RL78 LoRaWAN® Sensor Demo Tutorial

Setup and Operation Method

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

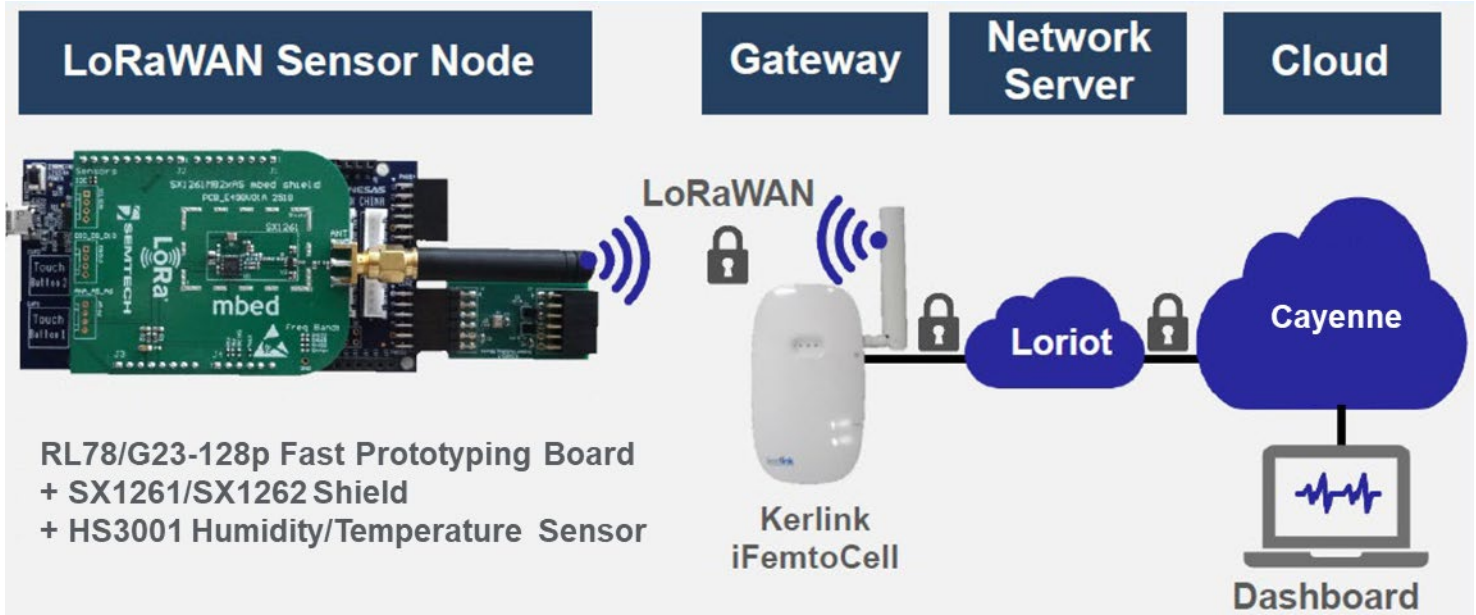
Notes on using the RF transceiver:

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

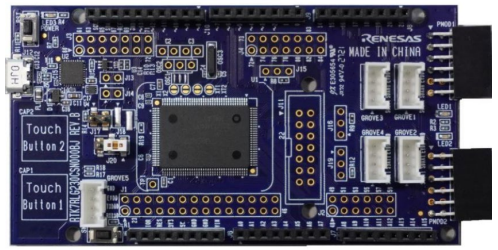
Outline

- This tutorial shows how to setup and operate RL78 LoRaWAN® Sensor Demo to experience LoRaWAN®-based IoT application
- In this demo, sensor data can be sent to cloud service via LoRaWAN® wireless network utilizing the LoRaWAN® end node software for RL78/G23 from Renesas and visualized on the cloud service.
- You can easily build a wireless network and realize IoT application with the LoRaWAN® ecosystem.



Required Equipment
In case RL78/G23-128p Fast Prototyping board is used

- RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ)(https://www.renesas.com/rl78g23-128p_fpb)
- 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)
- Relative Humidity Sensor Pmod™ Board (US082-HS3001EVZ)(https://www.renesas.com/us/en/products/sensor-products/humidity-sensors/us082-hs3001evz-relative-humidity-sensor-pmod-board-renesas-quick-connect-iot)
- Kerlink Wirnet iFemtoCell (https://www.kerlink.com/product/wirnet-ifemtocell)
- Micro USB (USB A-Micro B) Cable



RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ)

Semtech SX1261 Shield

Relative Humidity Sensor Pmod™ Board (US082-HS3001EVZ)

Kerlink Wirnet iFemtoCell

Ordering Reference

Semtech SX1261/SX1262 Shield and Kerlink Wirnet iFemtoCell (LoRaWAN® Gateway)

- **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.

- **Kerlink Wirnet iFemtoCell (LoRaWAN® Gateway)**

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/lora_products/kerlink-wirnet-ifemtocell/

Certification

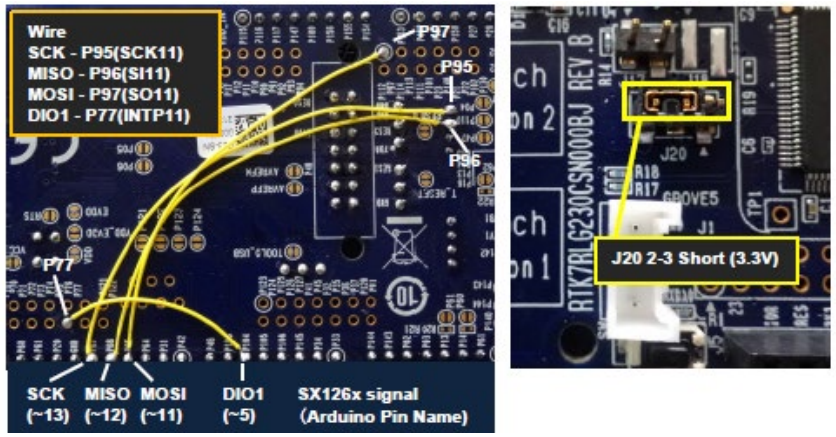
868	915	923
• Europe • Turkey • India	• USA • Canada	• Australia • New-Zealand • Singapore • Argentina • Brazil • Taiwan • South Korea • Japan • Hong-Kong • Malaysia • Indonesia • Vietnam • Thaïland • Philippines

Setup for LoRaWAN® End Node

Setup LoRaWAN® End node (1)

Hardware Setup in case RL78/G23-128p Fast Prototyping Board is used

1) Wirings and change of power supply setting

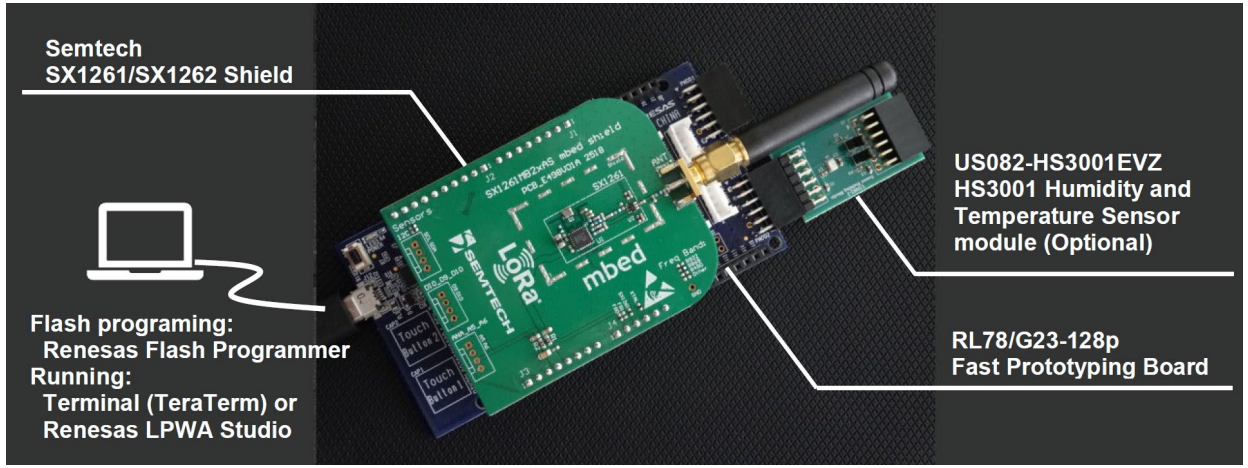


STEP1:
Wire SX126x(SCK,MISO,MOSI and DIO1) to RL78/G23(SCK11,SI11,SO11, and INTP11).

STEP2:
Power supply selection header (J20) should be changed from 5V (1-2 short) to 3.3V(2-3 short).

STEP3:
Plug the SX126x shield. Plug the US082-HS3001EVZ to the PMOD2 connector.

2) Connection of boards and cables



Setup LoRaWAN® End node (2)
Write LoRaWAN® Sensor Demo software to flash memory

- **Download LoRaWAN(R)-Sensor Demo Package**
  - RL78/G23, RL78/G14 LoRaWAN(R)-Sensor Demo Package
    https://www.renesas.com/us/en/document/scd/rl78g23-rl78g14-lorawan-sensor-demo-rev210?language=en&r=1245206

- **Flash programming to RL78/G23-128p Fast Prototyping Board**
  - Download Renesas Flash Programmer (RFP)
    RFP V3.08.3 or higher required.
    https://www.renesas.com/rfp

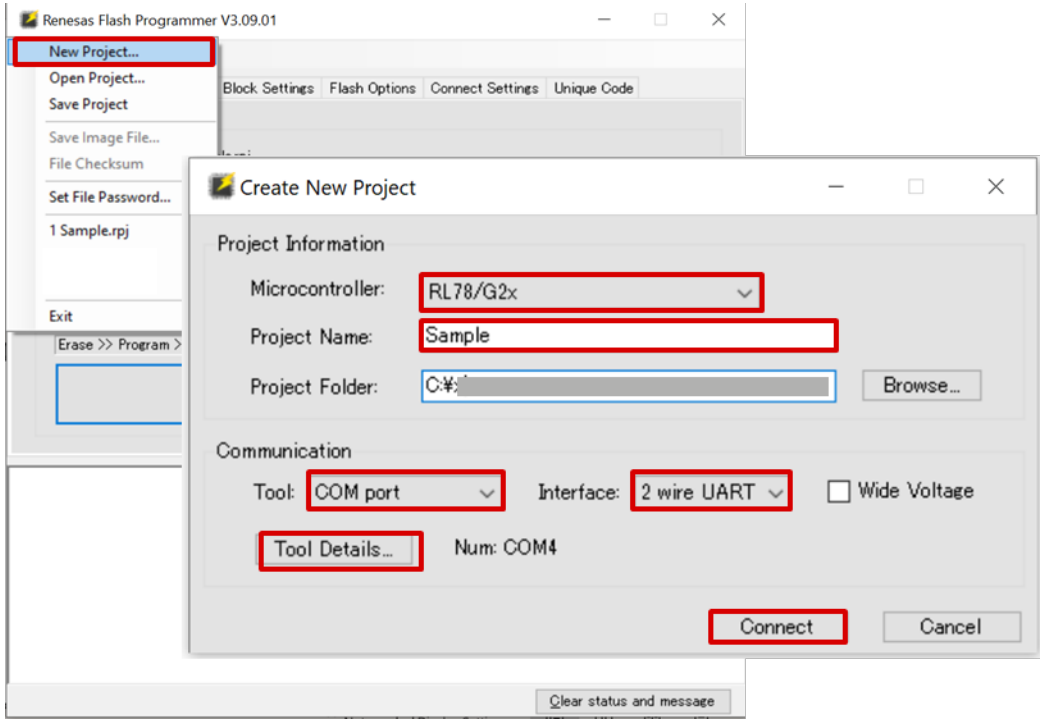
  - Write LoRaWAN® Sensor Demo software to flash memory by RFP

    Write the following file to RL78/G23-128p Fast Prototyping Board (Refer to next slide for more details)

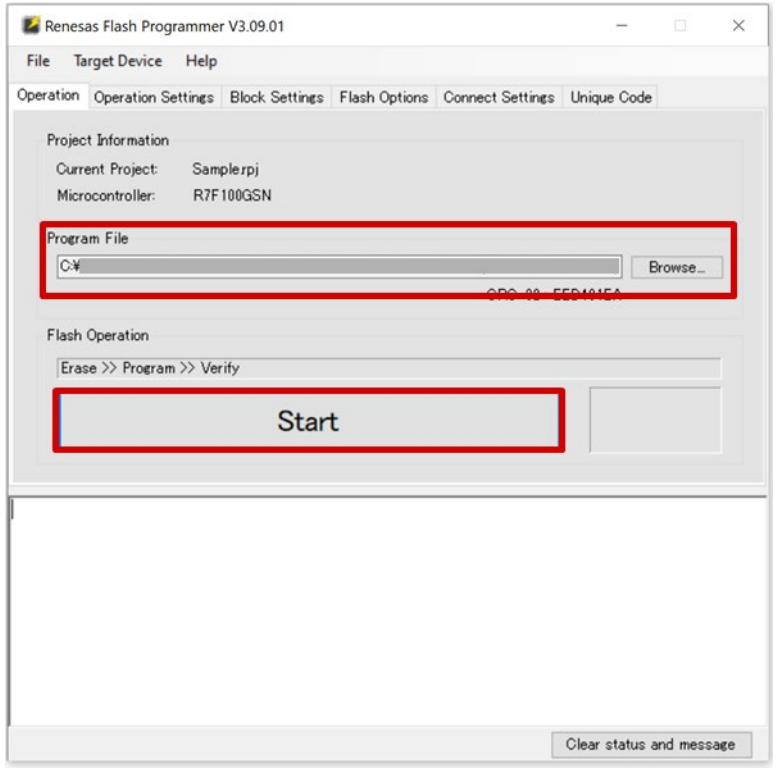
    samples¥project¥e2studio¥rl78g23-128pfpb_sx126x¥LoRaSensorSample¥DefaultBuild¥LoRaSensorSample.mot

Setup LoRaWAN® End node (3)
Write LoRaWAN® Sensor Demo software to flash memory

1. Select **New Project**.
2. Select **RL78/G2x** in Microcontroller.
3. Enter project name in Project Name.
4. Select **COM port** in Tool and **2 wire UART** in Interface.
5. Click **Tool Details** and select COM port number.
6. Click **Connect**.



7. Select software file (LoRaSensorSample.mot) in **Program file**.
8. Click **Start**.



Setup for LoRaWAN® Gateway and LoRaWAN® Network Server

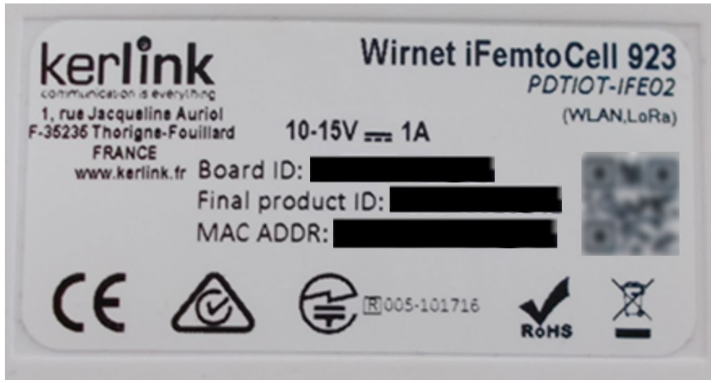
Setup LoRaWAN® Gateway

Login to Kerlink LoRaWAN® Gateway by Terminal software(SSH)

- **Necessary information of gateway for setup**

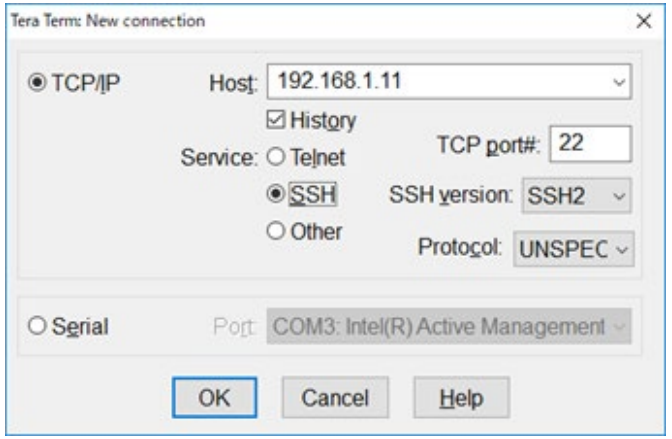
  Individual information of iFemtoCell is as follows.

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



Gateway rear label

- **Login to gateway**
  - Connect the gateway to the LAN environment
  - Execute ”arp –a“ command from Windows command prompt. Identify the gateway by the MAC address and confirm the IP address of the gateway assigned by the DHCP server.
  - Connect and login to the confirmed IP address (e.g.: 192.168.1.11) via SSH using Tera Term. Login name: “root“, Password: Above default password



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

Setup LoRaWAN® Gateway (2)
Install LORIOT Software to Kerlink LoRaWAN® Gateway

- **Install LORIOT software for iFemtoCell to Kerlink gateway**
  - Once login to the gateway, enter the following commands to install the software

```
cd /tmp
wget https://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 -s ap2.loriot.io
```

Change to the LORIOT server name to be used

  - Enter the following command for reboot

```
reboot
```

Note: By downloading and/or using any software from the list you Agree with the EULA.
https://loriot.io/terms-of-service.html

LORIOT LoRaWAN® Network Server

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

- LORIOT Network Server has three plans. In this tutorial, COMMUNITY PUBLIC NETOWORK SERVER is used.

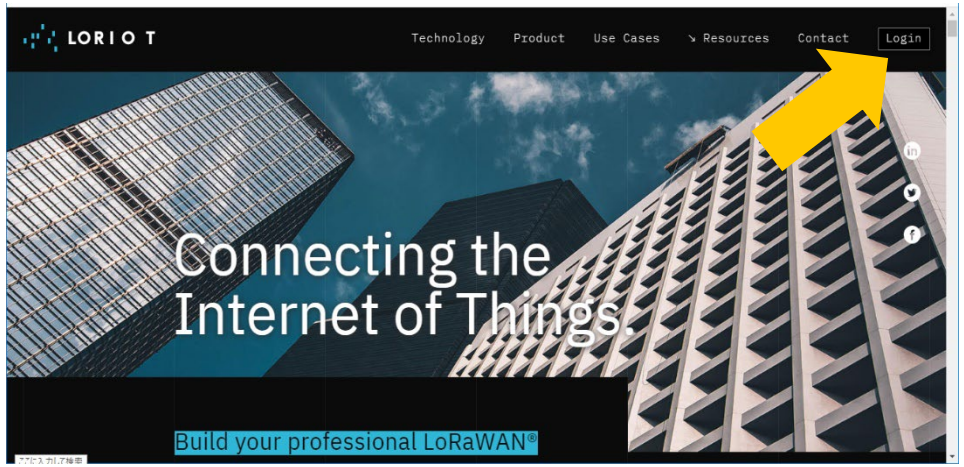
	COMMUNITY PUBLIC NETWORK SERVER 13 Worldwide Community Public Servers Public LoRaWAN® servers on-demand including **FREE connectivity**. Ideal for Academic/Development/Proof-of-concept/Small-scale/non-critical.	PROFESSIONAL PUBLIC SERVER Professional Network Server for production services Professional 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	unlimited Gateways FREE	Unlimited	Unlimited
Included Devices	30 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® Network Server (1)
Web Browser (LORIOT)

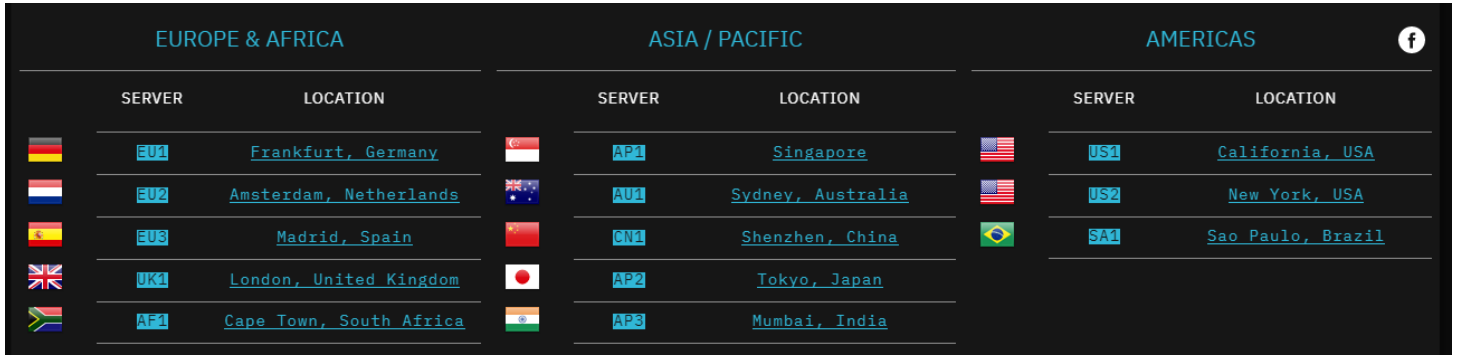
- **Create LORIOT account**
  - Access to https://www.loriot.io/login.html
  - Select a SERVER close to your location
  - Click Register a new account

Note: Please use Google Chrome, Firefox or Microsoft Edge for a web browser

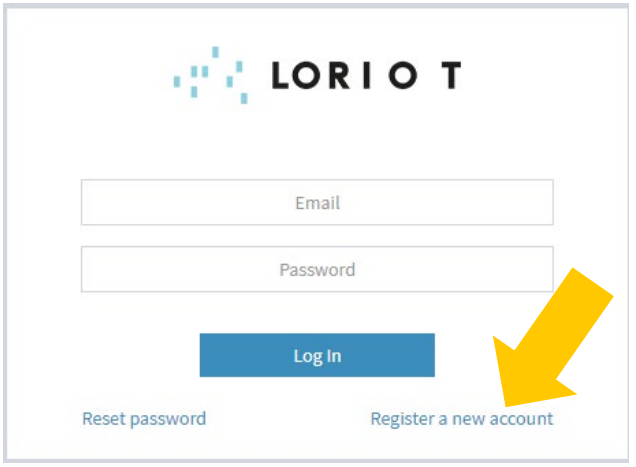
https://www.loriot.io/



https://www.loriot.io/login.html

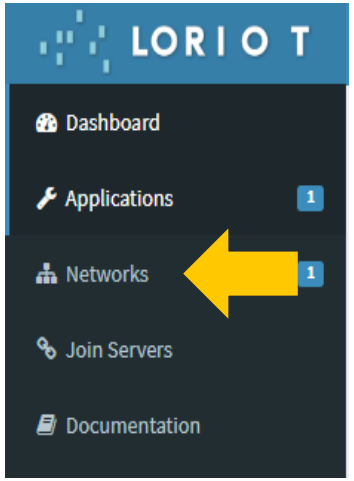


EUROPE & AFRICA		ASIA / PACIFIC		AMERICAS	
SERVER	LOCATION	SERVER	LOCATION	SERVER	LOCATION
EU1	Frankfurt, Germany	AP1	Singapore	US1	California, USA
EU2	Amsterdam, Netherlands	AU1	Sydney, Australia	US2	New York, USA
EU8	Madrid, Spain	CN1	Shenzhen, China	SA1	Sao Paulo, Brazil
UK1	London, United Kingdom	AP2	Tokyo, Japan		
AF1	Cape Town, South Africa	AP3	Mumbai, India		

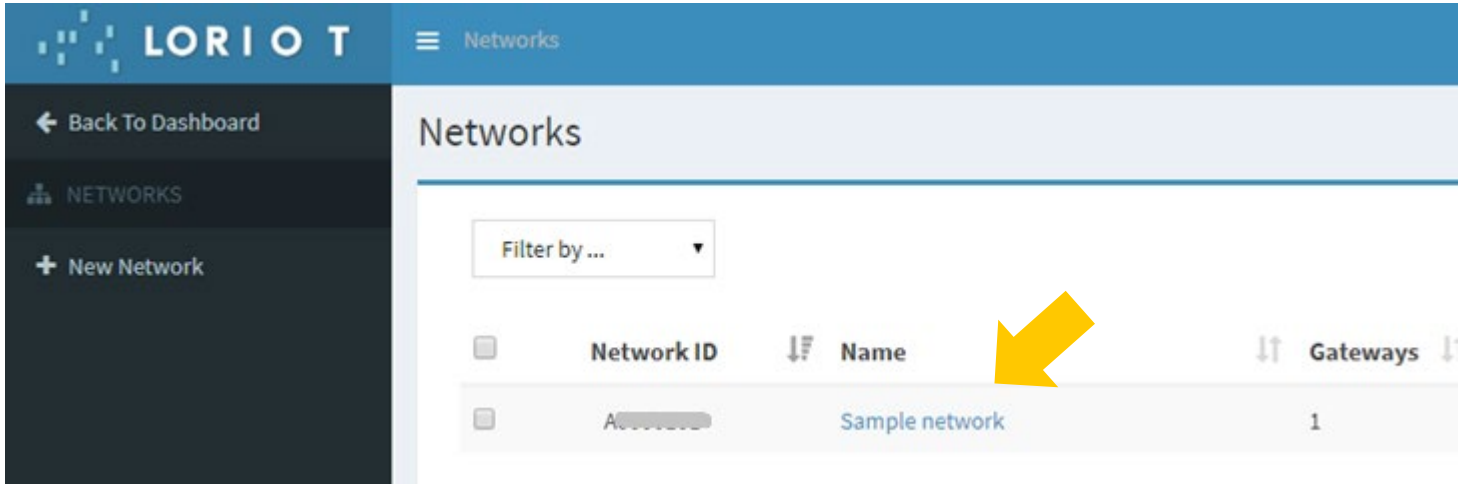


Setup LoRaWAN® Network Server (2)
Web Browser (LORIOT)

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

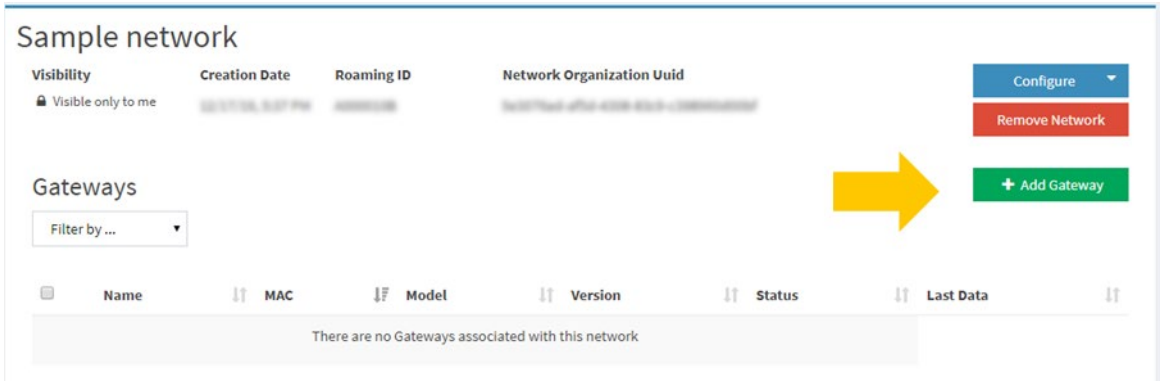


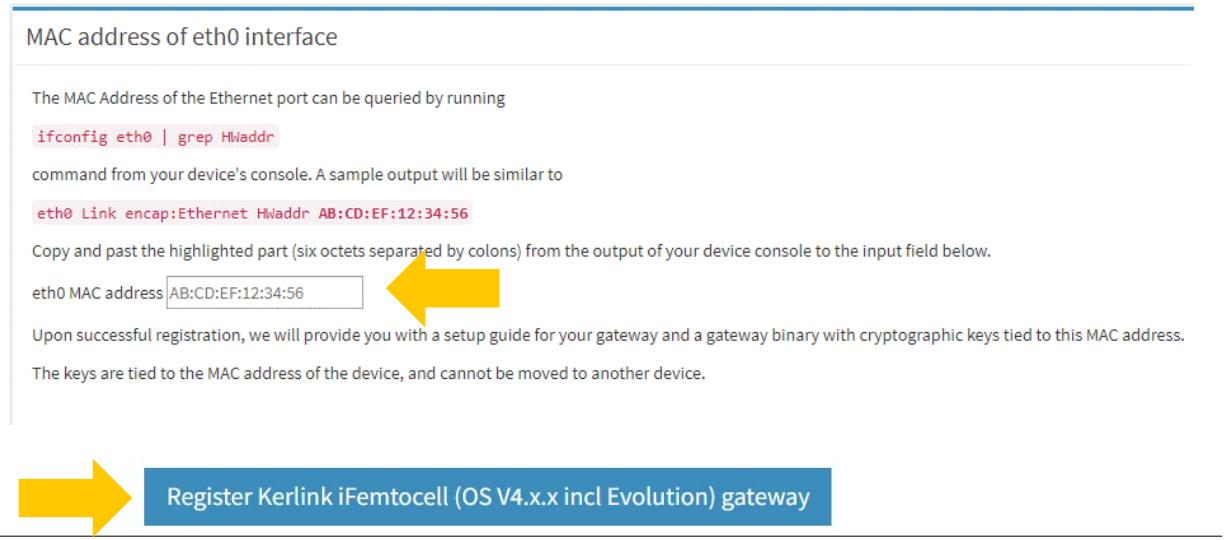
  - Click Sample network



Setup LoRaWAN® Network Server (3)
Web Browser (LORIOT)

- **Register gateway**
  - Click “+Add Gateway”
  - Select “Kerlink iFemtocell”
  - Set gateway MAC ADDR to eth0 MAC address
  - Set gateway location in Gateway Location
  - Click “Register Kerlink iFemtocell gateway”

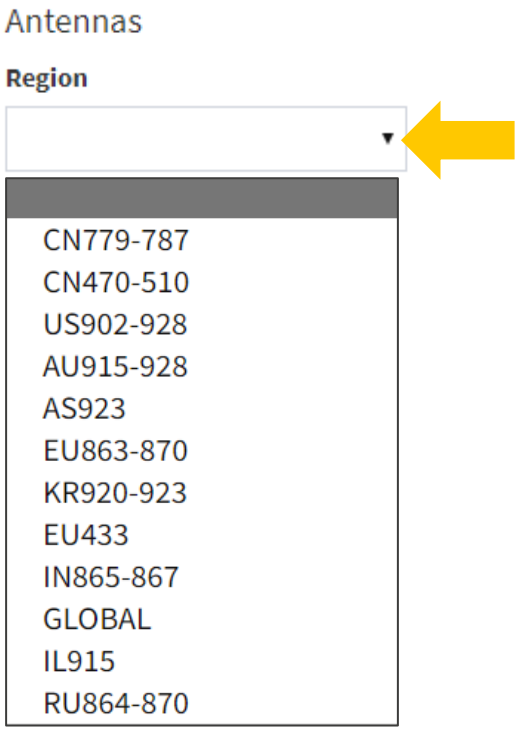




Setup LoRaWAN® Network Server (4)
Web Browser (LORIOT)

- **Set region**
  - Click Region in Configuration
  - 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

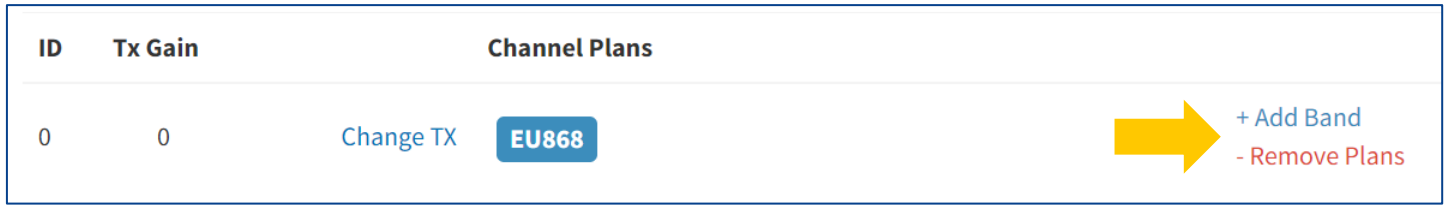
    Example:

    Europe: EU868

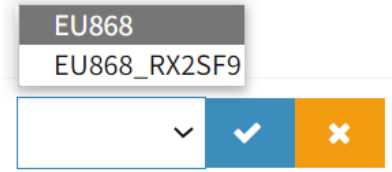
    US: US915_CH0_7

    JAPAN: AS923-1
  - Click “Restart”

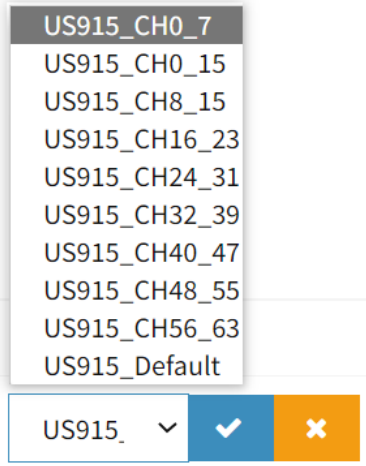
    Note: Restart will not be shown when gateway is not online.



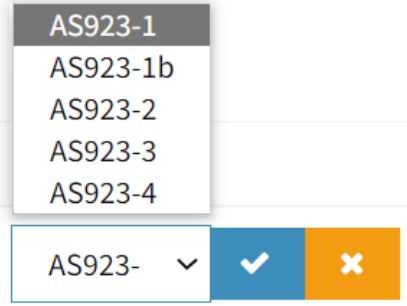
Region:EU863-870



Region: US902-928



Region: AS923

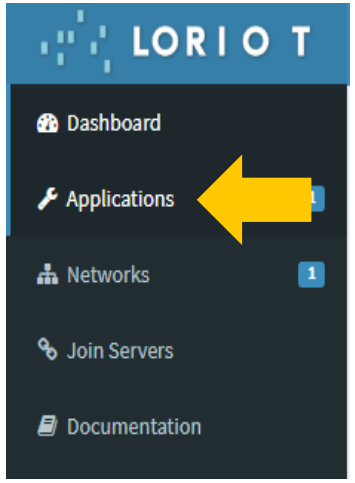


Regarding Channel Plan, see below for other regions.
Supported Frequency Plans
https://docs.loriot.io/display/LNS/Supported+Frequency+Plans

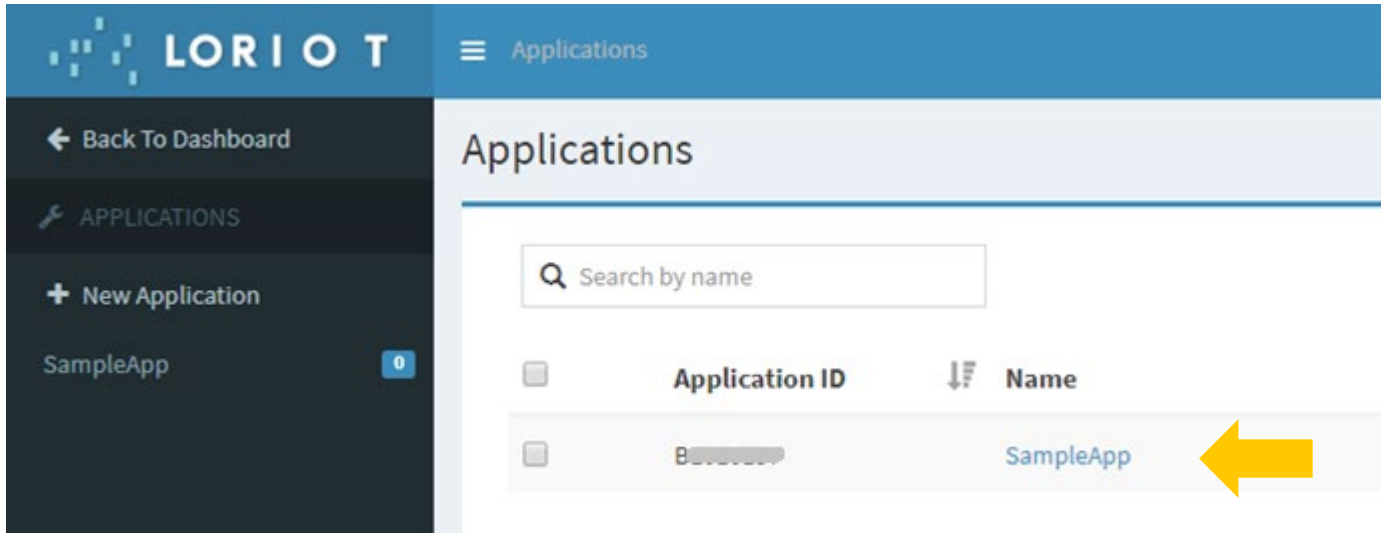
Registration of End Node to LoRaWAN® Network Server

Registration of End Node to LoRaWAN® Network Server (1)
Web Browser (LORIOT)

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

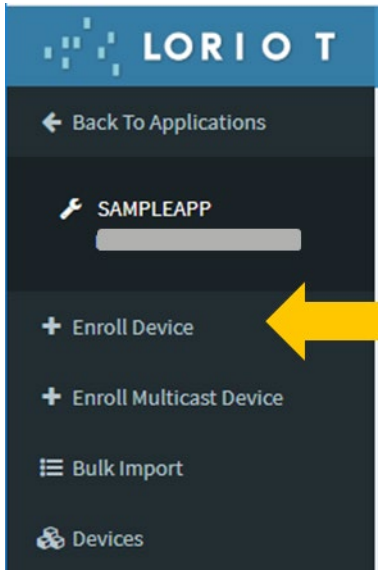


  - Click Dashboard→ Applications SampleApp



Registration of End Node to LoRaWAN® Network Server (2)
Web Browser (LORIOT)

- Click Enroll Device



Registration of End Node to LoRaWAN® Network Server (3)
Web Browser (LORIOT)

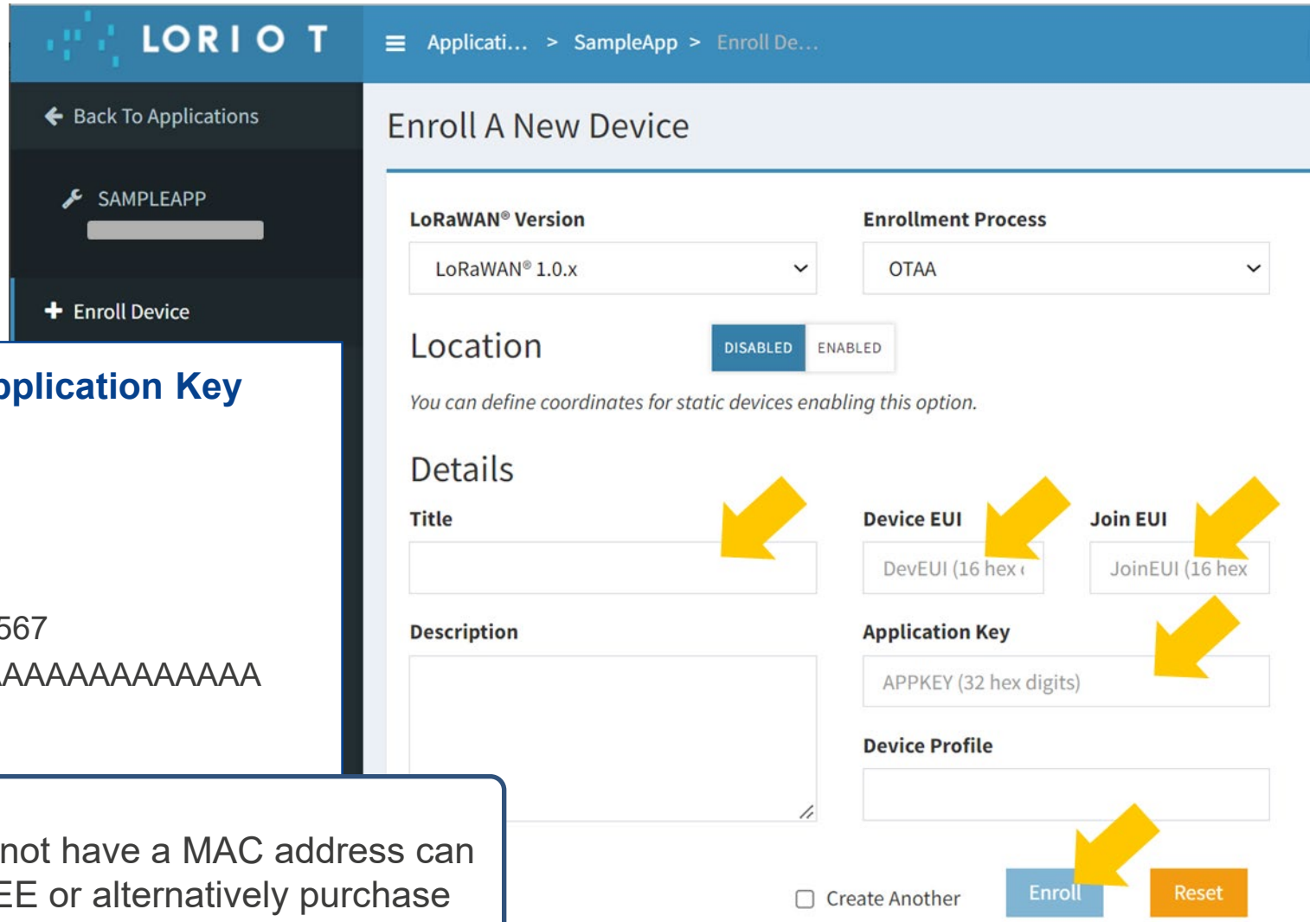
Please prepare 48-bit MAC address. Put FF: FE in the middle of the 48-bit MAC address and use it as a 64-bit Device EUI.

- **Ender Title, Device EUI, Join EUI, and Application Key**

  Example:
  - Title=demo
  - Device EUI=xxxxxxFFFExxxxxx
    xxxxxx is the following MAC address
  - Join EUI (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 can purchase it from IEEE or alternatively purchase an EEPROM with a MAC address written.

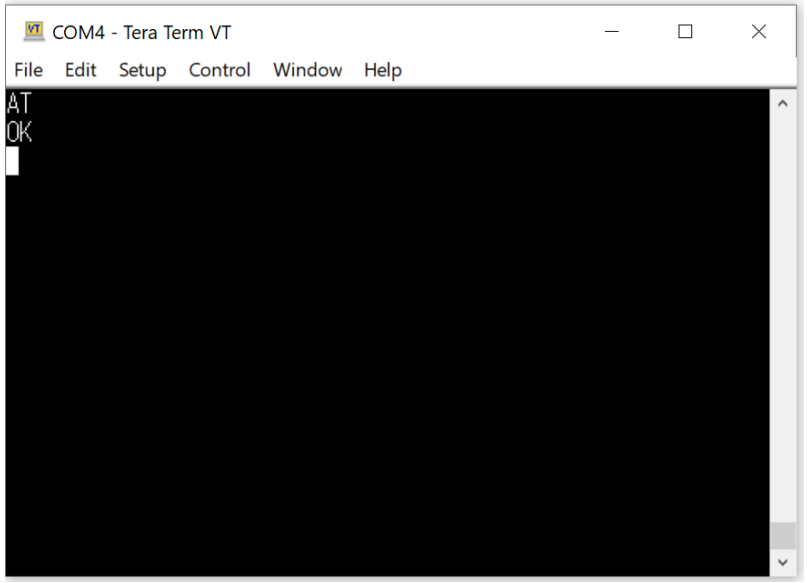


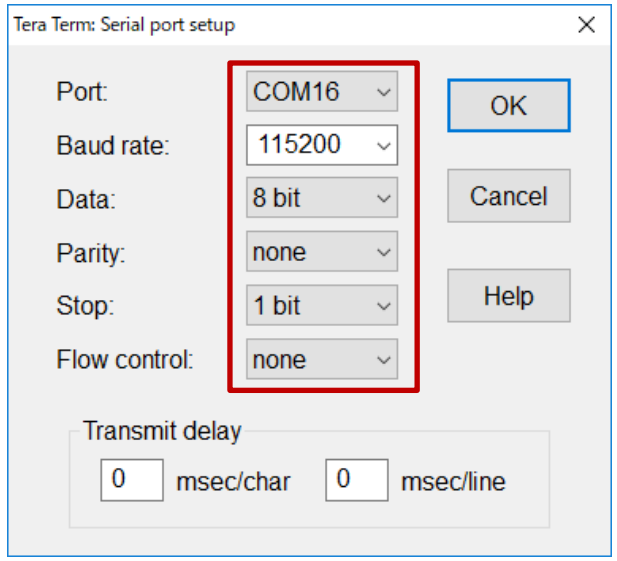
LoRaWAN® Sensor Demo Operation Method

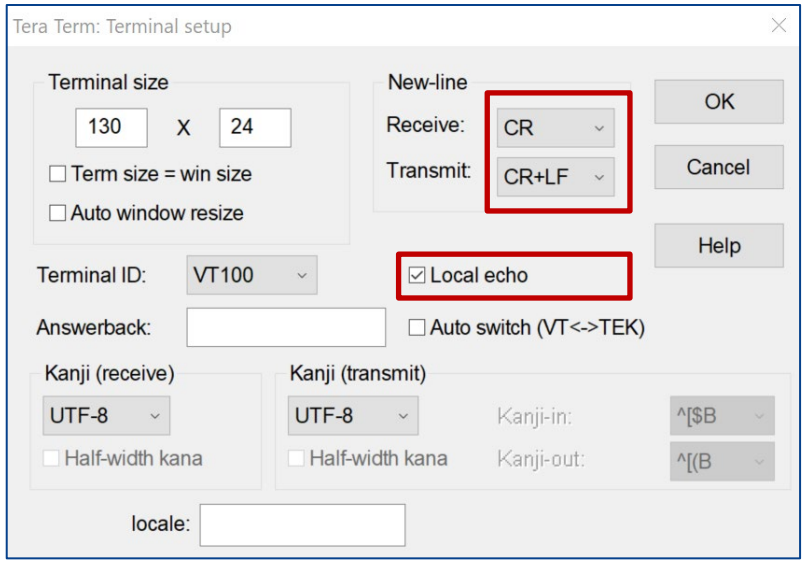
Operation method of LoRaWAN® End Node (1)

Terminal Software used to connect to End Node

- **Confirmation of UART connection**
  - Connect with PC by Terminal Software
  - Setup Serial and Terminal of right figure
    COM Port number in Port needs to be changed for the one you use
  - Enter ‘AT’ for control confirmation and confirm ‘OK’







Operation method of LoRaWAN® End Node (2)
Configuration of end node

- **Example of configuration**

Enter the following commands in Terminal Software

1. Set LoRaWAN® specific parameters with AT-commands

AT+REGION=X ← X: 0, 1, 6	// Region: 0:EU868, 1:US915(*Note1), 6:AS923-Group1
AT+CLASS=0	// Class A
AT+ACTMODE=1	// Activation: OTAA
AT+DEVEUI=XXXXXXXXXXXXXX	// DevEUI
AT+APPEUI=0123456701234567	// AppEUI
AT+APPKEY=55555555555555AAAAAAAAAAAAAAAA	// AppKey
AT+SAVE	// Save settings

Note1: Enter the following command before AT+SAVE in case US915_CH8_15 is used for channel plan
AT+CHDEFMASK=FF00,0000,0000,0000,0002

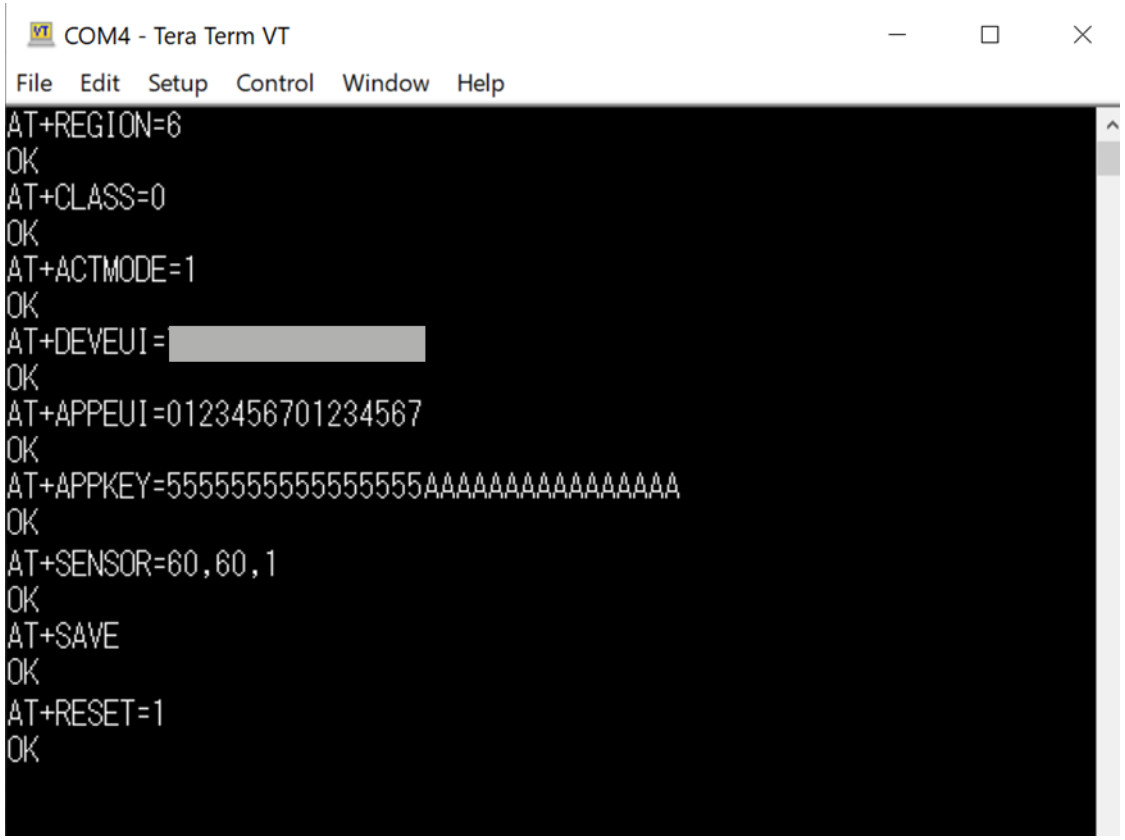
2. Set sensor demo specific parameters with AT-command

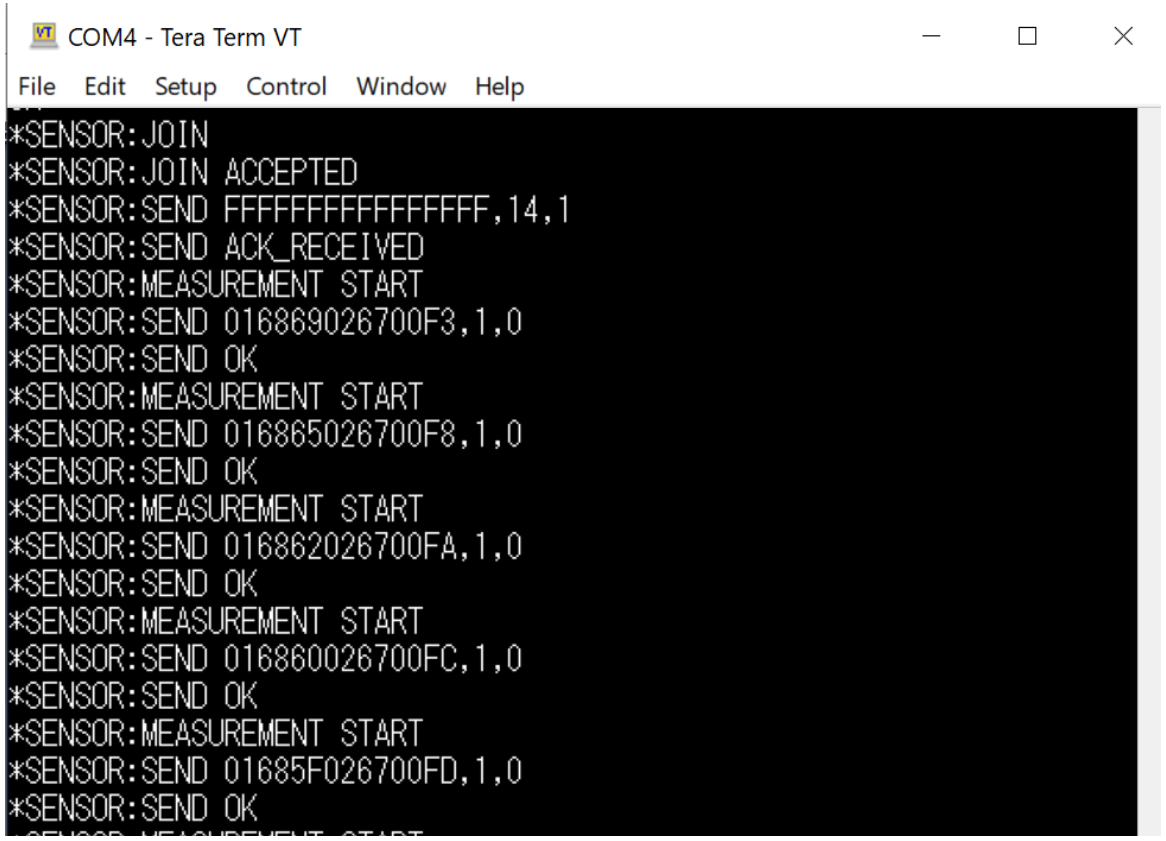
AT+SENSOR=60,60,1	// Set parameters (*Note2)
AT+SAVE	// Save settings to data flash
AT+RESET=1	// Auto start after reset

Note2: AT+SENSOR=REJOIN,MEASURE,MODE
REJOIN: Join retry interval after join failure [sec], MEASURE: Next measurement after Tx [sec], MODE: 1: Auto start mode

Operation method of LoRaWAN® End Node (3)
Example of execution screen of end node

- **Example of execution screen of end node**



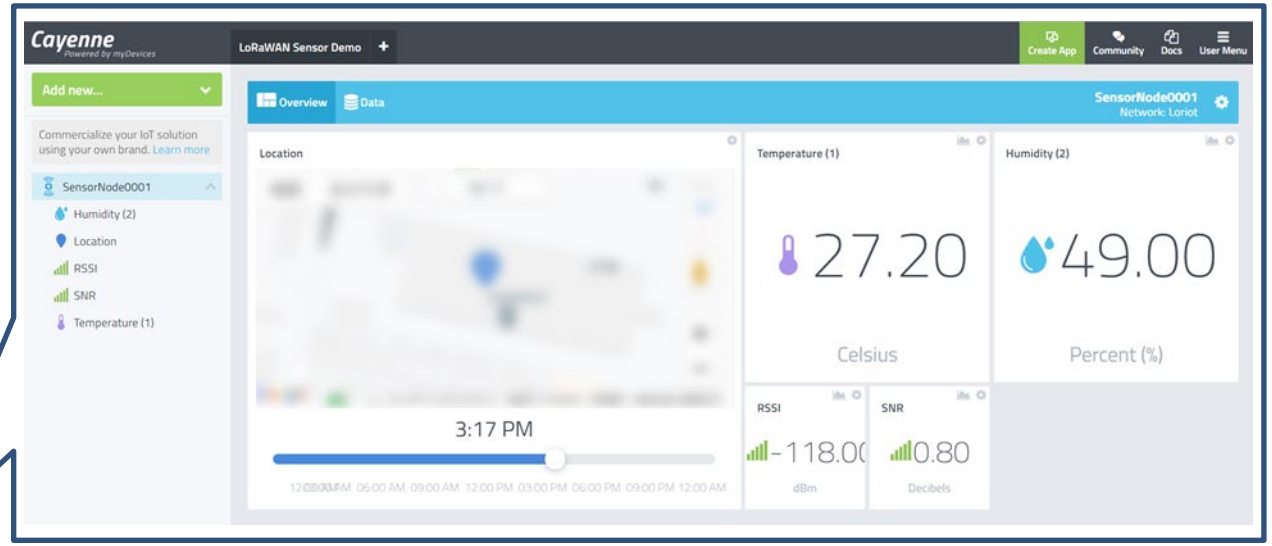


Data Visualization
Cayenne for LoRa®

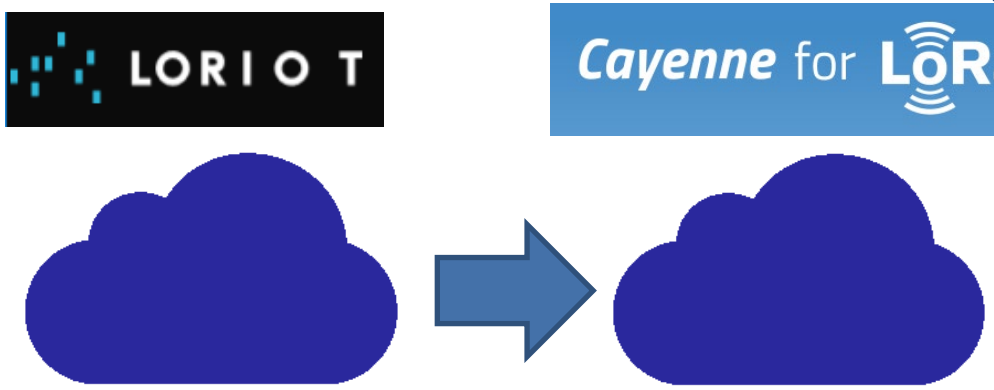
- Sensor data such as temperature and humidity can be displayed on Cayenne dashboard via LORIOT network server.

Cayenne for LoRa®

https://developers.mydevices.com/cayenne/lora/

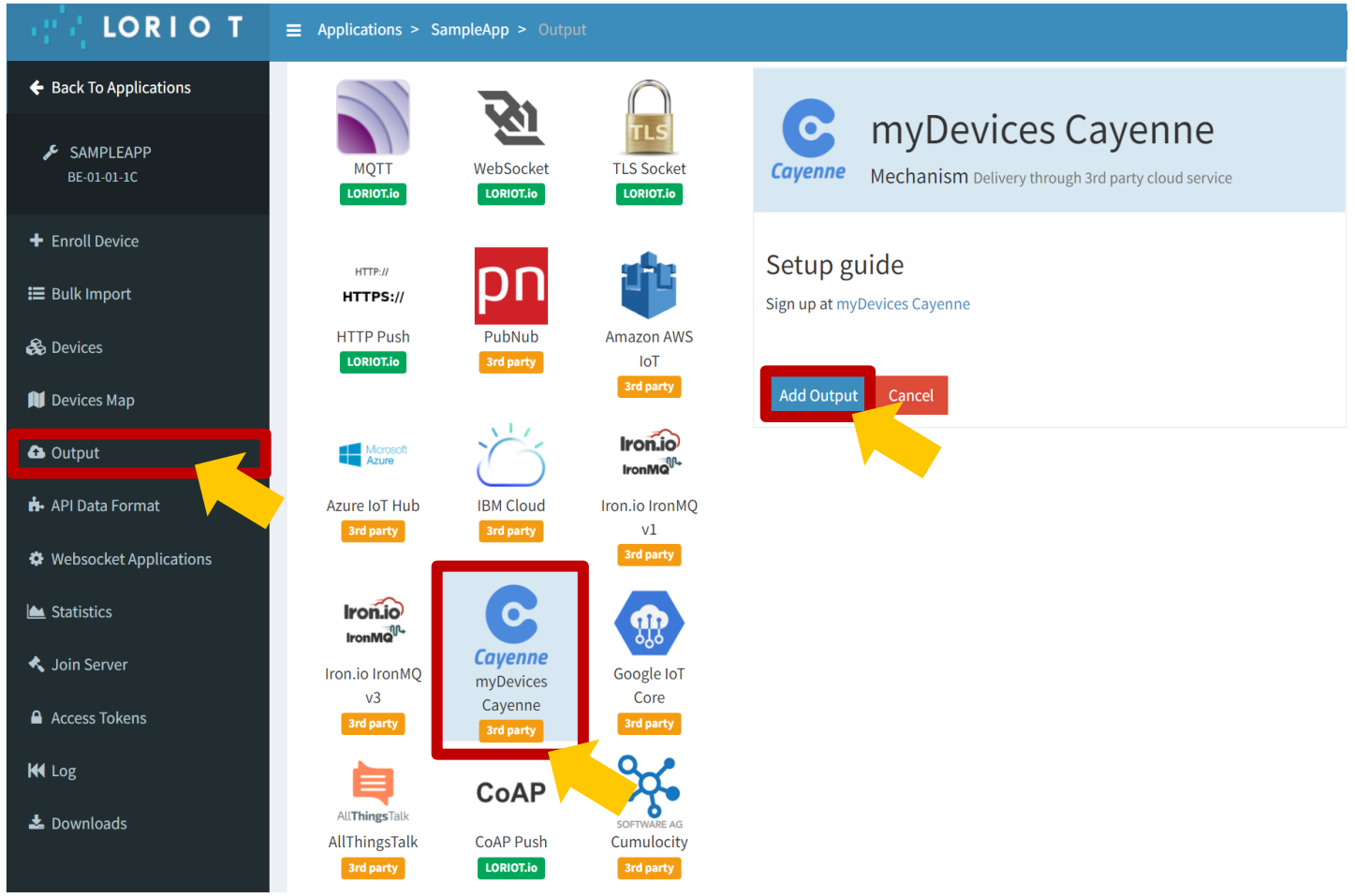


Network Server



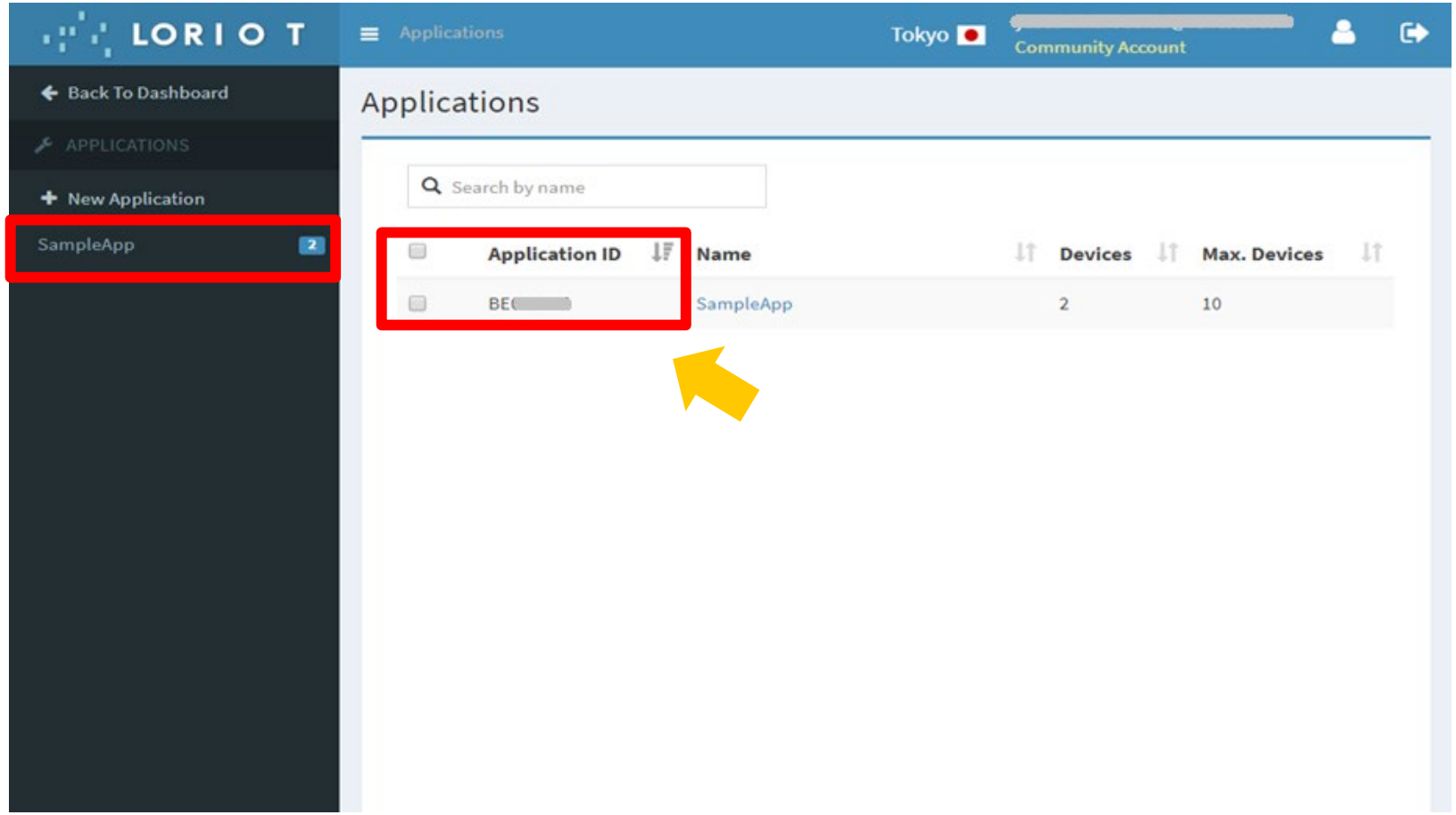
Data Visualization
Network Server Setting for Output (Cayenne)

- **Set output of network server**
  - Click Dashboard → Application → SampleApp → Output
  - Click Cayenne
  - Click Add Output



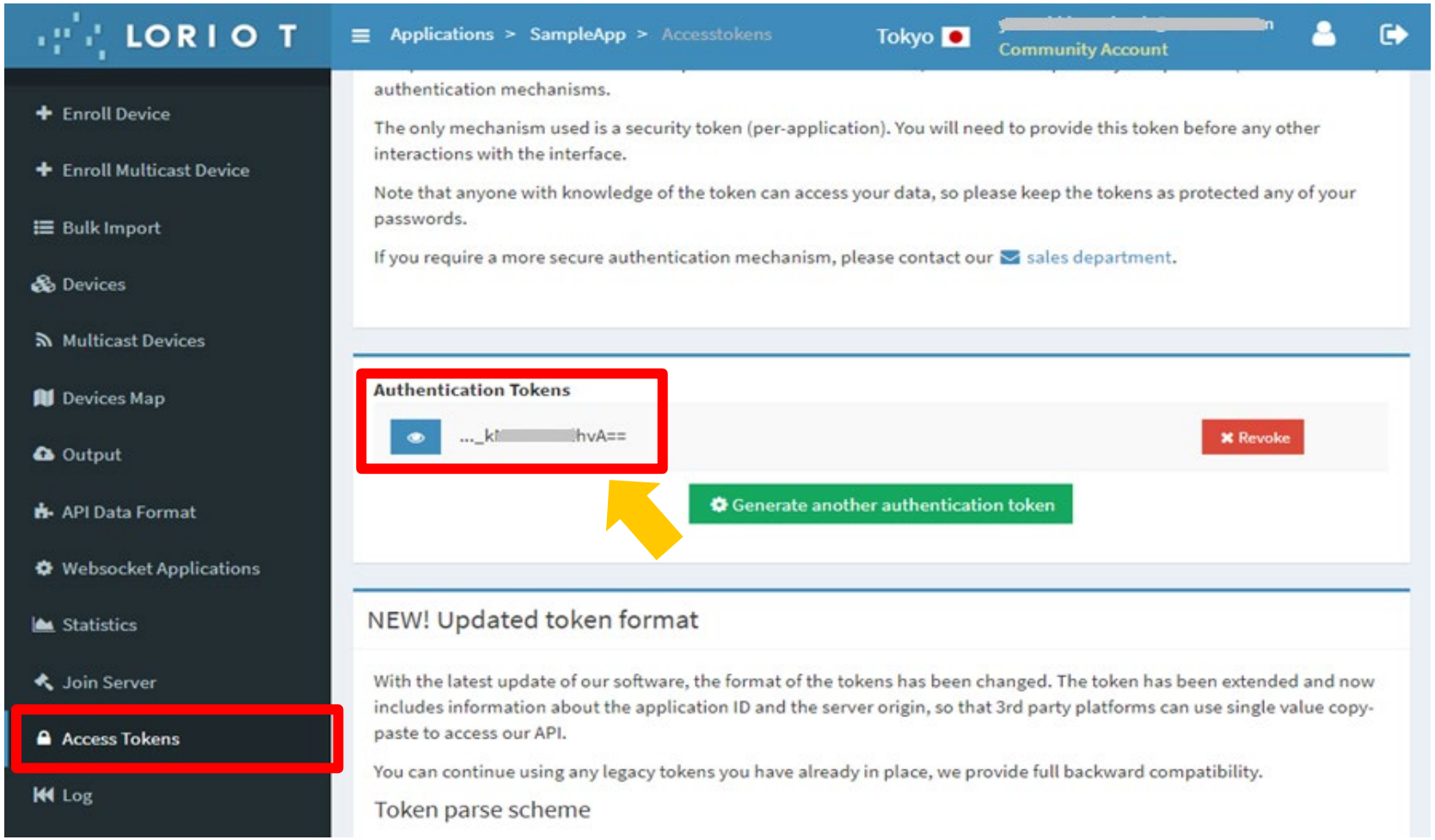
Data Visualization
Get Network Server Information (1)

- **Remember Application ID for setting of Cayenne later**



Data Visualization
Get Network Server Information (2)

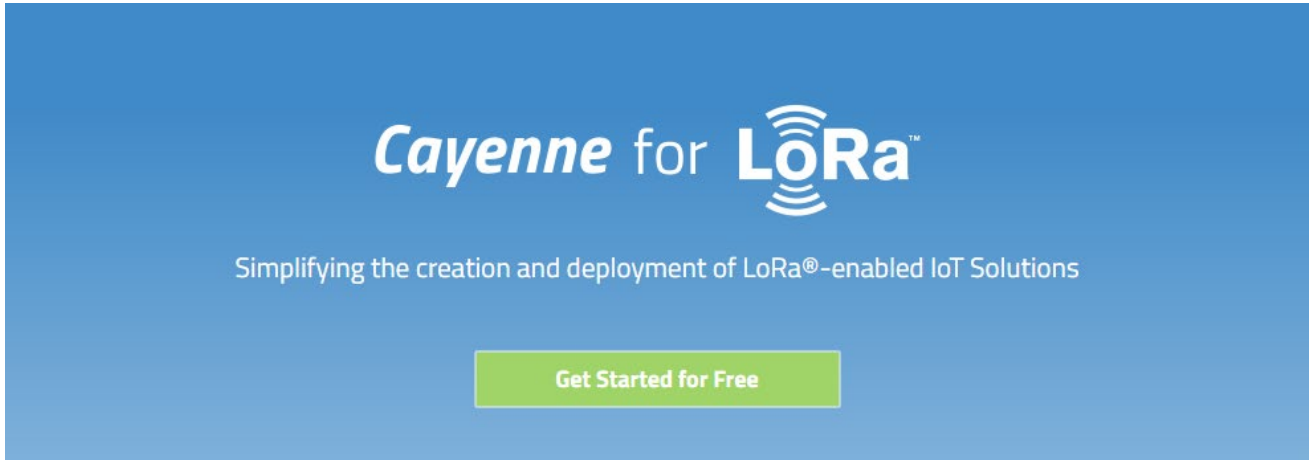
- **Remember Token for setting of Cayenne later**

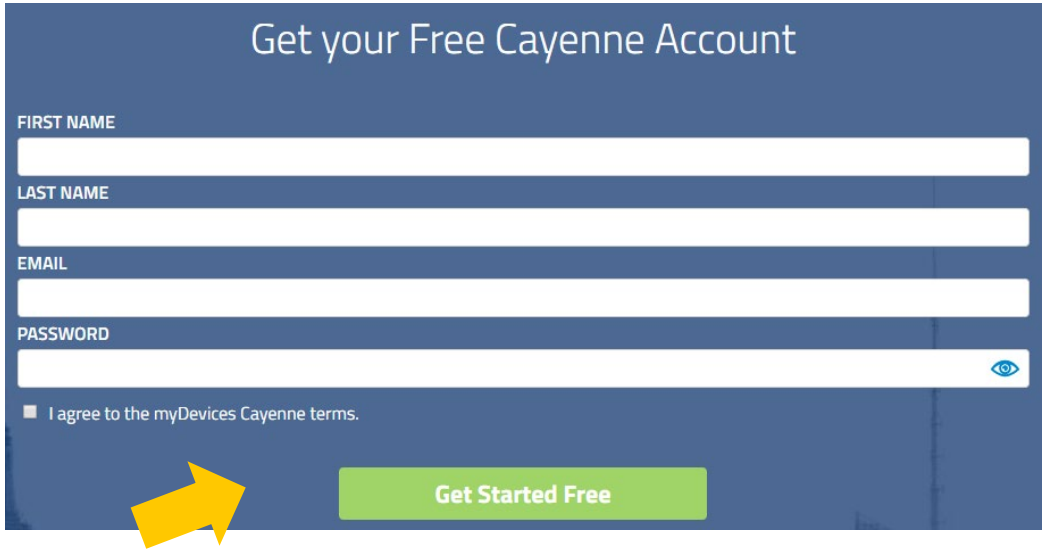


Data Visualization
Create Account of Cayenne for LoRa®

- **Access to Cayenne for LoRa®**
  https://developers.mydevices.com/cayenne/lora

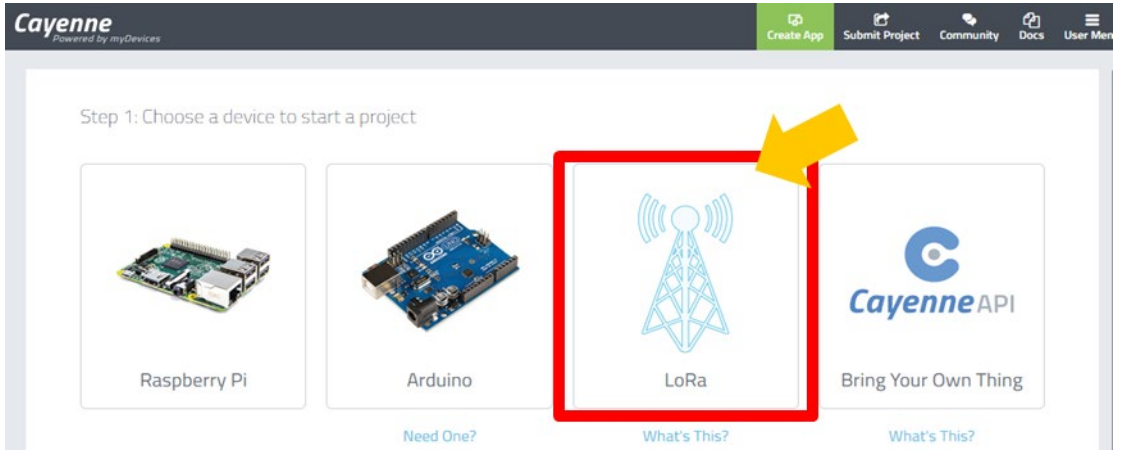
- **Crate Account**



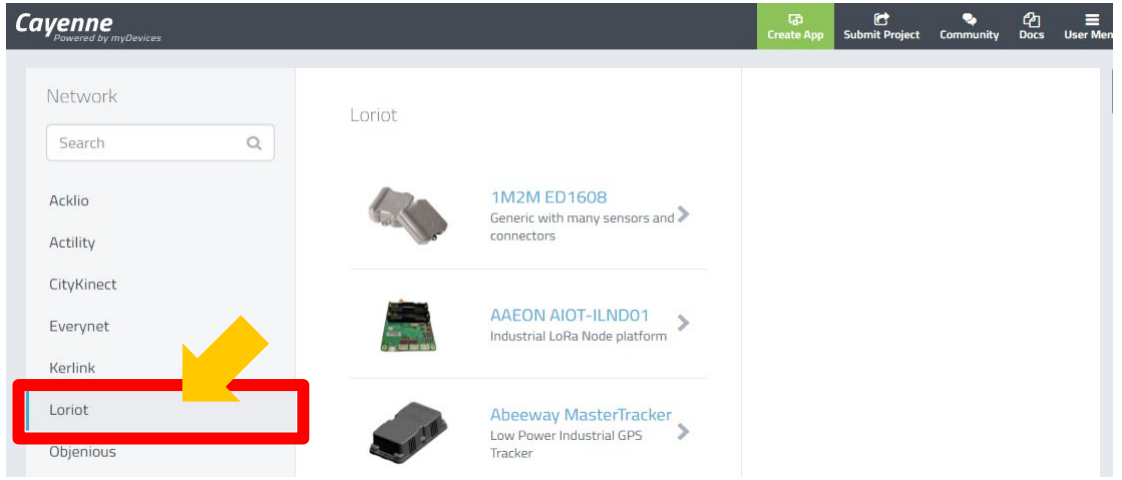


Data Visualization
Setting Cayenne for LoRa® (1)

- Login to Cayenne
- Click “LoRa®”

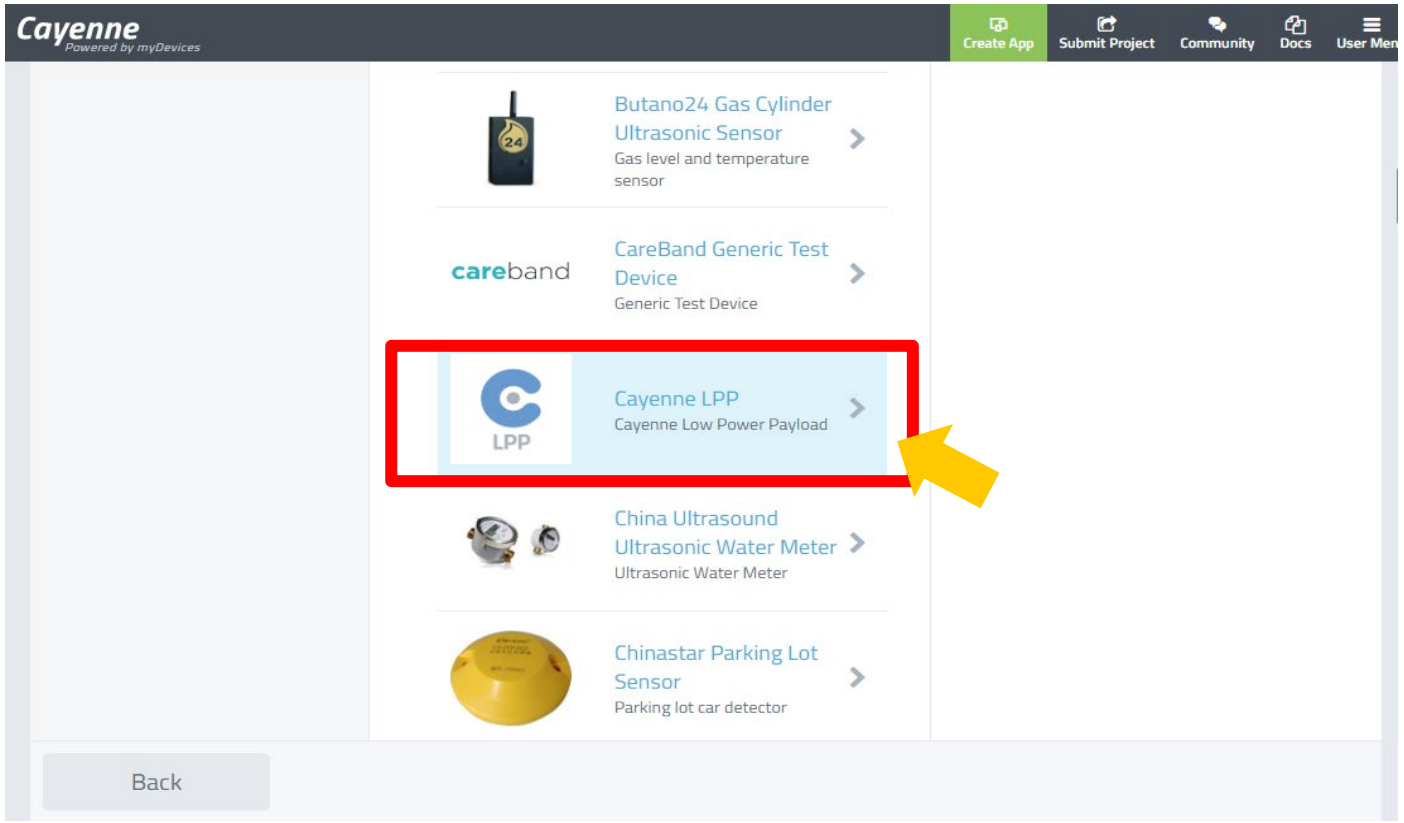


- Click “Loriot”



Data Visualization
Setting Cayenne for LoRa® (2)

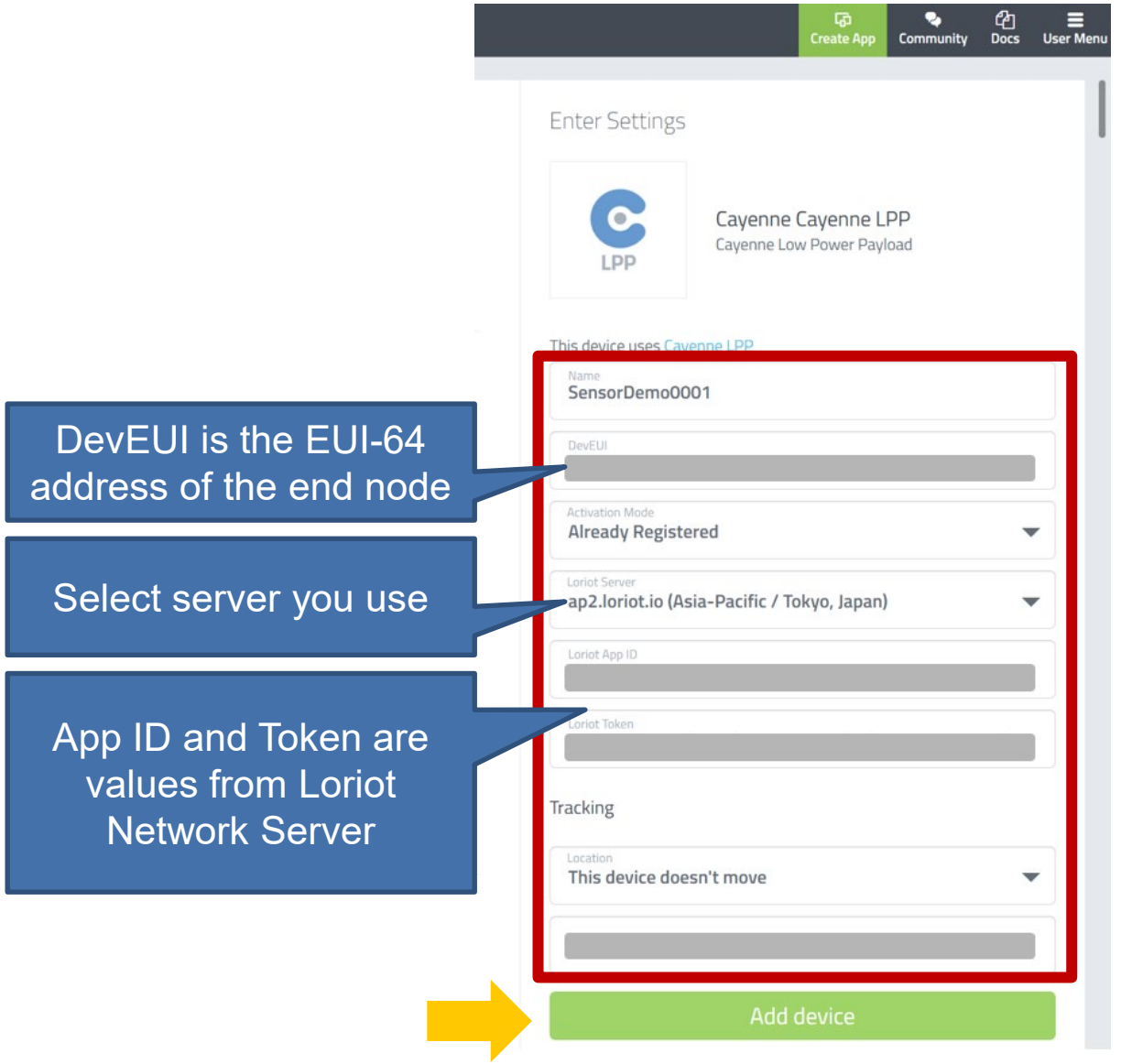
- Click “Cayenne LPP”



Data Visualization
Setting Cayenne for LoRa® (3)

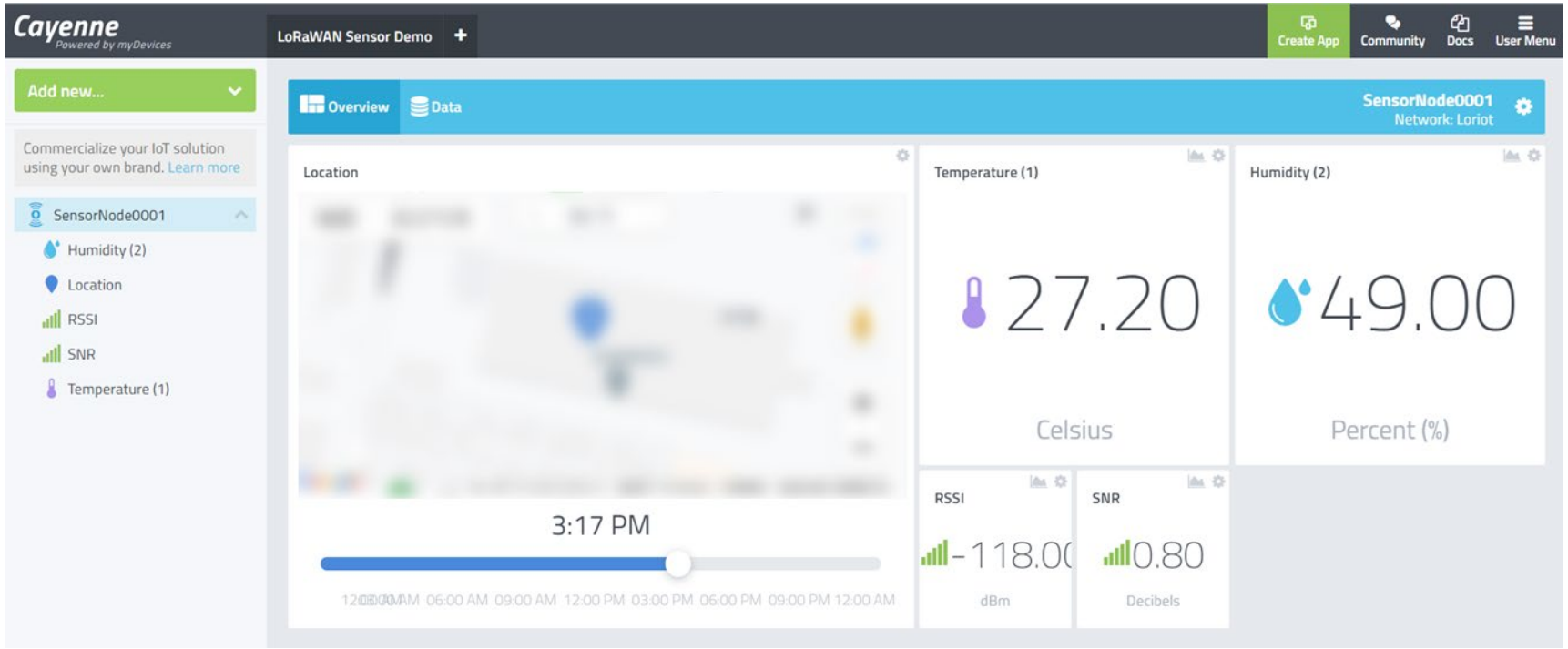
- **Set Information of device and network server**
  - Device EUI
  - Loriot information (Loriot App ID, Loriot Token)
  - Others

- **Click Add Device**
  - This button will be enabled once you enter the correct information.



Data Visualization
Display at Cayenne for LoRa®

- Values of temperature and humidity sensor will be displayed once the data is sent from the end node
- Icons for temperature and humidity sensor can be customized by menu shown when to left-click on chart and the gear wheel on the icons
- You can also check it on your smart phone



Related Videos

- **RL78 LoRaWAN® Sensor Demo Tutorial**

  https://www.renesas.com/us/en/video/rl78-lorawan-sensor-demo-tutorial

- **RL78 LoRa®-based Solution**

  https://www.renesas.com/us/en/video/rl78-lora-based-solution

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