

RA 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:

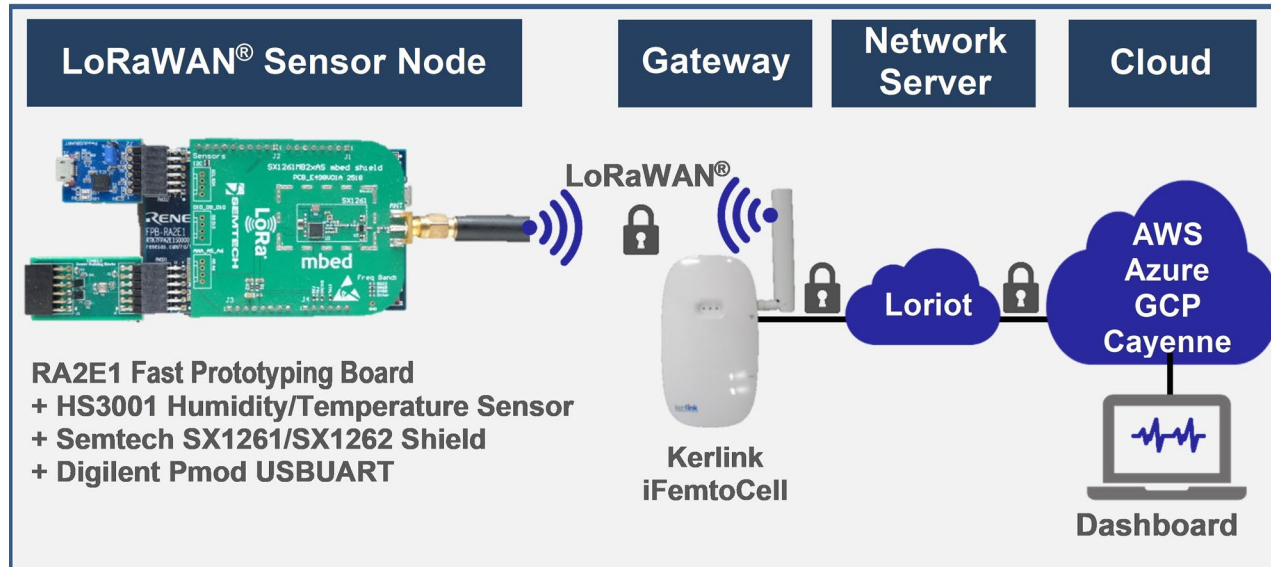
The use of wireless receivers and transmitters is restricted by international standards and domestic regulations. Wireless receivers and transmitters must therefore be used in accordance with the applicable laws and regulations of the country in which they are being used.

Contents

- **LoRaWAN[®] Features**
- **Required Equipment**
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- **LoRaWAN[®] Sensor Demo Operation**

Outline

- This tutorial shows how to setup and operate RA 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 RA2E1 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

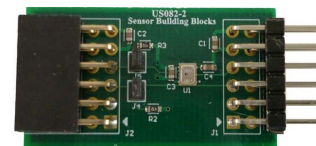
- RA2E1 Fast Prototyping Board (RTK7FPA2E1S00001BE)(<https://www.renesas.com/us/en/products/microcontrollers-microprocessors/ra-cortex-m-mcus/rtk7fpa2e1s00001be-ra2e1-fast-prototyping-board>)
- Semtech SX1261 Shield (<https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1261>) or Semtech SX1262 Shield (<https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1262>)
- 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>)
- Digilent Pmod USBUART (<https://reference.digilentinc.com/reference/pmod/pmodusbuart/start>)
- Micro USB (USB A-Micro B) Cable



RA2E1 Fast Prototyping Board
(RTK7FPA2E1S00001BE)



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

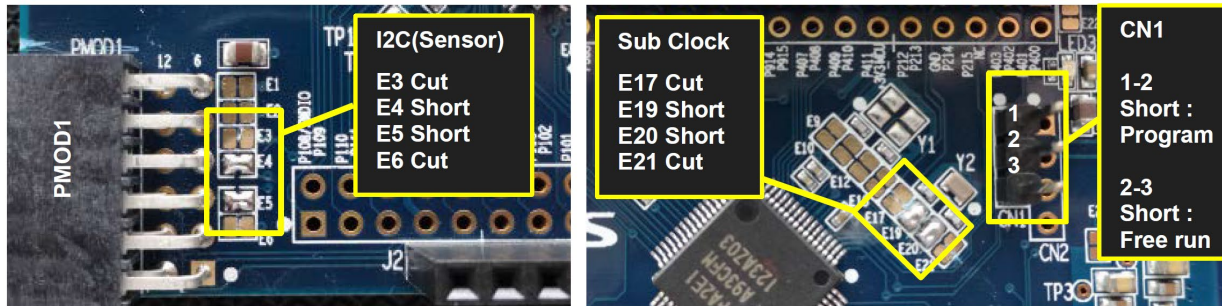
868	915	923
<ul style="list-style-type: none">• Europe• Turkey• India	<ul style="list-style-type: none">• USA• Canada	<ul style="list-style-type: none">• Australia• New-Zealand• Singapore• Argentina• Brazil• Taiwan• South Korea• Japan• Hong-Kong• Malaysia• Indonesia• Vietnam• Thailand• Philippines

Setup for LoRaWAN[®] End Node

Setup LoRaWAN® End node (1)

Hardware Setup

1) Pattern cut and short. Change of debugger setting



STEP1:

Cut E3, E6, E17, and E12. Short E4, E5, E19, and E20.

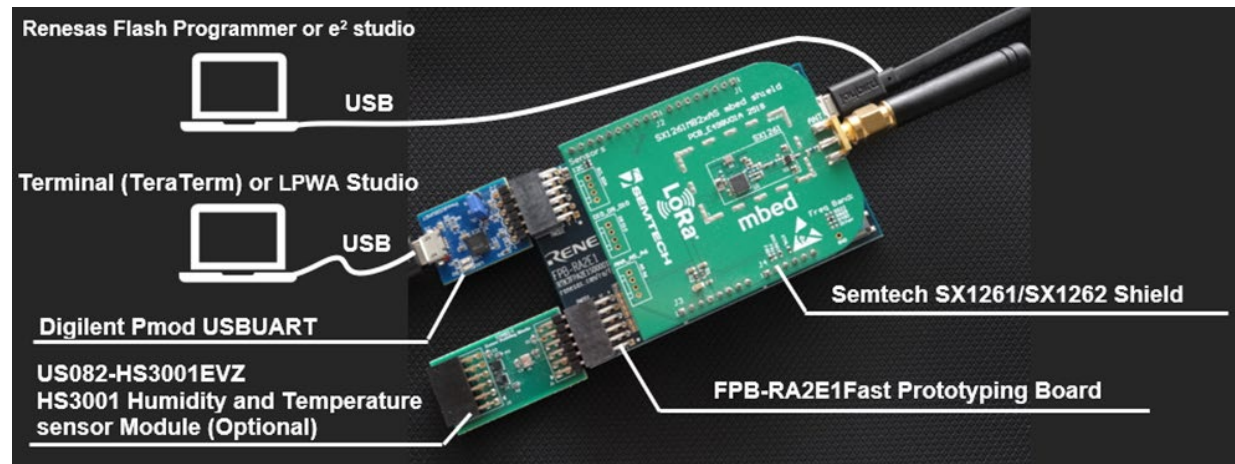
STEP2:

Plug the SX126x shield to the Arduino Uno connector, US082-HS3001EVZ to the PMOD1 connector, and the Pmod USBUART to the PMOD2 connector.

STEP3:

Short pin 1 and 2 of CN1 with jumper plug when to download the sample software with the flash programmer.
Short pin 2 and 3 of CN1 with jumper plug to make the sample software running after the reset.

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**

- RA2E1 LoRaWAN(R)-Sensor Demo Package

<https://www.renesas.com/us/en/document/scd/ra2e1-lorawan-sensor-demo-rev-210?r=1635706>

- **Flash programming to RA2E1 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

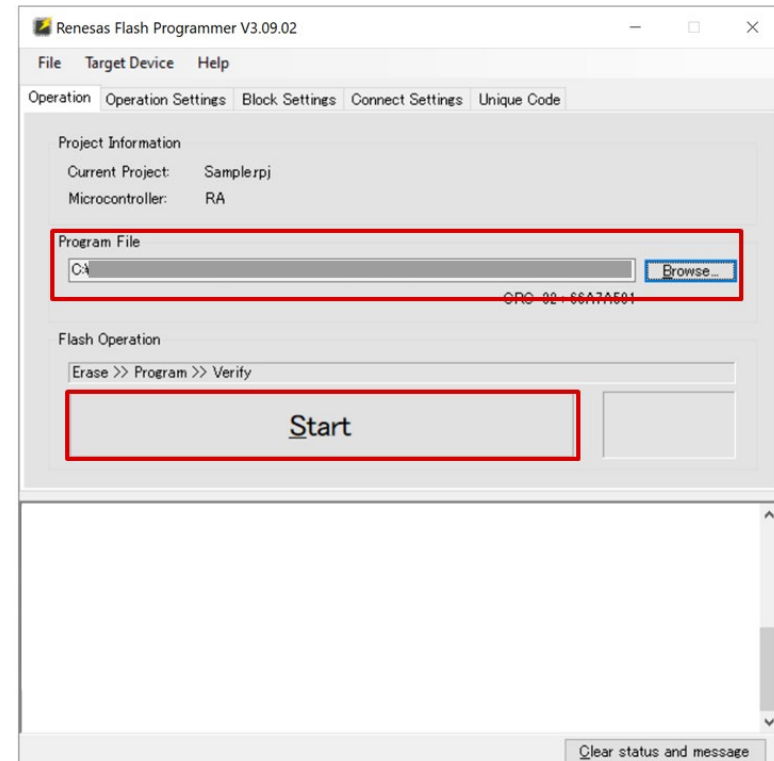
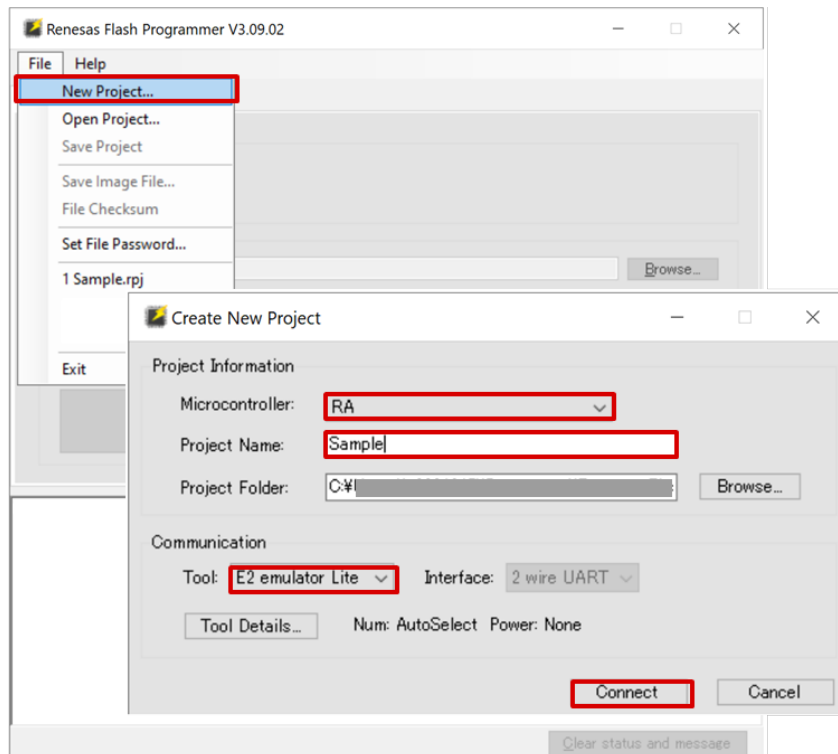
Write the following file to RA2E1 Fast Prototyping Board (Refer to next slide for more details)

`samples\project\studio\ra2e1fpb_sx126x\LoRaSensorSample\LoRaSensorSample.hex`

Setup LoRaWAN[®] End node (3)

Write LoRaWAN[®] Sensor Demo software to flash memory

1. Select **New Project**.
2. Select **RA** in Microcontroller.
3. Enter project name in Project Name.
4. Select **E2 emulator Lite** in Tool.
5. Click **Connect**.
7. Select software file (LoRaSensorSample.hex) 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)



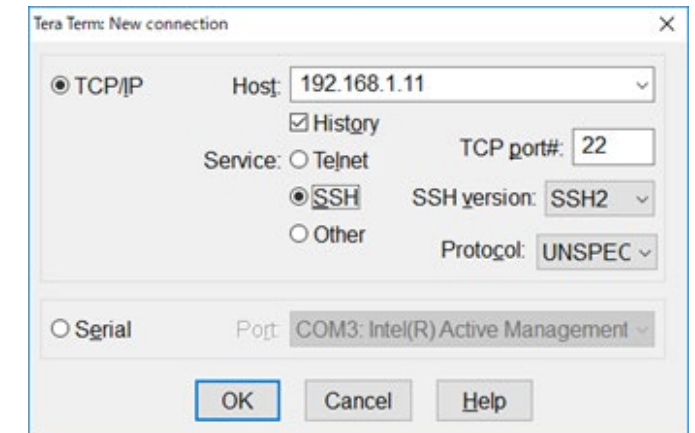
Gateway rear label

▪ 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 LORIENT Software to Kerlink LoRaWAN[®] Gateway

- **Install LORIENT software for iFemtocell to Kerlink gateway**

- Once login to the gateway, enter the following commands to install the software

```
cd /tmp
```

Change to the LORIENT server name to be used

```
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
```

- 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 NETWORK 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)

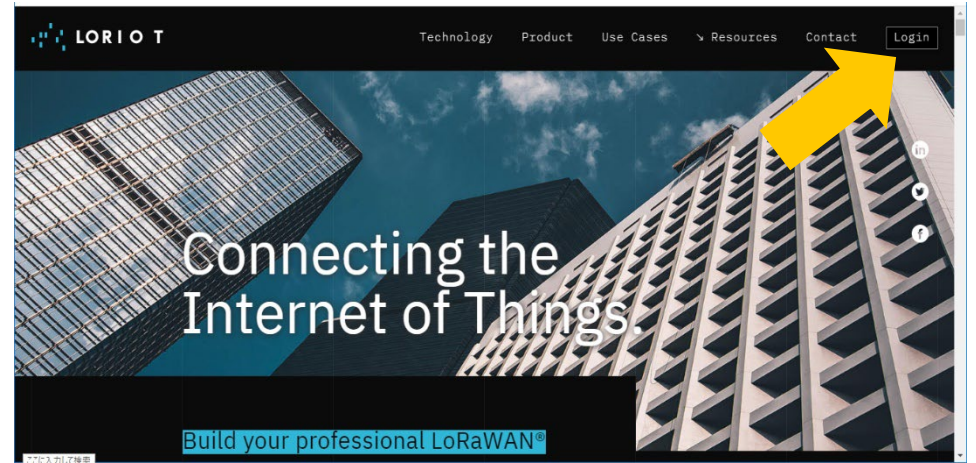
Web Browser (LORIoT)

■ 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
	EU3	Madrid, Spain		CN1	Shenzhen, China		SA1	Sao Paulo, Brazil
	UK1	London, United Kingdom		AP2	Tokyo, Japan			
	AF1	Cape Town, South Africa		AP3	Mumbai, India			

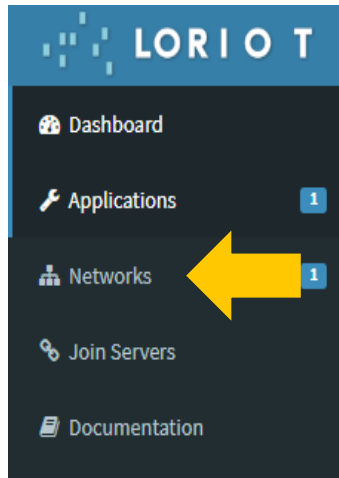
Reset password Register a new account

Setup LoRaWAN® Network Server (2)

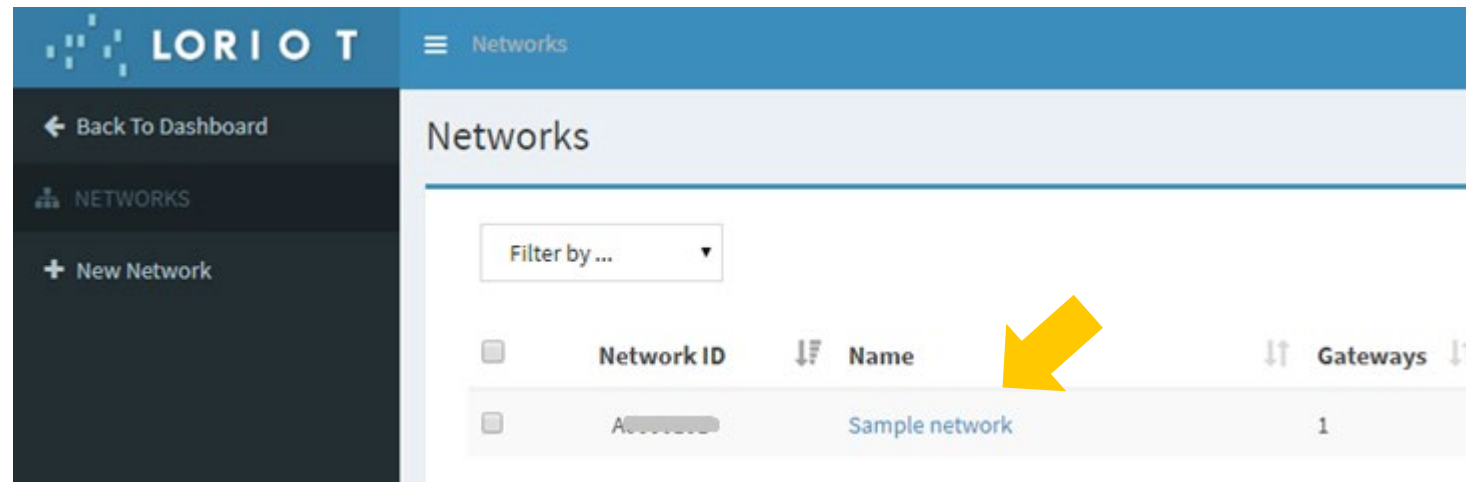
Web Browser (LORIoT)

▪ Add Gateway

- Click Dashboard→ Networks



- Click Sample network

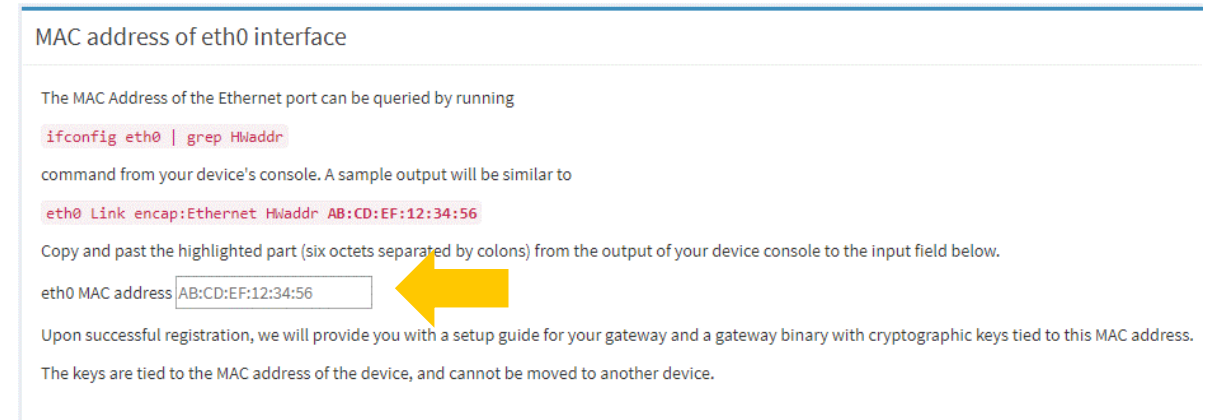
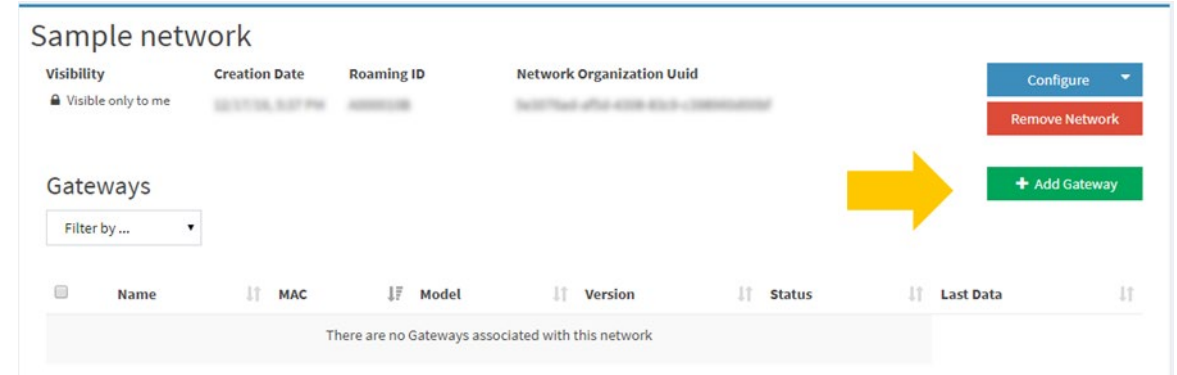


Setup LoRaWAN® Network Server (3)

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

Antennas

Region

- CN779-787
- CN470-510
- US902-928
- AU915-928
- AS923
- EU863-870
- KR920-923
- EU433
- IN865-867
- GLOBAL
- IL915
- RU864-870



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.

ID	Tx Gain	Channel Plans	
0	0	Change TX	<div style="display: flex; align-items: center;"> <div style="border: 1px solid #ccc; padding: 2px; margin-right: 5px;">EU868</div> <div style="margin-left: 20px;"> ➔ <div style="display: flex; flex-direction: column; gap: 5px;"> + Add Band - Remove Plans </div> </div> </div>

Region: EU863-870

EU868

EU868_RX2SF9

▼
✓
✕

Region: US902-928

US915_CH0_7

US915_CH0_15

US915_CH8_15

US915_CH16_23

US915_CH24_31

US915_CH32_39

US915_CH40_47

US915_CH48_55

US915_CH56_63

US915_Default

US915_ ▼
✓
✕

Region: AS923

AS923-1

AS923-1b

AS923-2

AS923-3

AS923-4

AS923- ▼
✓
✕

Restart
←

Regarding Channel Plan, see below for other regions.

Supported Frequency Plans

<https://docs.loriot.io/display/LNS/Supported+Frequency+Plans>

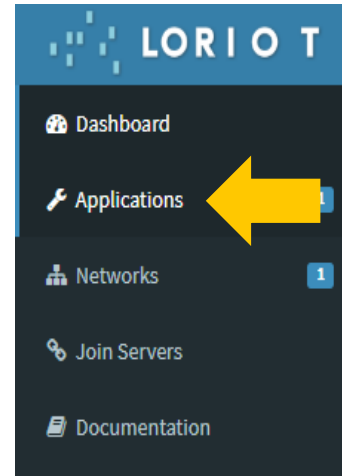
Registration of End Node to LoRaWAN[®] Network Server

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

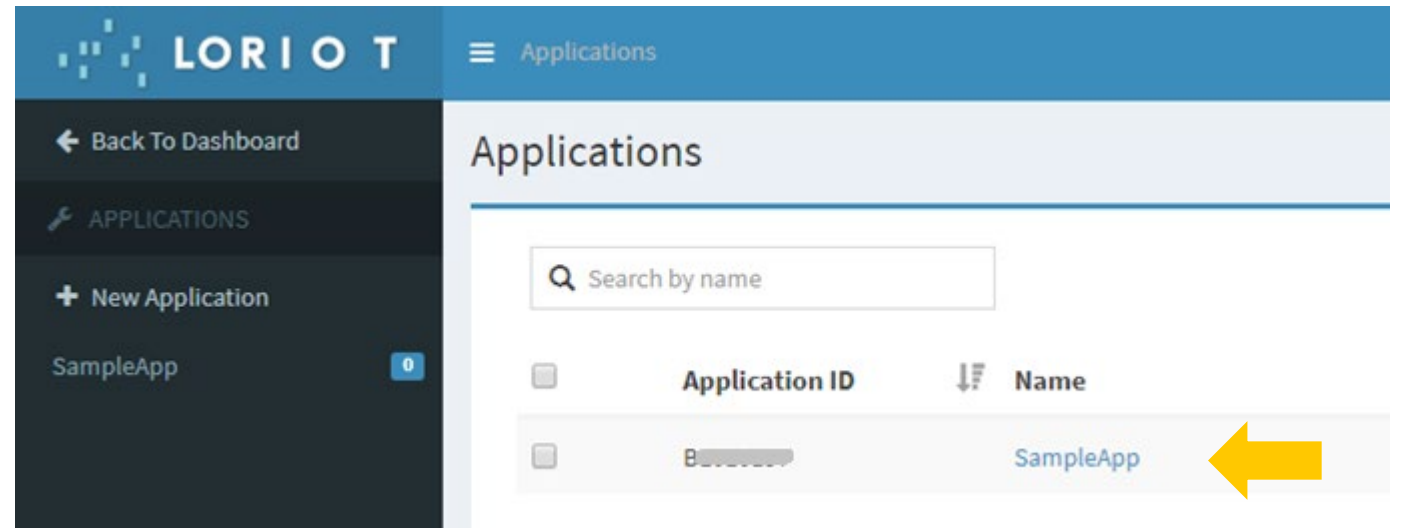
Web Browser (LORIoT)

▪ Add Device

- Click Dashboard→ Applications



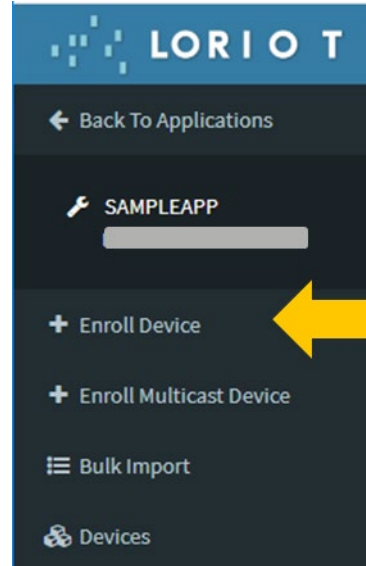
- Click Dashboard→ Applications SampleApp



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.

← Back To Applications

SAMPLEAPP

+ Enroll Device

Enroll A New Device

LoRaWAN® Version: LoRaWAN® 1.0.x

Enrollment Process: OTAA

Location: DISABLED ENABLED

You can define coordinates for static devices enabling this option.

Details

Title:

Description:

Device EUI: (DevEUI (16 hex digits))

Join EUI: (JoinEUI (16 hex digits))

Application Key: (APPKEY (32 hex digits))

Device Profile:

Create Another

▪ Enter 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= 5555555555555555AAAAAAAAAAAAAAAAAA
(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.

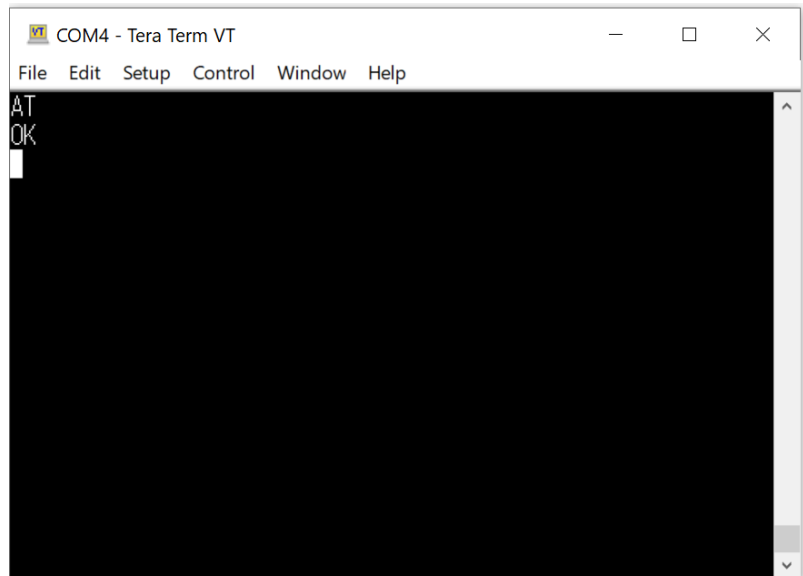
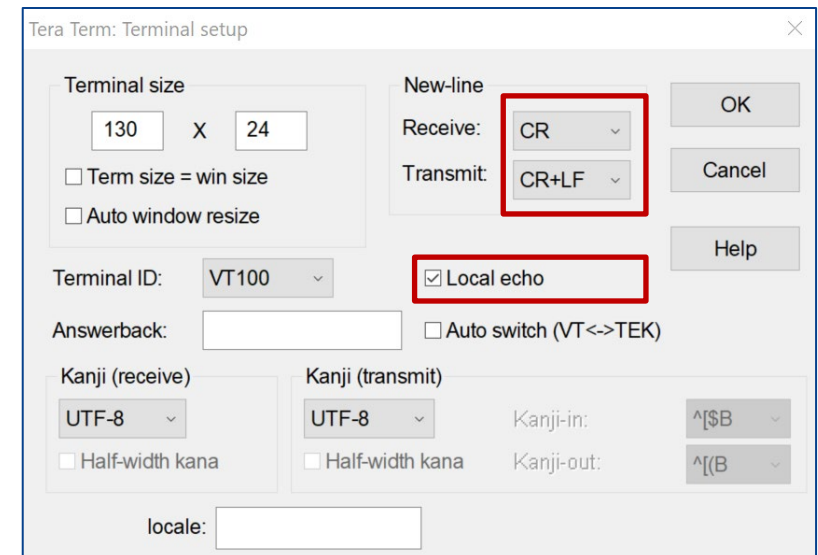
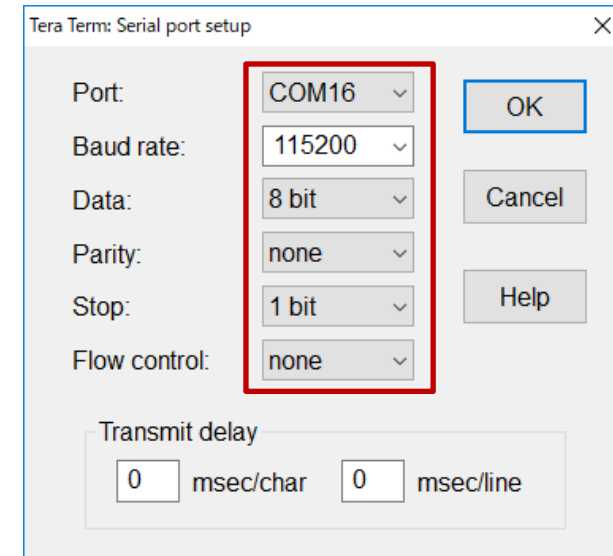
LoRaWAN[®] Sensor Demo Operation Method

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=XXXXXXXXXXXXXXXX // DevEUI
AT+APPEUI=0123456701234567 // AppEUI
AT+APPKEY=5555555555555555AAAAAAAAAAAAAAAA // 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

```
COM4 - Tera Term VT
File Edit Setup Control Window Help
AT+REGION=6
OK
AT+CLASS=0
OK
AT+ACTMODE=1
OK
AT+DEVEUI=
OK
AT+APPEUI=0123456701234567
OK
AT+APPKEY=5555555555555555AAAAAAAAAAAAAAAA
OK
AT+SENSOR=60,60,1
OK
AT+SAVE
OK
AT+RESET=1
OK
```

```
COM4 - Tera Term VT
File Edit Setup Control Window Help
*SENSOR: JOIN
*SENSOR: JOIN ACCEPTED
*SENSOR: SEND FFFFFFFFFFFFFFFF,14,1
*SENSOR: SEND ACK_RECEIVED
*SENSOR: MEASUREMENT START
*SENSOR: SEND 016869026700F3,1,0
*SENSOR: SEND OK
*SENSOR: MEASUREMENT START
*SENSOR: SEND 016865026700F8,1,0
*SENSOR: SEND OK
*SENSOR: MEASUREMENT START
*SENSOR: SEND 016862026700FA,1,0
*SENSOR: SEND OK
*SENSOR: MEASUREMENT START
*SENSOR: SEND 016860026700FC,1,0
*SENSOR: SEND OK
*SENSOR: MEASUREMENT START
*SENSOR: SEND 01685F026700FD,1,0
*SENSOR: SEND OK
*SENSOR: MEASUREMENT START
```

Data Visualization

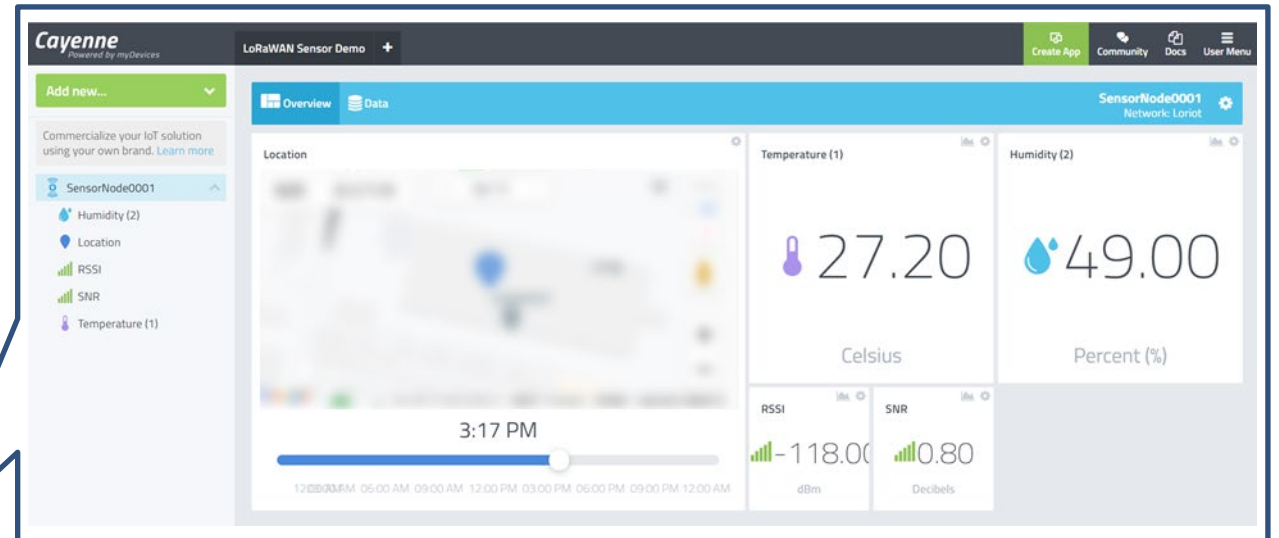
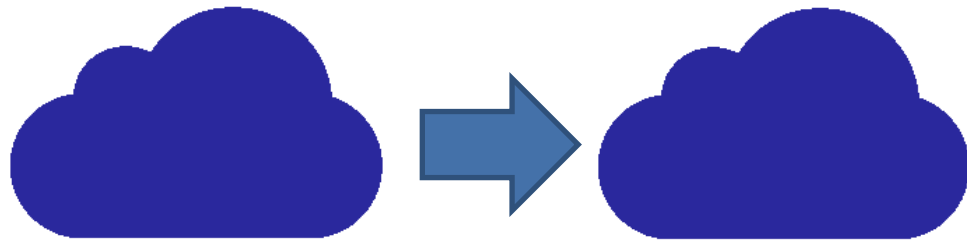
Cayenne for LoRa®

- 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

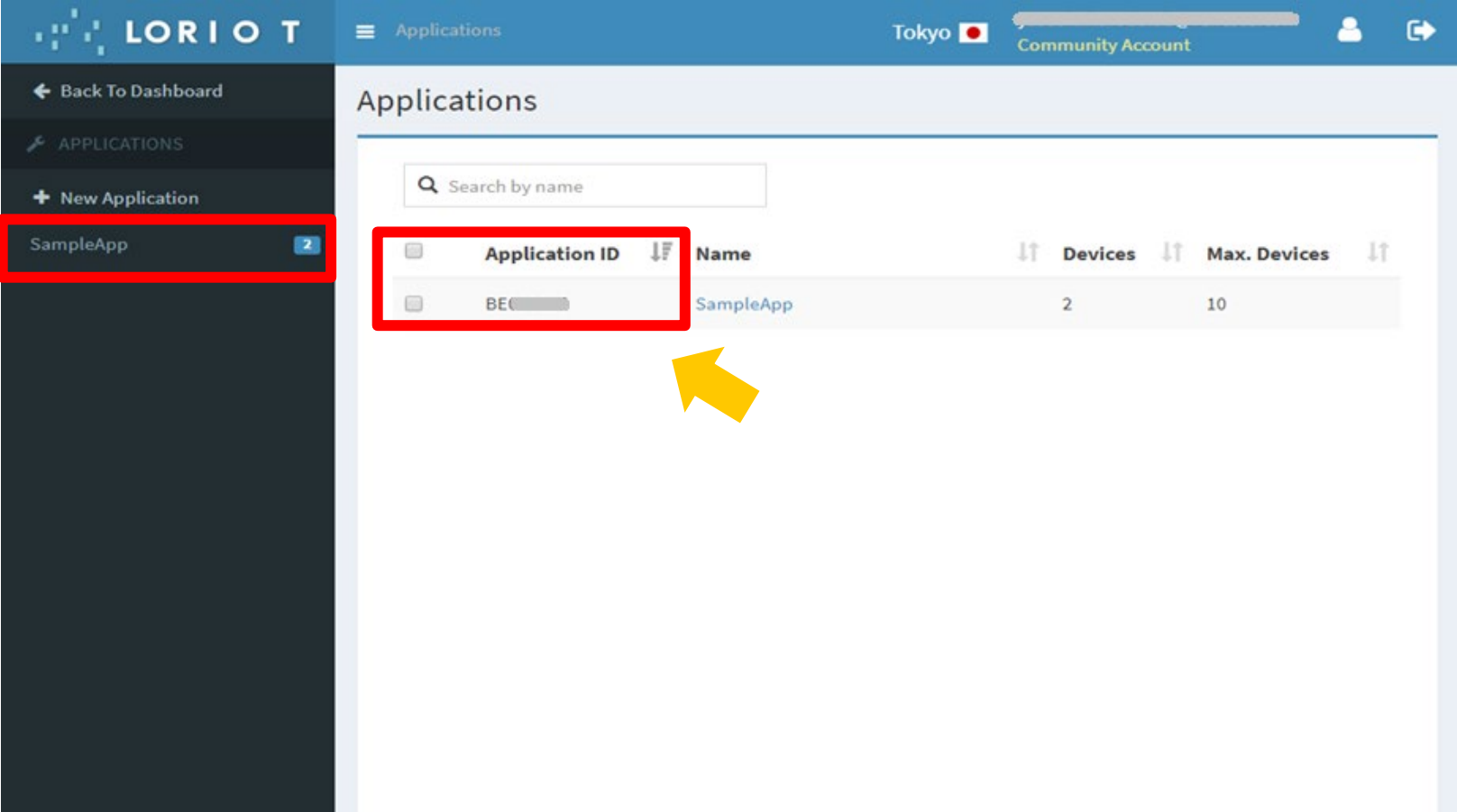
The screenshot displays the LORIO T web interface for configuring the output of a network server. The breadcrumb navigation shows 'Applications > SampleApp > Output'. The left sidebar contains a menu with 'Output' highlighted in red. The main content area shows a grid of output mechanisms, with 'Cayenne myDevices Cayenne' highlighted in red. A modal dialog is open, showing 'Add Output' and 'Cancel' buttons, with a yellow arrow pointing to the 'Add Output' button.

Mechanism	Source
MQTT	LORIO.io
WebSocket	LORIO.io
TLS Socket	LORIO.io
HTTP://	LORIO.io
HTTPS://	LORIO.io
HTTP Push	LORIO.io
PubNub	3rd party
Amazon AWS IoT	3rd party
Microsoft Azure	3rd party
Azure IoT Hub	3rd party
IBM Cloud	3rd party
Iron.io IronMQ v1	3rd party
Iron.io IronMQ v3	3rd party
Cayenne myDevices Cayenne	3rd party
Google IoT Core	3rd party
AllThingsTalk	3rd party
CoAP	LORIO.io
CoAP Push	LORIO.io
SOFTWARE AG Cumulocity	3rd party

Data Visualization

Get Network Server Information (1)

- Remember Application ID for setting of Cayenne later



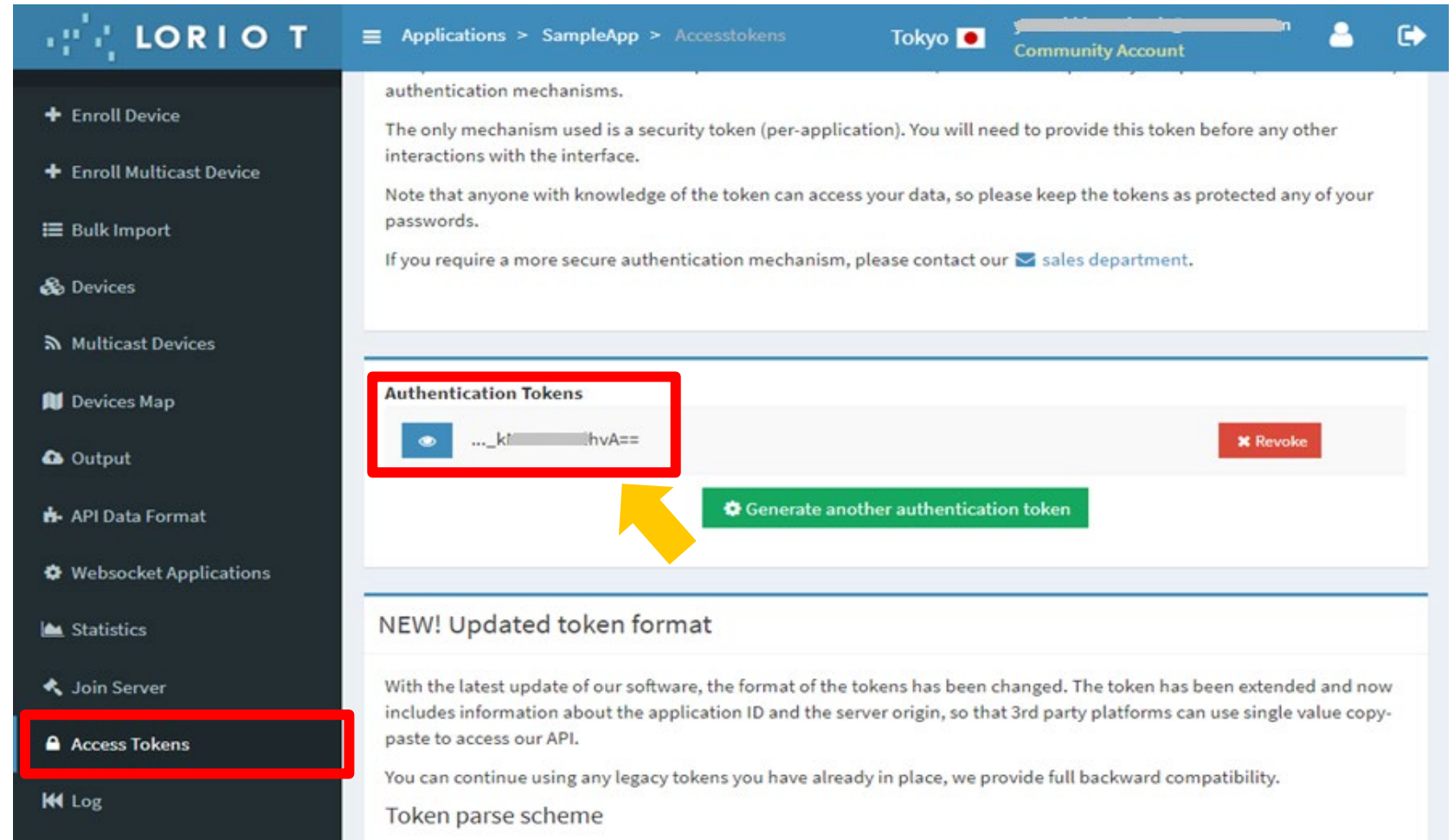
The screenshot shows the LORION web interface. The left sidebar contains navigation options: 'Back To Dashboard', 'APPLICATIONS', 'New Application', and 'SampleApp' (highlighted with a red box and a '2' badge). The main content area is titled 'Applications' and features a search bar and a table. The table has columns for 'Application ID', 'Name', 'Devices', and 'Max. Devices'. The first row is highlighted with a red box and contains the values 'BE...', 'SampleApp', '2', and '10'. A yellow arrow points to the 'Application ID' cell.

Application ID	Name	Devices	Max. Devices
BE...	SampleApp	2	10

Data Visualization

Get Network Server Information (2)

- Remember Token for setting of Cayenne later



The screenshot shows the LORION web interface. The left sidebar contains a menu with the following items: Enroll Device, Enroll Multicast Device, Bulk Import, Devices, Multicast Devices, Devices Map, Output, API Data Format, Websocket Applications, Statistics, Join Server, Access Tokens (highlighted with a red box), and Log. The main content area is titled 'Applications > SampleApp > Accesstokens'. It contains a section for 'Authentication Tokens' with a table listing a token value (partially obscured by a red box and a yellow arrow) and a 'Revoke' button. Below the table is a green button labeled 'Generate another authentication token'. A 'NEW! Updated token format' section is also visible, providing information about the latest update to the token format.

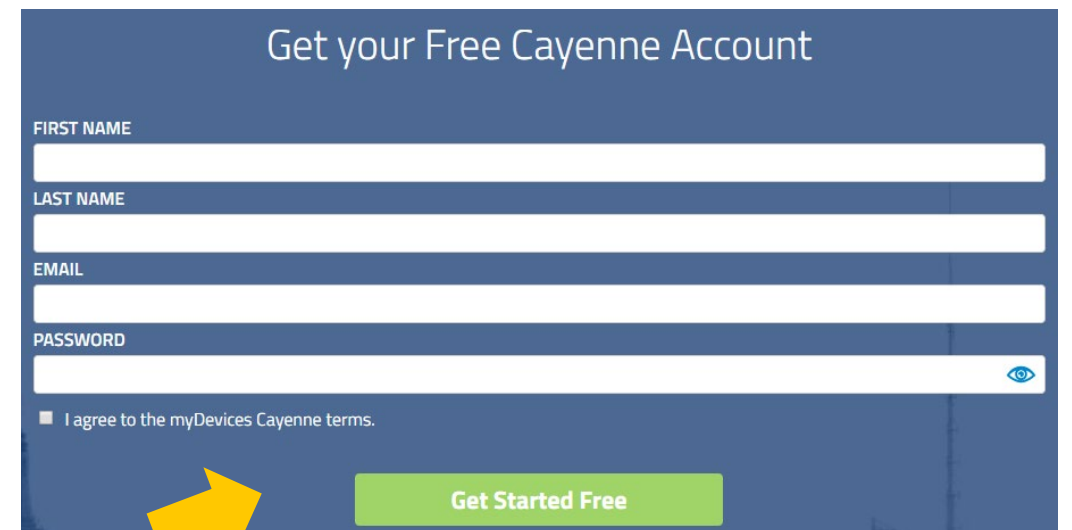
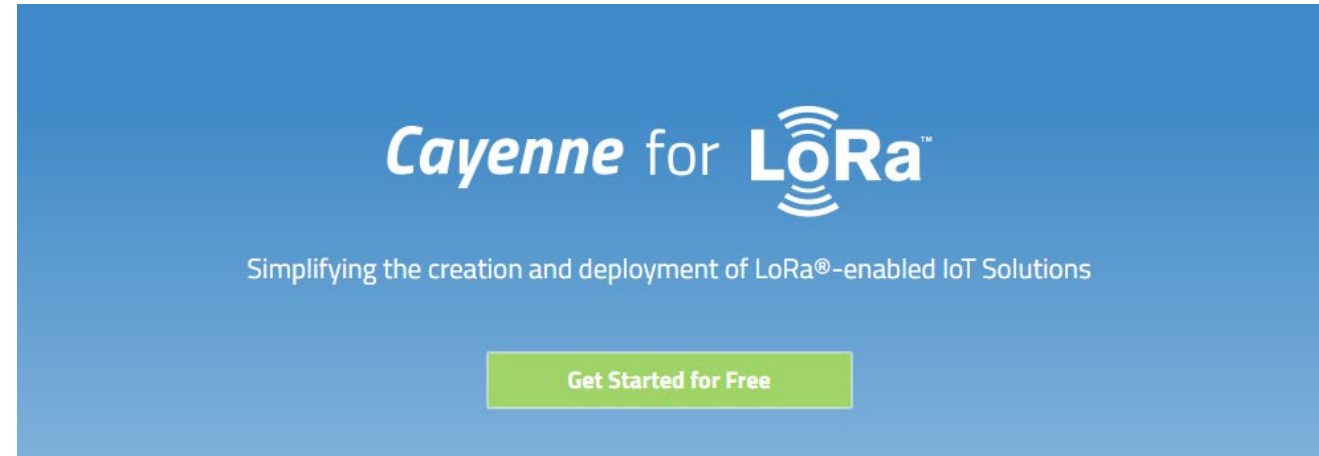
Data Visualization

Create Account of Cayenne for LoRa®

- Access to Cayenne for LoRa®

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

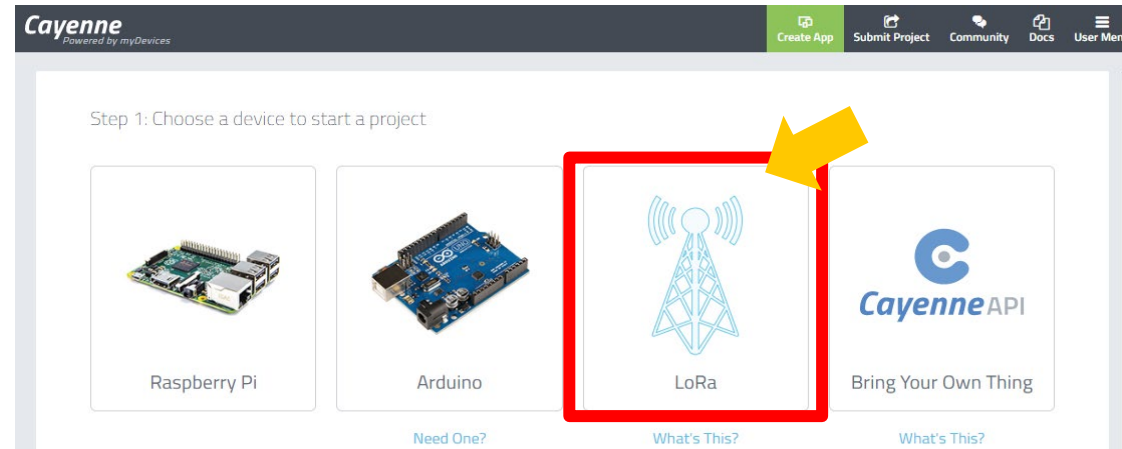
- Create Account

A registration form titled 'Get your Free Cayenne Account'. It has a dark blue background. The form contains four input fields: 'FIRST NAME', 'LAST NAME', 'EMAIL', and 'PASSWORD'. The 'PASSWORD' field has a small eye icon on the right. Below the fields is a checkbox with the text 'I agree to the myDevices Cayenne terms.' At the bottom right is a green button with the text 'Get Started Free'. A yellow arrow points to the bottom left corner of the form.

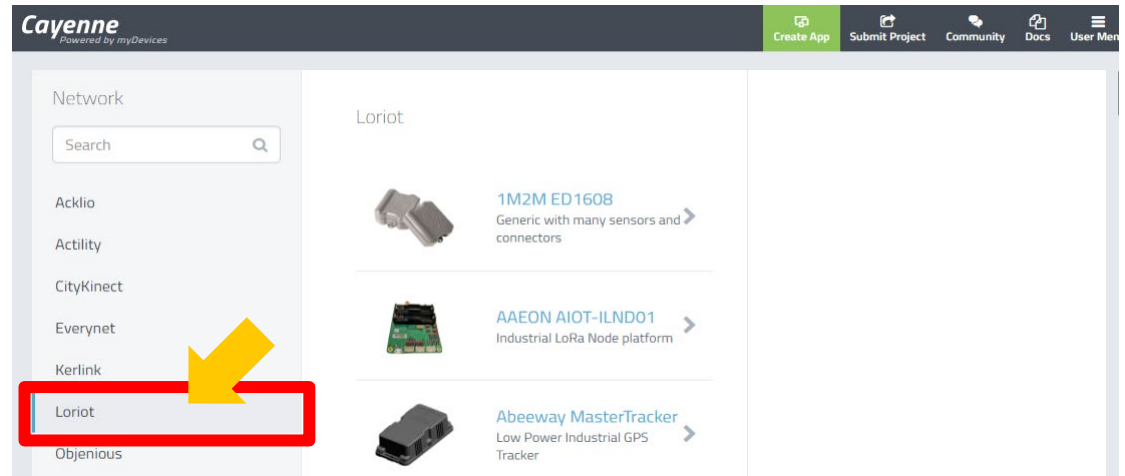
Data Visualization

Setting Cayenne for LoRa® (1)

- Login to Cayenne
- Click “LoRa®”



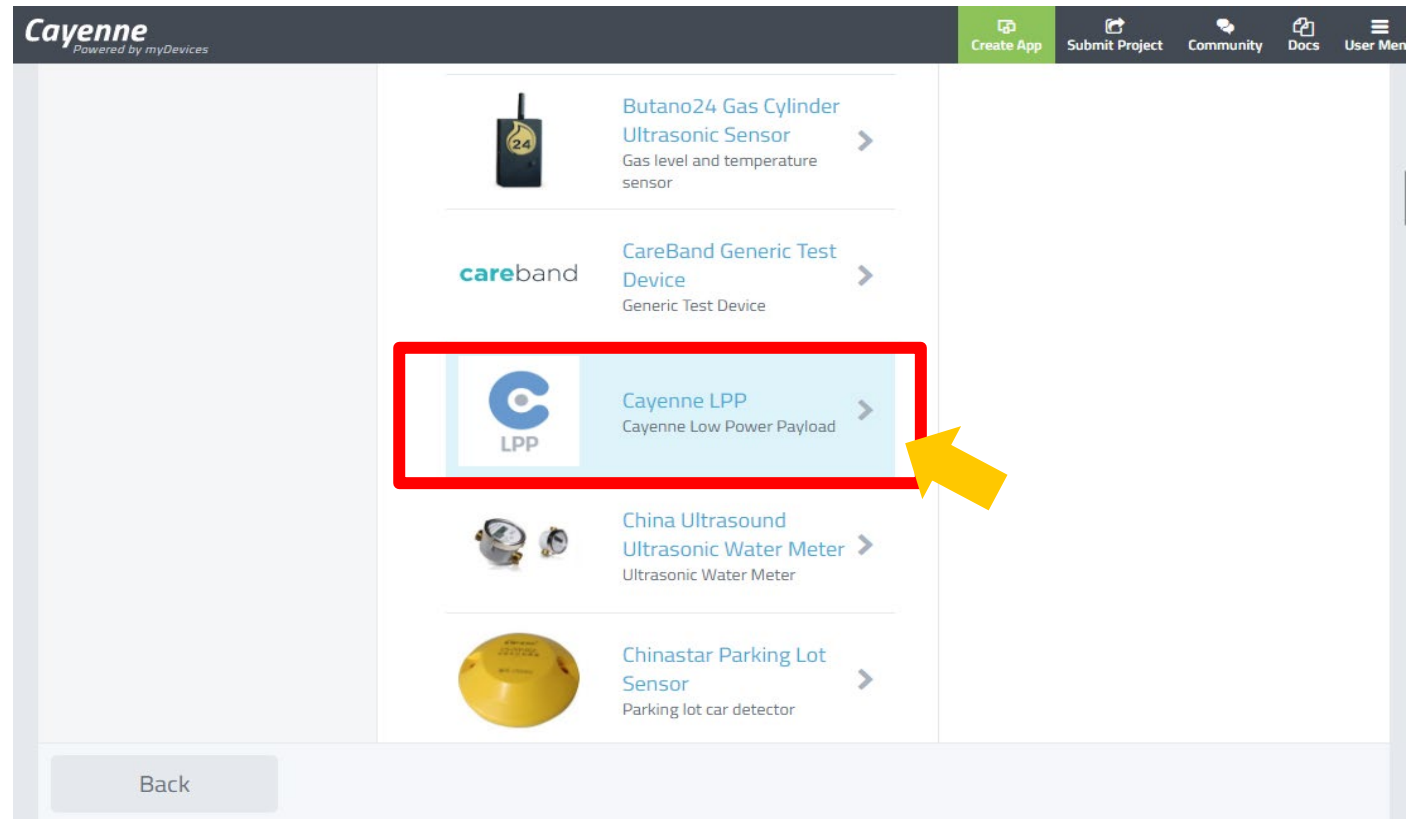
- Click “Loriot”



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
 - Lorient information (Lorient App ID, Lorient Token)
 - Others
- **Click Add Device**
 - This button will be enabled once you enter the correct information.

The screenshot shows the 'Enter Settings' page for a Cayenne LPP device. The page title is 'Enter Settings' and the device name is 'Cayenne Cayenne LPP' with the subtitle 'Cayenne Low Power Payload'. The page is divided into several sections: 'Name' (SensorDemo0001), 'DevEUI' (input field), 'Activation Mode' (Already Registered), 'Lorient Server' (ap2.loriot.io (Asia-Pacific / Tokyo, Japan)), 'Lorient App ID' (input field), 'Lorient Token' (input field), 'Tracking' (Location: This device doesn't move), and an 'Add device' button. A red box highlights the 'Name', 'DevEUI', 'Lorient App ID', and 'Lorient Token' fields. Three blue callout boxes provide instructions: 'DevEUI is the EUI-64 address of the end node' points to the DevEUI field, 'Select server you use' points to the Lorient Server dropdown, and 'App ID and Token are values from Lorient Network Server' points to the Lorient App ID and Lorient Token fields. A yellow arrow points to the 'Add device' button.

DevEUI is the EUI-64 address of the end node

Select server you use

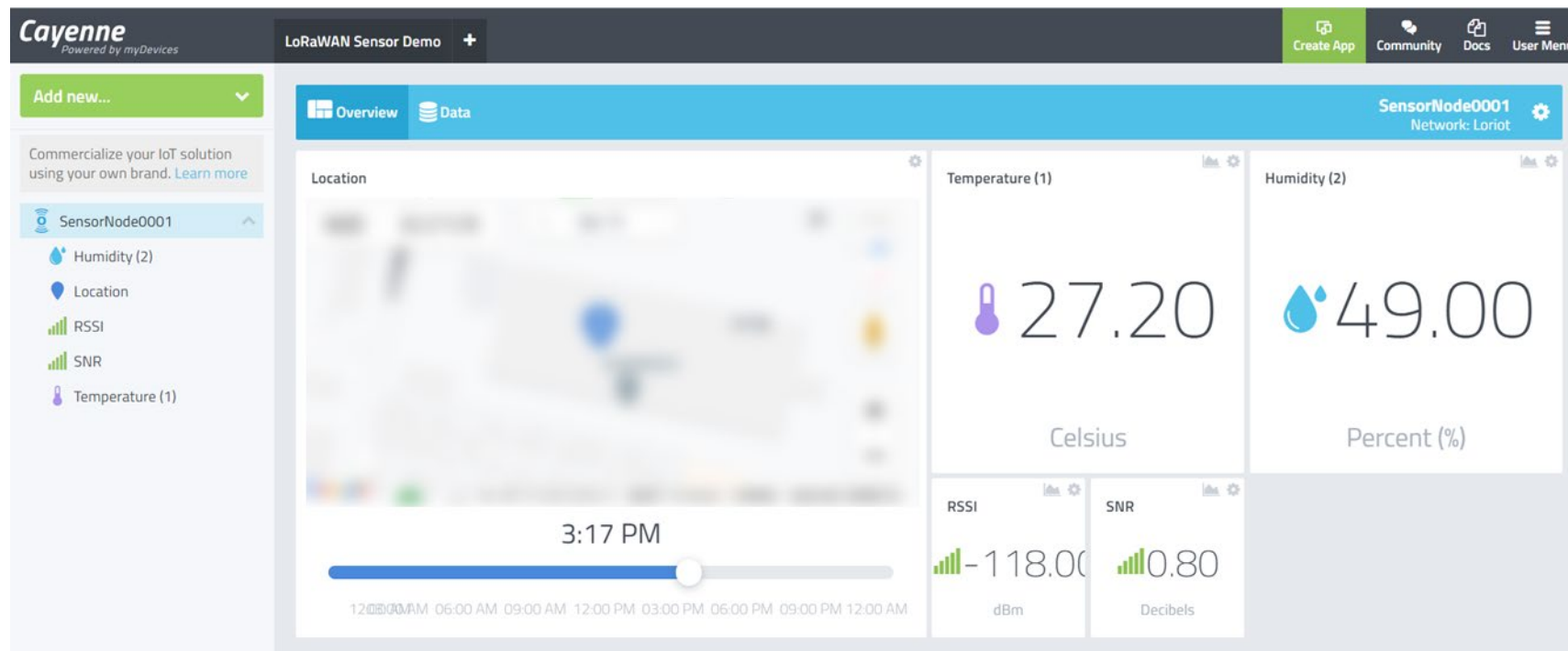
App ID and Token are values from Lorient Network Server

Add device

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

- **RA LoRaWAN® Sensor Demo Tutorial**

<https://www.renesas.com/us/en/video/ra-lorawan-sensor-demo-tutorial>

- **RA LoRa® Solution**

<https://www.renesas.com/us/en/video/ra-lora-based-solution>

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