions
Global Frequency Plans
https://docs.loriot.io/display/LNS/Global+Frequency+Plans

SETUP LoRaWAN NETWORK SERVER(5)
WEB BROWSER(LORIOT)

- **Set Channel Plans**
  - Click “- Remove Plans”
  - Click “+Add Band”
  - Select Channel Plan

    Example:
    - Europe: EU868
    - US: US915_CH8_15
    - JAPAN:AS923
  - Click “Restart”



Regarding Channel Plan, see below for other regions.
Supported Frequency Plans
https://docs.loriot.io/display/LNS/Supported+Frequency+Plans

SETUP LoRaWAN GATEWAY FOR NETWORK SERVER(LORIOT)
KERLINK GATEWAY BY TERMINAL SOFTWARE(SSH)

- **Execute LORIOT Gateway self-extracting installer**

Once connected on the gateway with an SSH console.

Run the following commands :

Change to the LORIOT server name to be used

- cd /tmp
- wget http://ap2.loriot.io/home/gwsw/loriot-kerlink-ifemtocell-kerlink_femtocell-SPI-0-latest.sh -O loriot-install.sh
- chmod +x loriot-install.sh
- ./loriot-install.sh –f

Run the following command for reboot

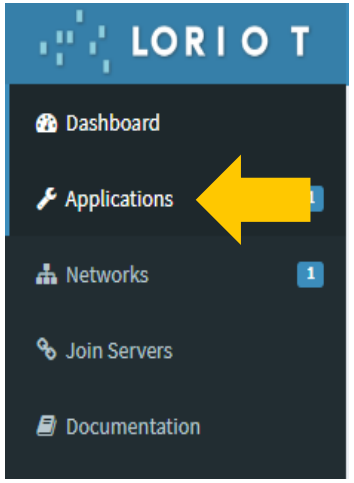
- reboot

– By downloading and/or using any software from the list you Agree with the EULA.
– https://ap2.loriot.io/assets/statics/eula.html

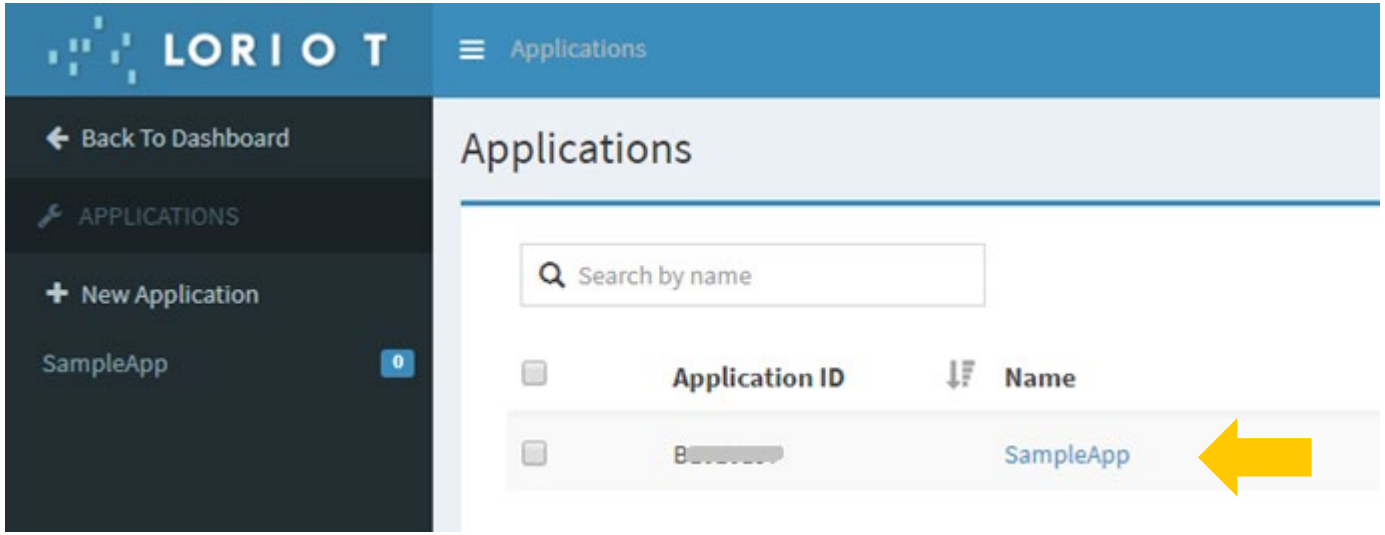
SETUP END NODE IN NETWORK SERVER

SETUP END NODE IN NETWORK SERVER(1)
WEB BROWSER(LORIOT)

- **Add Device**
  - Click Dashboard→ Applications

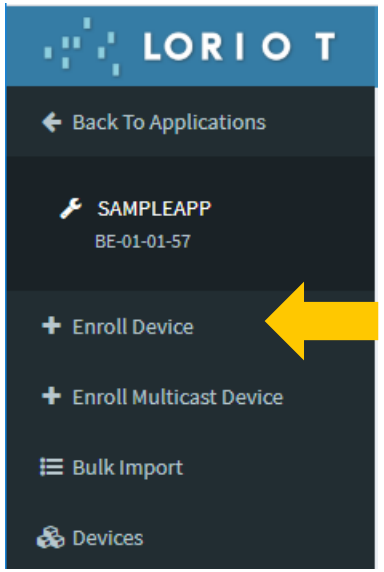


  - Click Dashboard→ Applications SampleApp



SETUP END NODE IN NETWORK SERVER(2)
WEB BROWSER(LORIOT)

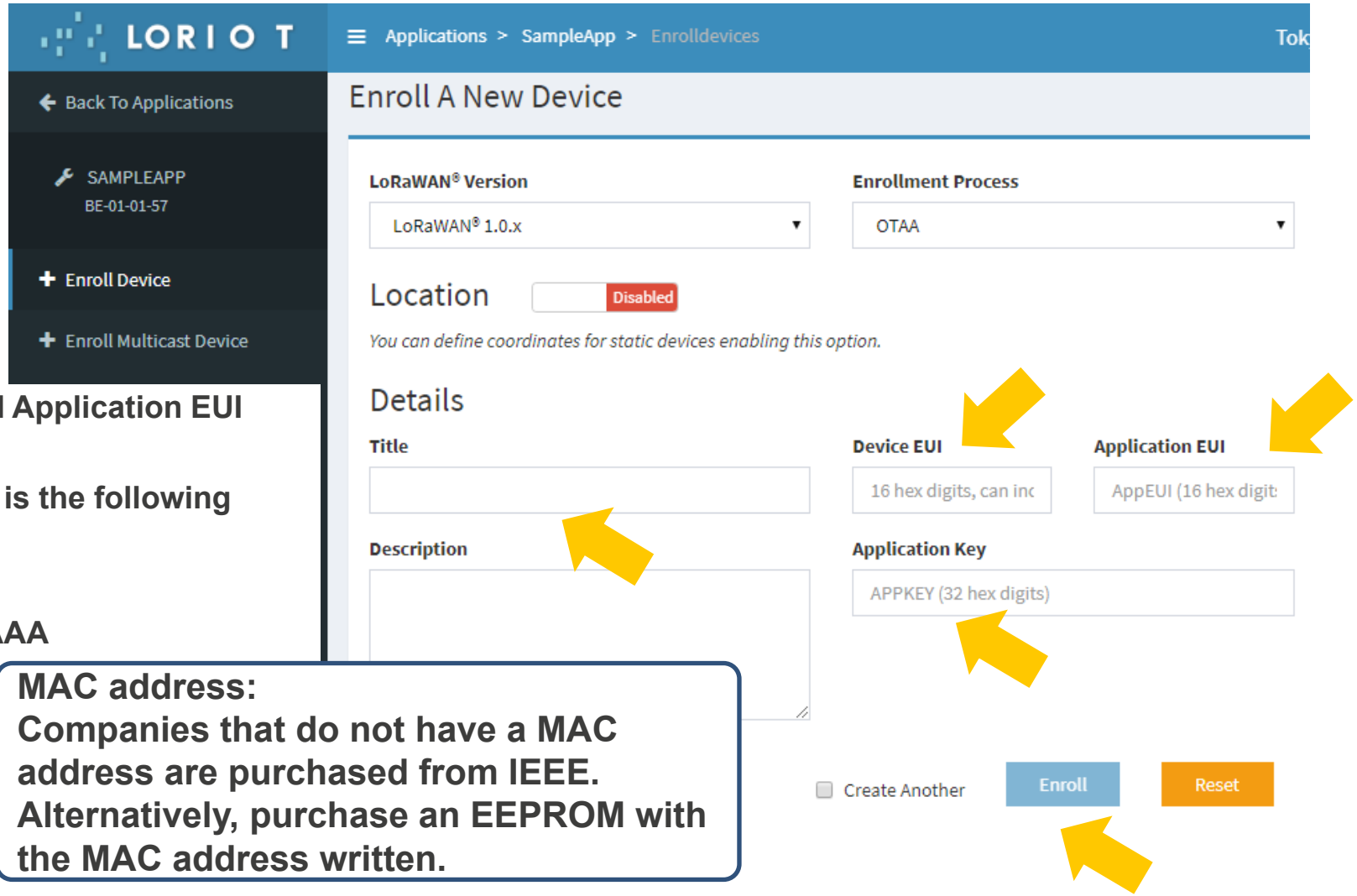
- Click Dashboard→Application→SampleApp→ Enroll Device



SETUP END NODE IN NETWORK SERVER(3)

WEB BROWSER(LORIOT)

About Device EUI
Please prepare 58-bit MAC address.
Put FF: FE in the middle of the 48-bit MAC address and use it as a 64-bit Device EUI.



- **Ender Title, Device EUI, Application EUI, and Application EUI**
  - Title=demo5
  - **Device EUI=xxxxxxFFFExxxxxx xxxxxx is the following**
  - **Application EUI= 0123456701234567**
  - **Application Key= 55555555555555555AAAAAAAAAAAAAAAA (5:16 digits and A:16 digits)**
- **Click Enroll**

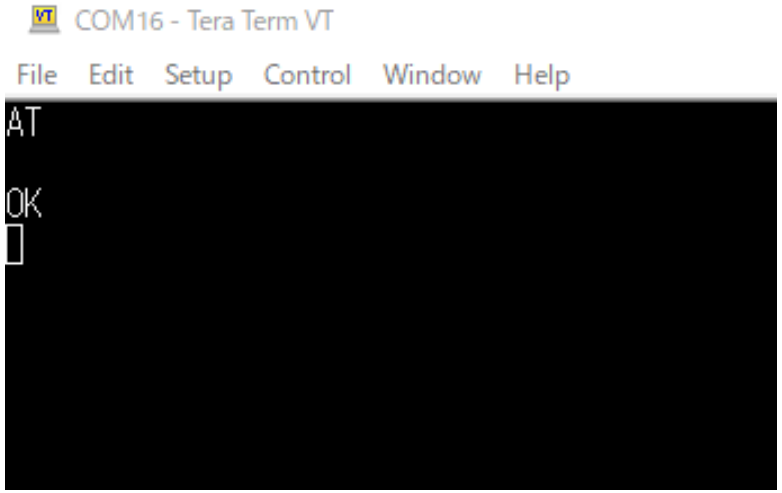
MAC address:
Companies that do not have a MAC address are purchased from IEEE. Alternatively, purchase an EEPROM with the MAC address written.

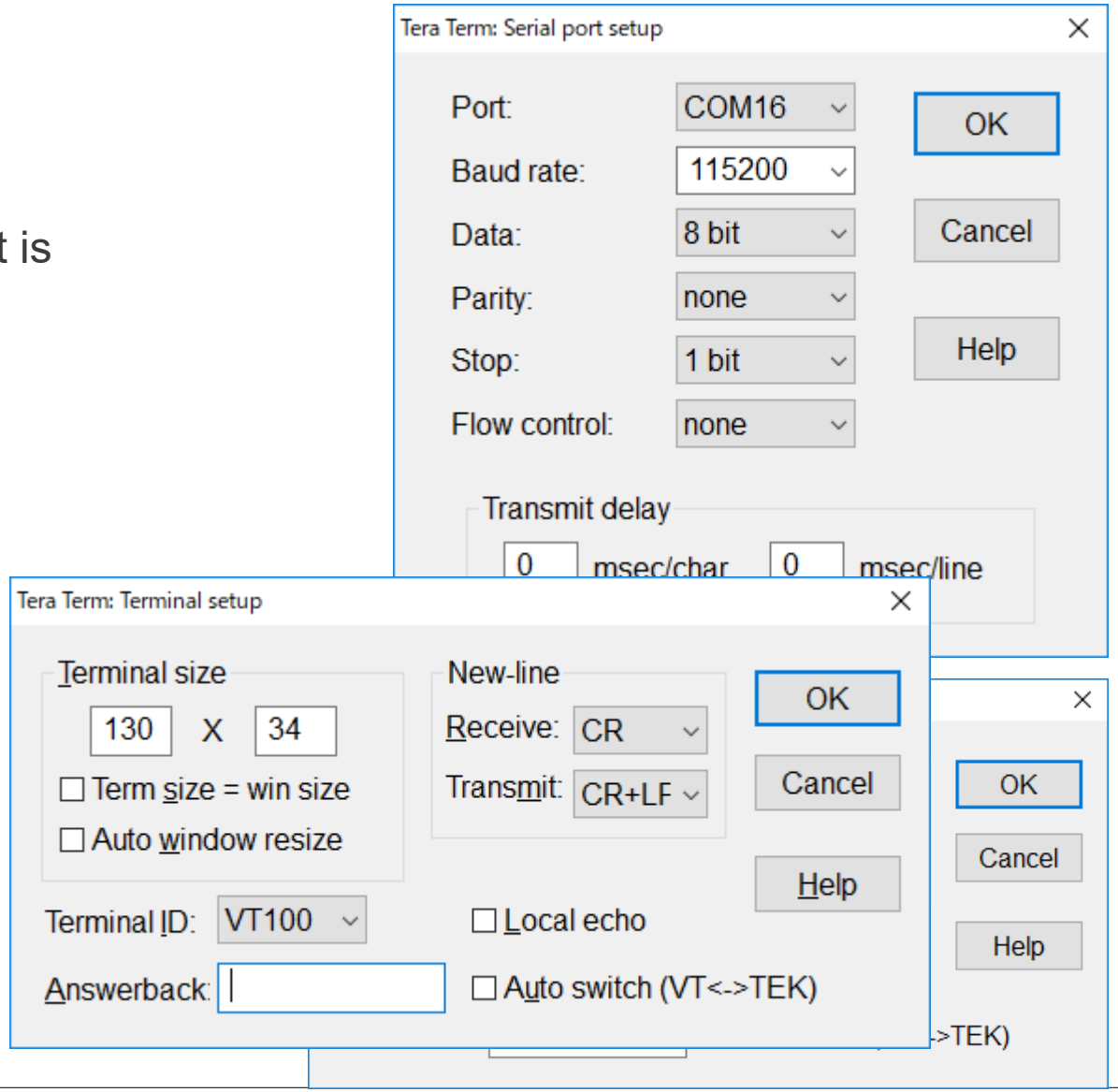
LoRaWAN® DEMONSTRATION EXECUTION

LoRaWAN END NODE(1)
TERMINAL SOFTWARE TO END NODE

Confirmation of UART connection

- Connect with PC by Terminal Software
  - Setup Serial and Terminal of right figure (Port is connection port)
- Enter AT for control confirmation
- Confirm OK





LoRaWAN END NODE(2)
TERMINAL SOFTWARE TO END NODE

Parameter setting
Execute command of the following by Terminal Software

Setup:

```
AT+REGION=X
AT+CLASS=0
AT+ACTMODE=1
AT+DEVEUI=XXXXFFFEXXXXXX
AT+APPEUI=0123456701234567
AT+APPKEY=55555555555555AAAAAAAAAAAAAAAA
AT+SAVE
```

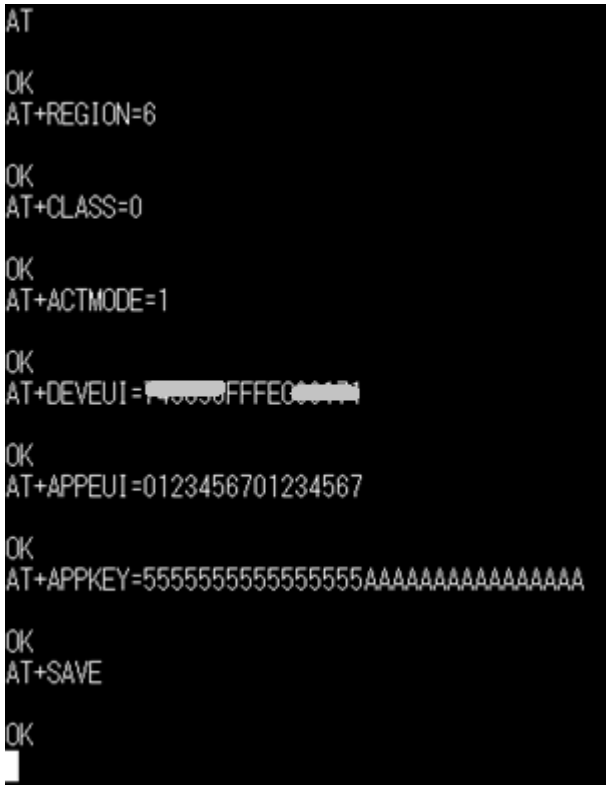
<region>
Operation region
0: EU868
1: US915
6: AS923

<class>
Device class
0: Class A (default)
2: Class C

<mode>
Activation mode
0: ABP
1: OTAA (default)

<deveui>
Address (EUI-64) of End node

Actual execution display



In case of US region:
Before AT+SAVE, set the following
AT+CHDEFMASK=FF00,0000,0000,0000,0002

LoRaWAN END NODE(3)
TERMINAL SOFTWARE TO END NODE

Network join and sending data

Execute the following commands by Terminal Software.

AT+JOIN
AT+SENDHEX=00112233

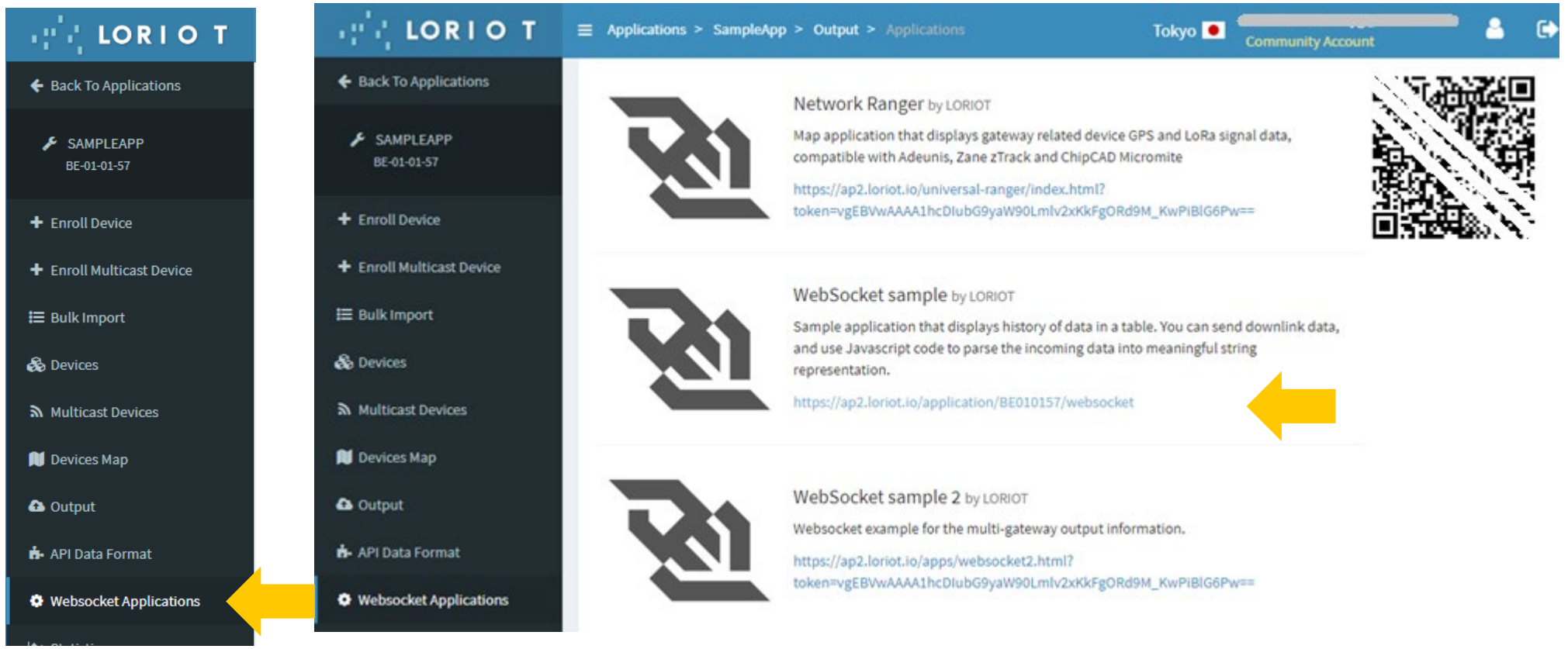
If the response is “ERROR” or “JOIN: JOIN_FAILED”, re-enter “AT+JOIN for retry.

Enter sending message.

Actual execution display

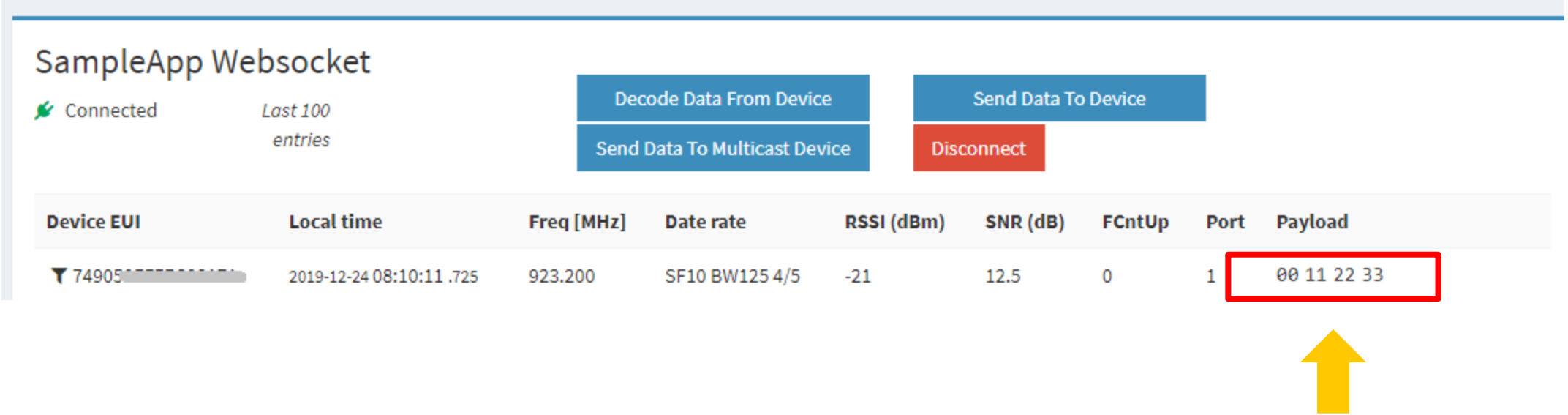
CONFIRMATION AT THE NETWORK SERVER(1)
WEB BROWSER(LORIOT)

- Click Dashboard→Application→SampleApp→WebsocketApplications
- Click Websocket sample



CONFIRMATION AT THE NETWORK SERVER(2)
WEB BROWSER(LORIOT)

You can check the data sent from the end node with SampleApp WebSocket of the web browser.



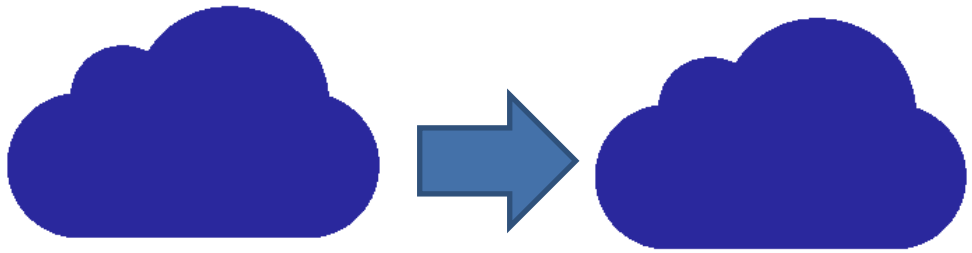
MORE VISUALIZATION(OPTION)

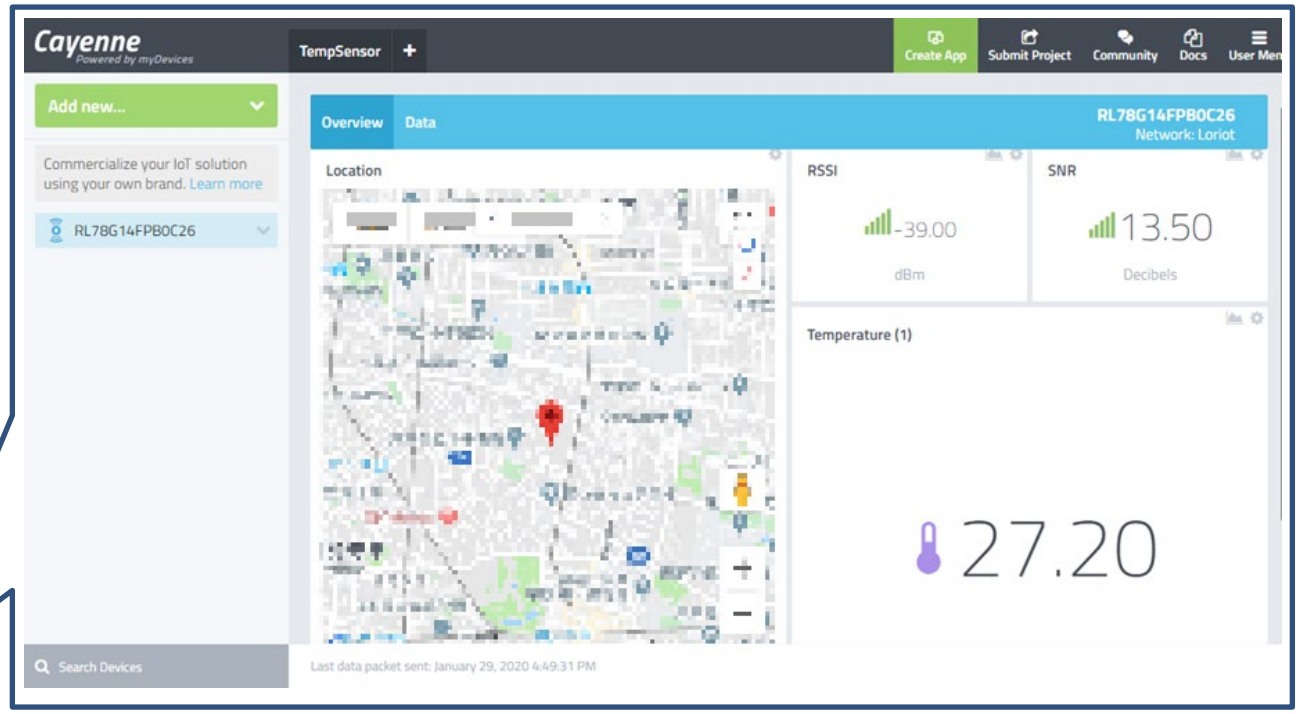
MORE VISUALIZATION

Shows how to display data information as temperature on Cayenne dashboard via LORIOT

Cayenne for LoRa
https://developers.mydevices.com/cayenne/lora/

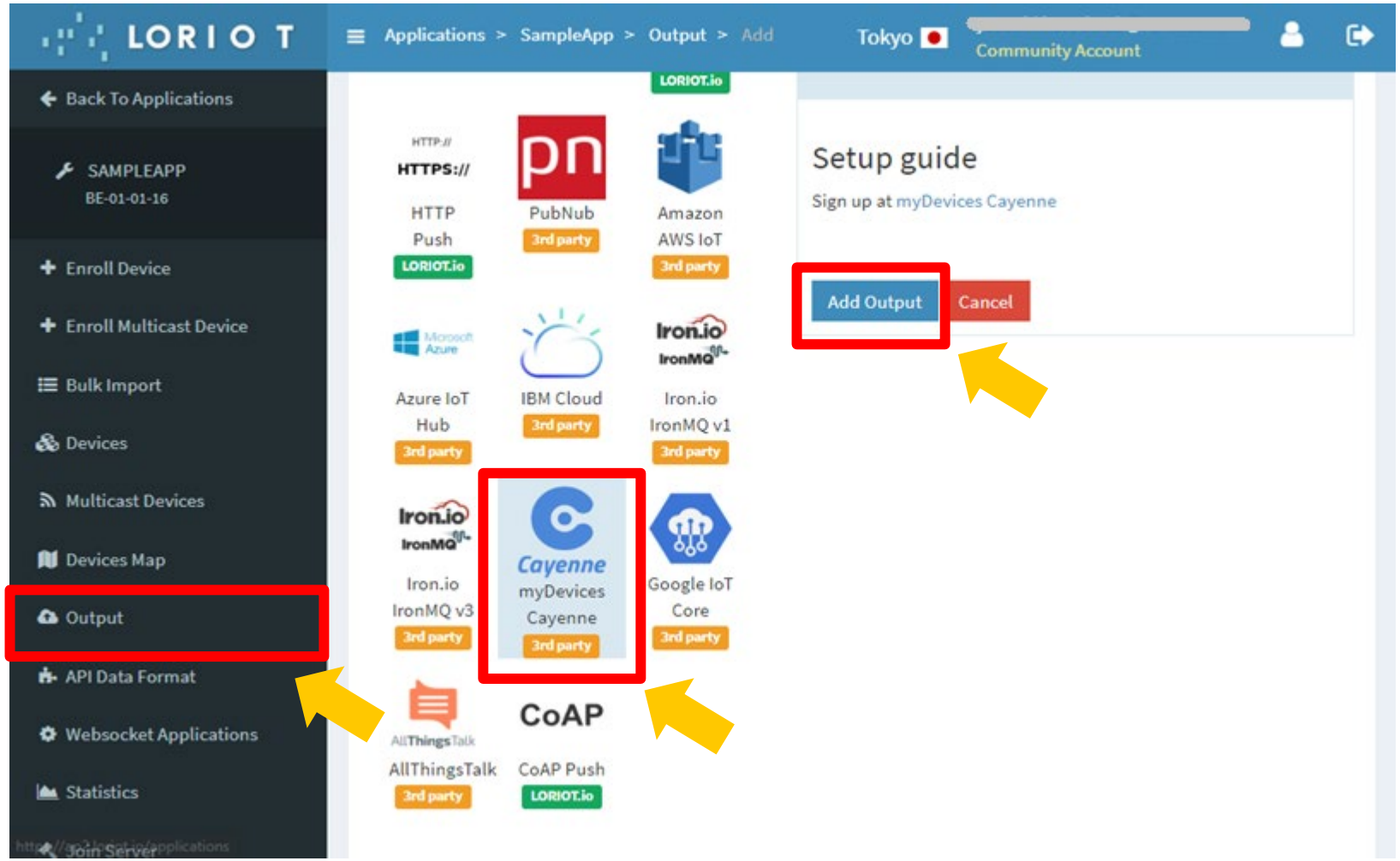
Network Server





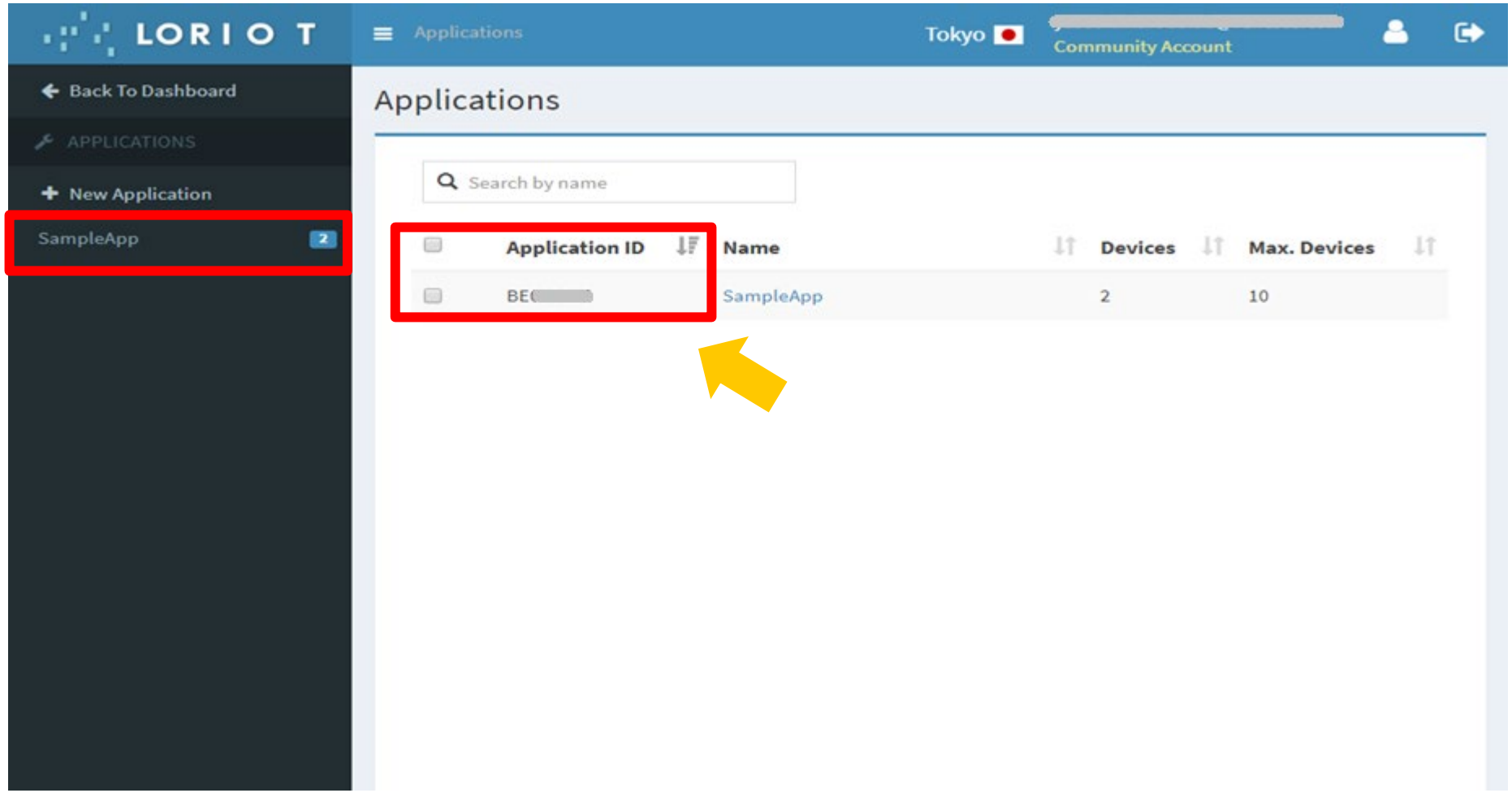
NETWORK SERVER SETTING FOR CAYENNE

- Click Dashboard→Application→SampleApp→Output
- Click Cayenne
- Click Add Output



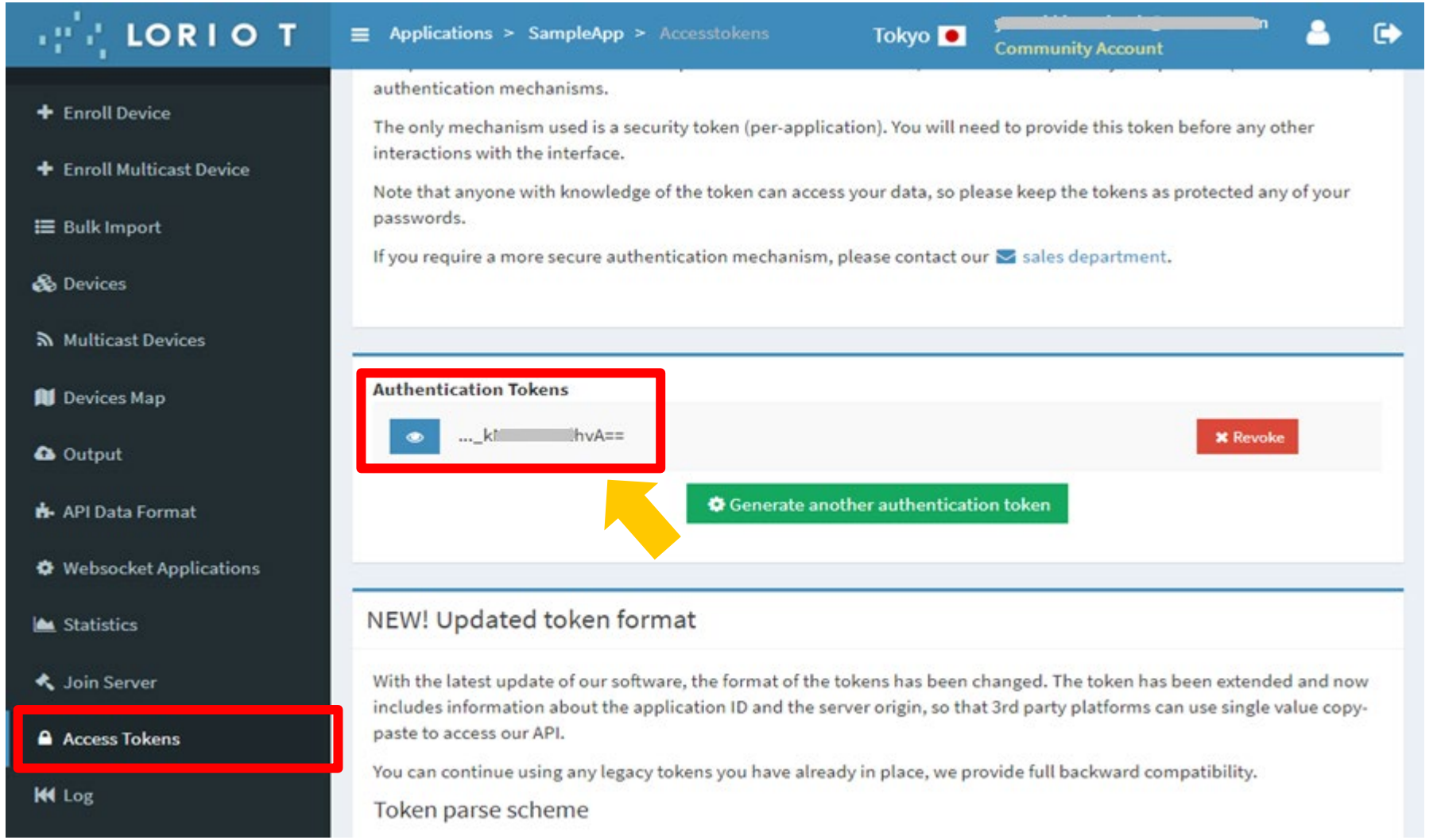
GET NETWORK SERVER INFORMATION(1)

- Remember **Application ID** for setting Cayenne



GET NETWORK SERVER INFORMATION(2)

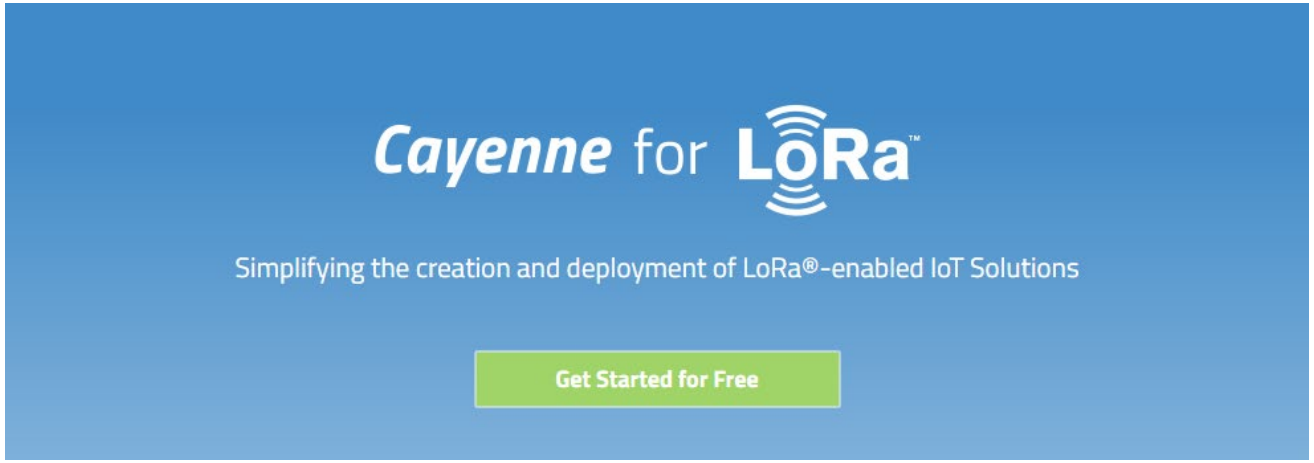
- Remember **Token** for setting Cayenne

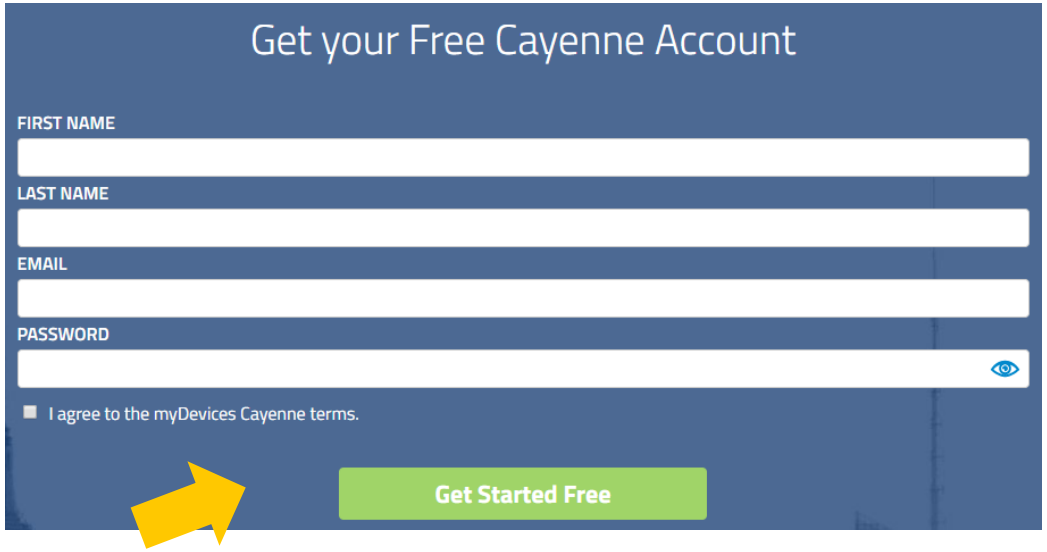


CREATE ACCOUNT CAYENNE FOR LoRa®

Cayenne for LoRa
https://developers.mydevices.com/cayenne/lora

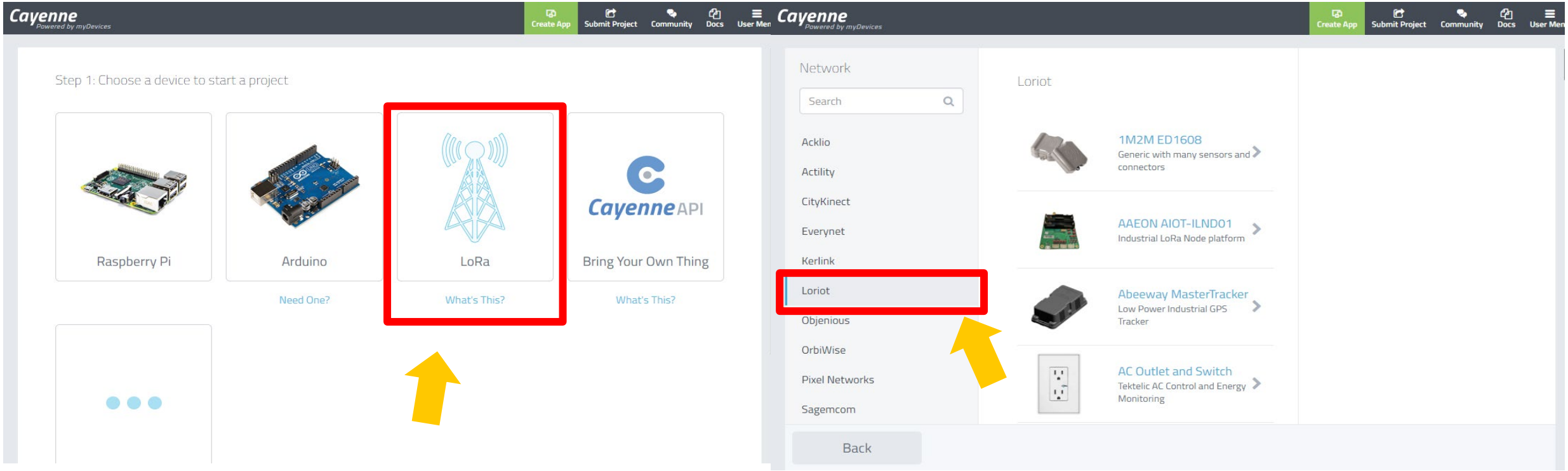
Crate Account





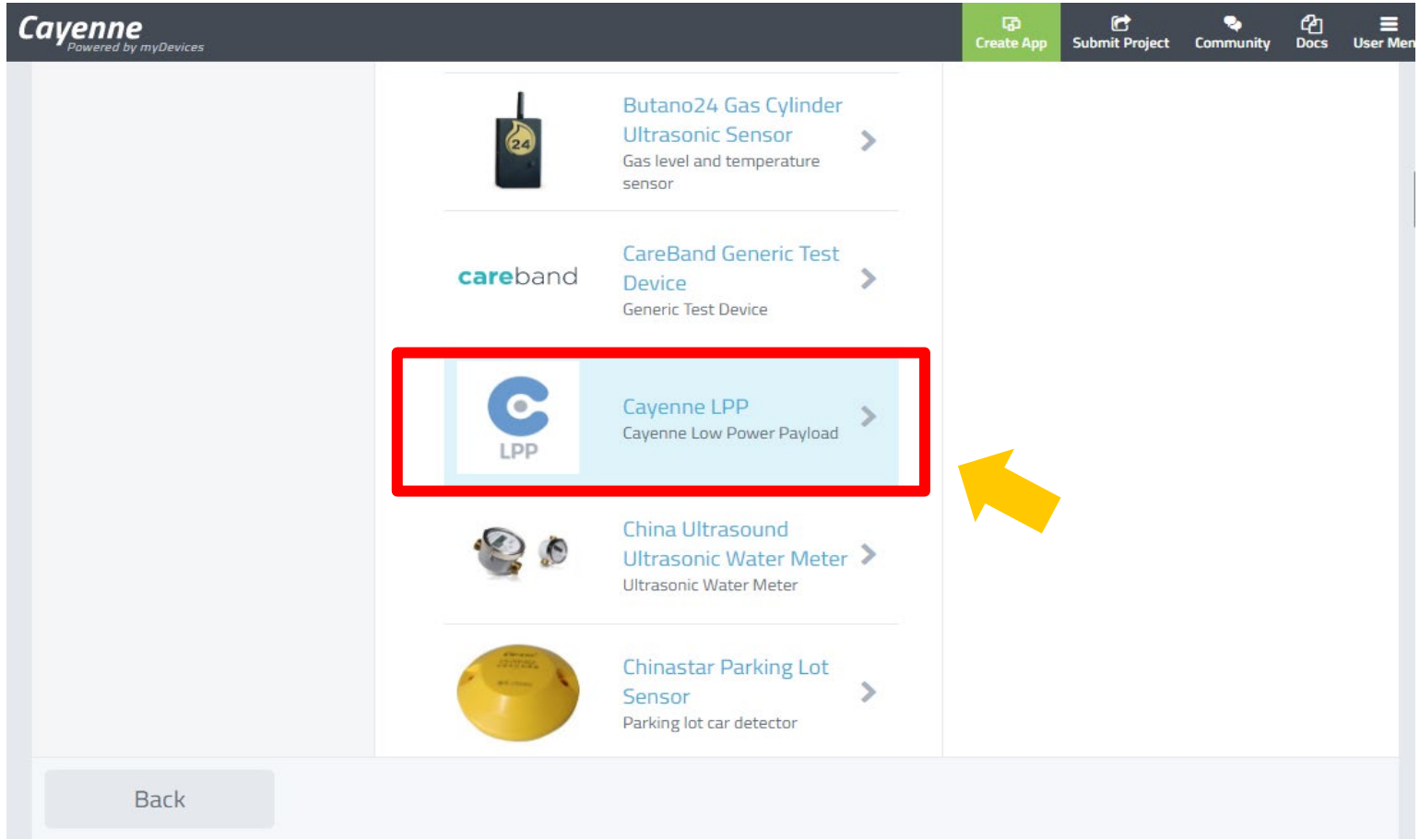
SETTING CAYENNE FOR LoRa(1)

- Login
- Click “LoRa”
- Click “Loriot”



SETTING CAYENNE FOR LoRa(2)

Click “Cayenne LPP”



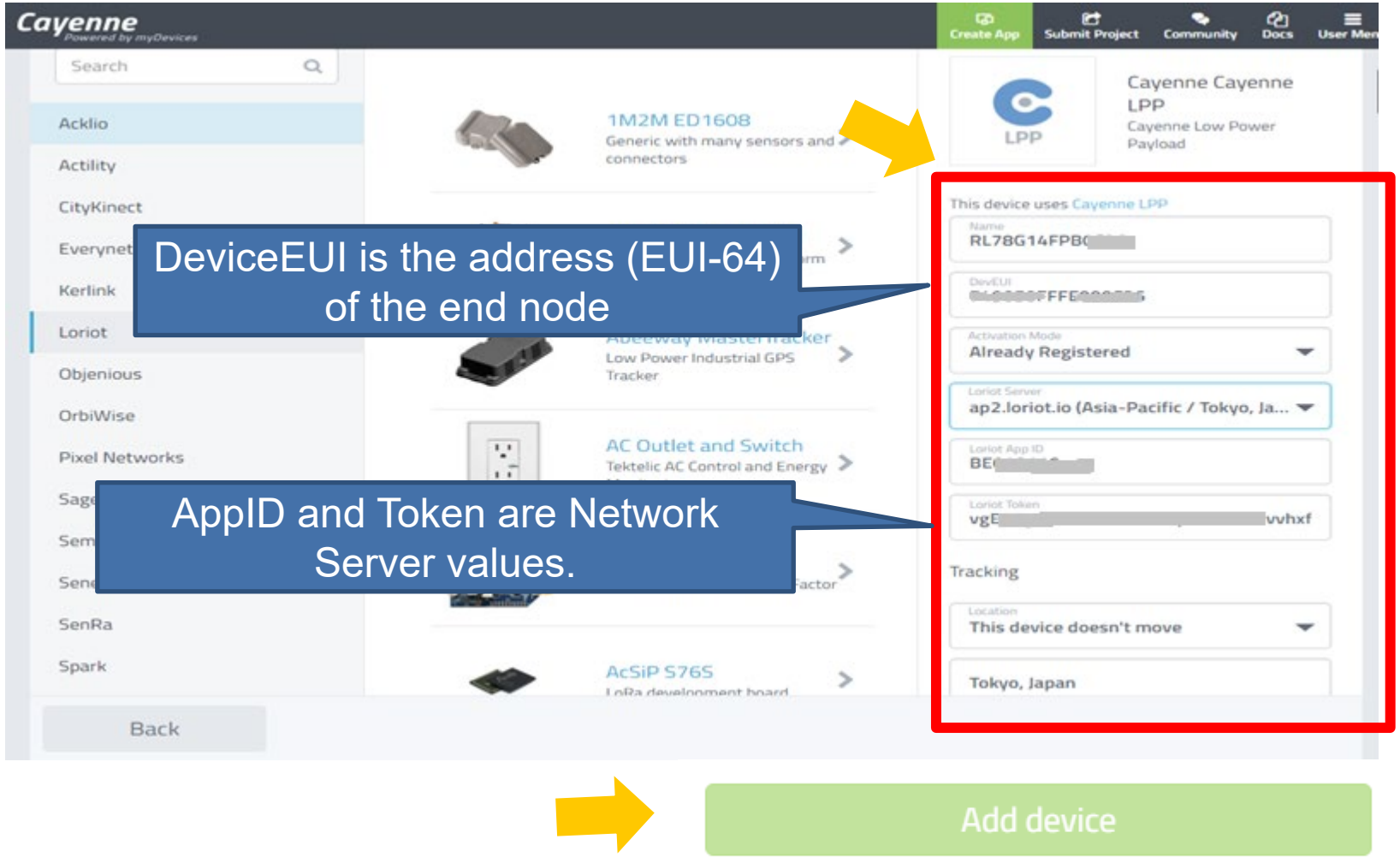
SETTING CAYENNE FOR LoRa(3)

Set Information

- Device information
- Loriot information(Loriot App ID, Loriot Token)
- Others

Click Add Device

- If you do not enter the correct information, this button will not be enabled.



DATA TRANSMISSION FROM LoRaWAN END NODE

How to send temperature information from LoRaWAN end node in LPP format by AT command

- First enable Cayenne sensor channels (64 pieces)
  - AT+FPORT=14 ←Use LoRaWAN port 14 for initialization
  - AT+SENDHEX=FFFFFFFFFFFFFFFF ← Sensor channel bitmap (0:disable,1:enable)

- The temperature information can be transmitted in the following format.
  - AT+FPORT=1 ← Use LoRaWAN port 1 for dynamic sensor information
  - AT+SENDHEX=Channel Number(1 byte) Temperature Tag (0x67) Temperature (2 bytes) Repeat after

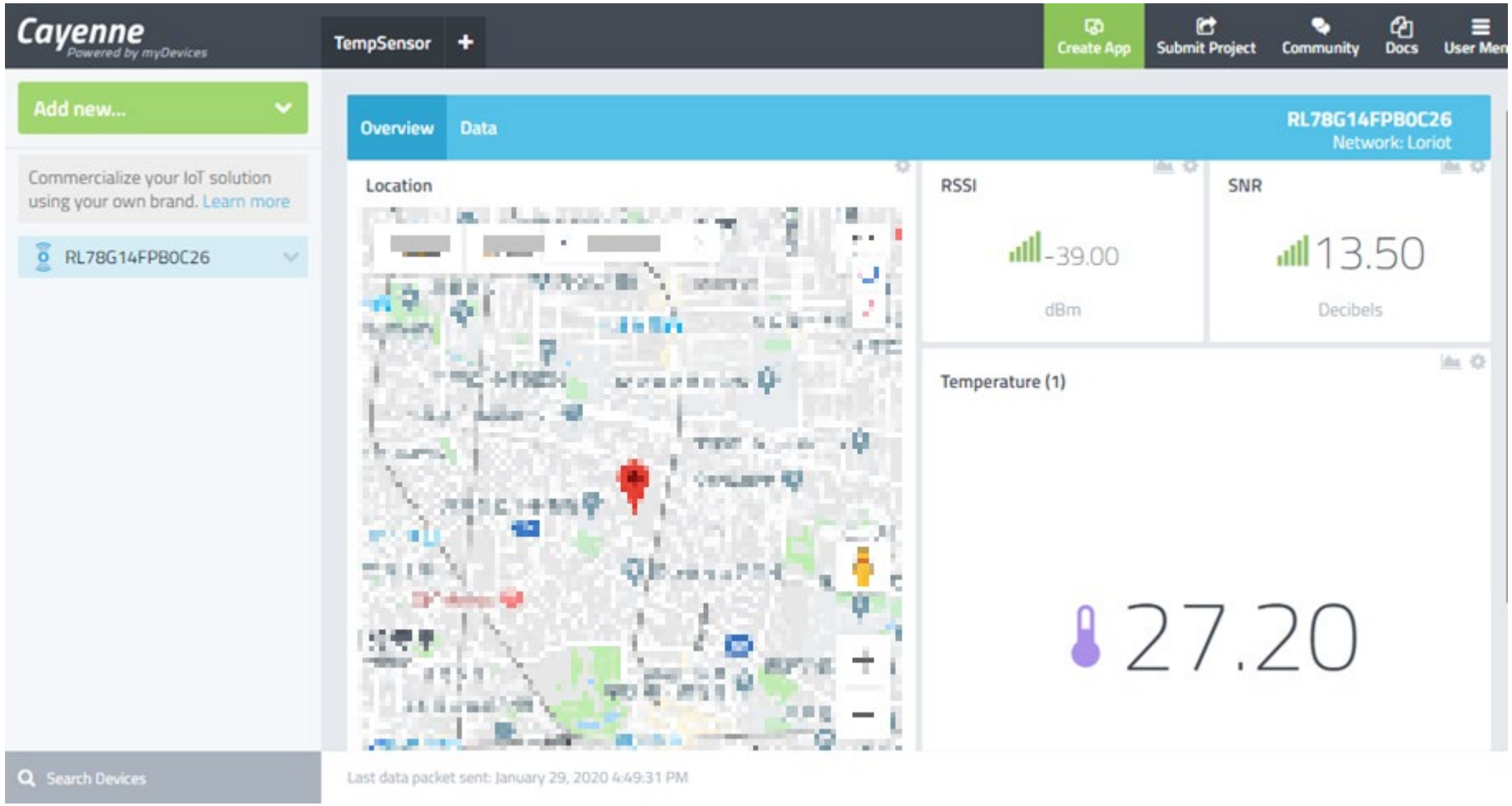
    - Example: AT+SENDHEX=01670110 ← Temperature Sensor:01, 0x0110=272=27.2 degree

    When transmitting multiple channels simultaneously
    - Example: AT+SENDHEX=0167011002670111 ← Temperature Sensor:01 is 27.2 degree, Temperature Sensor:02 is 27.3 degree

Please refer to the following for Data Types when you want to send data other than temperature.
https://community.mydevices.com/t/cayenne-lpp-2-0/7510

DISPLAY AT CAYENNE FOR LoRa

PC example



You can also check it on your smartphone.

Cayenne

Renesas.com

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