

IoT Dev-Kit for LoRa

QuickStartGuide

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IMST GmbH

Carl-Friedrich-Gauss-Str. 2-4

D-47475 Kamp-Lintfort



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Aim of this Document

Aim of this document is to give some quick start instructions how to start working with the WiMOD IoT DevKit for LoRa™.

Confidentiality Note

This document has to be treated confidentially. Its content must not be published, duplicated or passed to third parties without our express permission.

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1 Evaluation Kit - Important Notice

IMST GmbH provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by IMST GmbH to be finished end-product fit for general consumer use. Persons handling the product must have electronics training and observe good engineering practice standards. As such the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing related protective considerations, including product safety and environmental measures typically found in the products that incorporate such semiconductor components or circuit boards. This evaluation kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, FCC, CE or UL and therefore may not meet the technical requirements of these directives or other related documents.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further the user indemnifies IMST from all claims arising from the handling or use of the goods. Due to the open construction of the product, it's the user responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES.

2 Introduction

This is a brief step-by-step guide for setting up our "IoT DevKit for LoRa™" that contains of the following components:

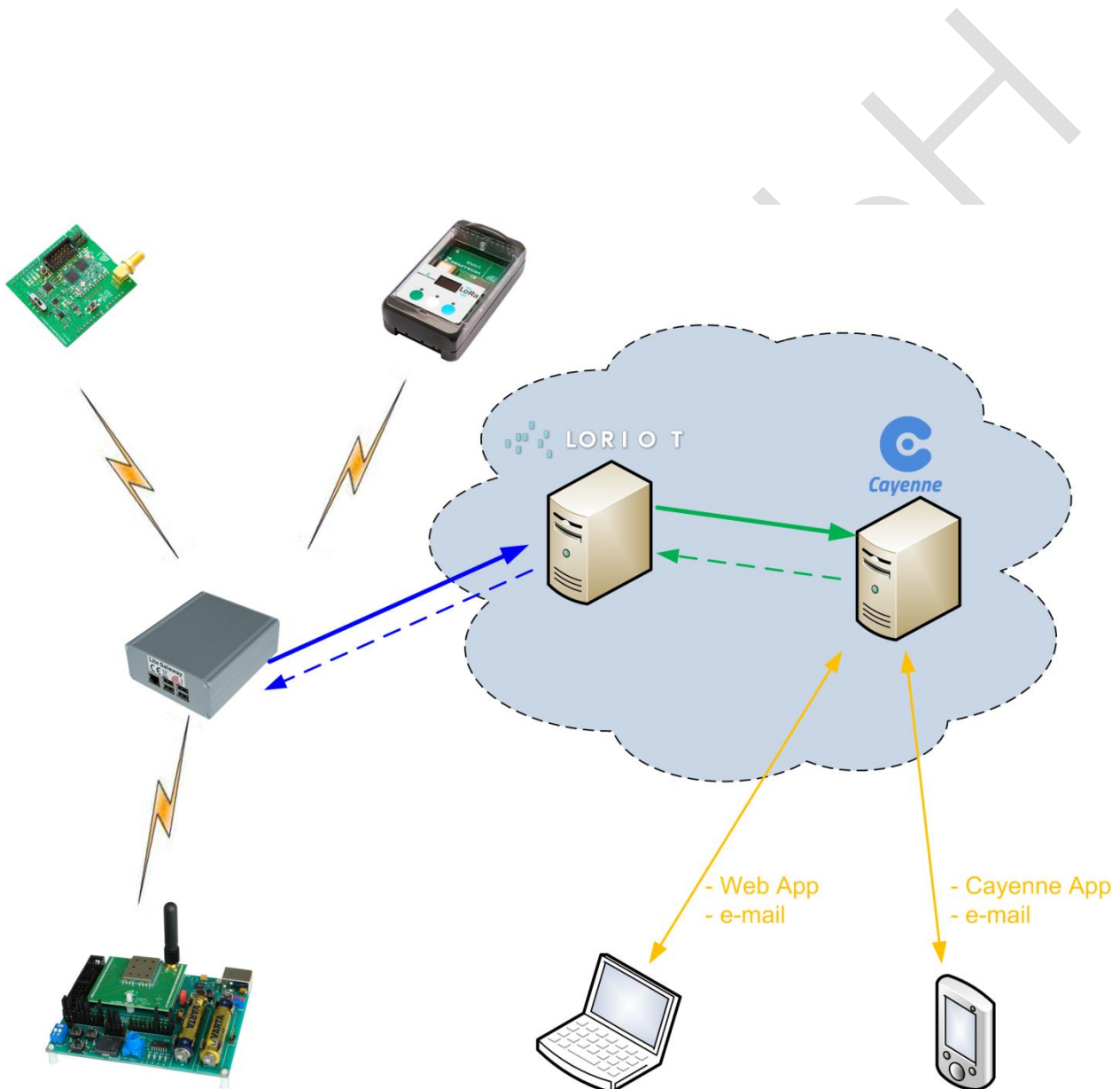
Nbr	Item	Comment
1	LoRa Lite Gateway (iC880A))	The LGW is a full LoRaWAN Gateway supporting up to 10 receive channels in parallel. It contains the iC880A.
1	Demo-Board + iM880B	This is one half of a SK-iM880B Starter Kit (SK-iM880B). It consists of an Adapter-Board with a soldered iM880B plugged on to a Demo-Board
1	Mote II (iM881A)	The Mote II is a demonstration platform including iM881A
1	WSA01	WiMOD Arduino Shield with iM880B
3	868MHz antennas	For LGW, the Demo-Board and the WSA01
1	Power Plug Adapter	For LGW
2	USB cables	For Demo-Board and Mote II
1	Programming Adapter	For programming the iM880B of the Demo Board via the SWD interface. (An external SWD Probe is required.)
1	CD / USB Stick	Includes all tools and the corresponding documentation



For further information how to work with the Lorient.io and the myDevices / Cayenne server please visit the corresponding web sides. Further information about the end devices can be found on <https://wireless-solutions.de/products/long-range-radio.html>.

2.1 General Idea / Message Flow

The following picture shows the message flow of LoRaWAN packets. The packets generated by a LoRaWAN End Device are received by the Lite Gateway, and could be forwarded e.g. to the Lorient LoRaWAN network server. From there the information is sent to the myDevices / Cayenne server, where the user can see this data. Please note that due to the free of charge service only uplink messages can be sent. The free of charge Lorient account does not allow downlink messages. Please contact Lorient for further details.



3 Required Software for Setting-up the IoT Dev-Kit

Besides an access to the internet the following tools must be available:

- IMST LoRaWAN EndNode Studio (V0.36.0 or newer) to operate the Demo-Board plus iM880B radio module
(<https://wireless-solutions.de/products/radiomodules/im880b-l.html>)
- Arduino IDE 1.8.2 (or newer) to operate WiMOD Shield for Arduino (WSA01)
(<http://arduino.org/>)
- IMST WiMOD ArduinoLib V1.3 (or newer) WiMOD Shield for Arduino (WSA01)
(https://wireless-solutions.de/products/starterkits/wimod_shield_for_arduino.html)
- Semtech LoRaMoteConfig Tool V1.6.RC4 (or newer) to operate the "Mote II"
(https://semtech.force.com/lora/LC_Resources)
- Arduino Due Board, or any other Arduino board that is compatible to UNO R3 layout. An Arduino board that supports additional UART interfaces is recommended.

4 Step-by-Step Guide: Setting up an IoT Dev-Kit

The following steps have to be done in order to "connect" the kit to the loriot.io and [myDevices.com](https://mydevices.com) / [Cayenne](https://cayenne.io) services.

4.1 Overview

Top Level Steps:

- [Create an Account @ Loriot.io](#)
- [Register your Gateway @ Loriot.io](#)
- [Power up your Gateway](#)
- [Setup a Sample Application @ Loriot](#)
 - Loriot creates a Sample App ID
 - [Setup the Network Application Parameters @ Loriot.io](#)
 - Loriot creates a Security Token
- [Create an Account @ myDevices Cayenne](#)
 - Select the Technology (LoRa) and End Device Hardware (Mote II, Demobaord+iM880B, Arduino Shield)
- [Configure Settings for this End Device @ myDevices Cayenne](#)
 - DevEUI of the end device
 - Name of Loriot Server
 - Loriot Sample App ID
 - Loriot Security Token
- [Device Setup - Add \(enroll\) a new Device @ Loriot.io](#)
 - Enter the DevEUI of the end device @ Loriot.io
 - Loriot creates DevAddr, NwkSKey, AppSKey, AppEUI for this end device
- Power up the end device ([Mote II](#), [Demobaord+iM880B](#), [Arduino Shield](#))
 - Configure the parameters DevAddr, NwkSKey, AppSKey, AppEUI within the end device
 - Activate the end device (ABP or OTAA)
 - Send data from the end device
- Data should be visible @ Loriot and myDevices / Cayenne

4.1.1 Create an Account @ Lorient.io

- Create a special Email address for the kit if you want. Please refer to 6.1
- Go to the <https://loriot.io> website and register this account.
- You will receive an Email from Lorient.io
- Click on the activation link in order to activate this account
- The result will look like this:

The screenshot shows the Lorient.io dashboard with the following sections:

- account information:** Email field, Name: Demo User IMST IoT Kit, and a Logout button.
- tier COMMUNITY NETWORK:** Welcome to LORRIOT.io Community Network! You are now part of a world-wide ecosystem of LoRaWAN developers. Your devices can use any community gateway to reach our network. As a reward for sharing your gateway, we provide you one Free Network Application.
- COMMUNITY NETWORK features:**
 - No account expiration
 - Roaming among all community gateways
 - [OpenLoRa Forum](#) support
 - One Free Network Application
- News:**
 - 18th July 2017 16:00 **IMPORTANT**: New version of the gateway binaries will be deployed on Thursday, 20th of July. No server downtime is expected. The release will address model-specific issues, it will improve installers for MultiTech gateways and the startup scripts, correct parsing for V2 gateway channel plans, and improve compatibility with Embit gateway.
 - 10th July 2017 13:00 **UPDATE**: We have a **fresh new user interface** ready for you. You will need to login separately into this interface, but can use both the current and the new in parallel. The old user interface will be sunset by October 2017. The release notes for the last update are now also available.
- Gateways** (only last 10 shown): A table with columns Location, Model, MAC, Version, and Last data. It shows "No gateways registered. Start by registering your gateway."
- Applications** (only last 10 shown): A table with columns Name, AppID, and Devices. It shows one application: SampleApp, BE-7A-0C-0F, 0.

4.1.2 Register your Gateway @ Lorient.io

Register the LoRa Lite Gateway with its MAC address on the loriot.io website.

- Click on the "registering your gateway" link
- Select "Raspberry Pi B" as platform
- Make sure to use the options "Radio front-end = IC880A" and "BUS = SPI"

Gateway Registration

Requirements and services

To register a gateway with our network, you need to provide some limited information about your gateway.


This information is used to uniquely identify your gateway in the network.

Upon registration, you will receive

- a download link to a gateway binary for your platform
- a set of cryptographic keys that will allow your gateway to participate in the network
- a guide on how to deploy the binary on your gateway

What is your base platform?

For more information on the gateway models, see our [gateway catalog](#)



Radio front-end

Bus

Raspberry Pi can be turned into a universal, inexpensive base for a LoRa gateway - for either development or real deployment.

Several USB and SPI attached concentrators are supported.

- Enter the MAC-Address of the device. Please refer to 6.2

MAC address of eth0 interface

The MAC Address of the Ethernet port can be queried by running

```
ifconfig eth0 | grep HWaddr
```

command from your device's console. A sample output will be similar to

```
eth0    Link encap:Ethernet HWaddr AB:CD:EF:12:34:56
```

Copy and past the highlighted part (six octets separated by colons) from the output of your device console to the input field below.

eth0 MAC address

Upon successful registration, we will provide you with a setup guide for your gateway and a gateway binary with cryptographic keys tied to this MAC address.

The keys are tied to the MAC address of the device, and cannot be moved to another device.

- Enter your (initial) postal address of the gateway.

Gateway location

To provide all users with a reasonable view of the coverage of the network, please provide the address at which the gateway will be placed.

When displayed to other users, the location will be offset by a random value to protect your privacy.

Country	<input type="text" value="Germany"/>
Address	<input type="text" value="Carl-Friedrich-Gauss-Str. 2"/>
ZIP Code	<input type="text" value="47475"/>
City	<input type="text" value="Kamp-Lintfort"/>

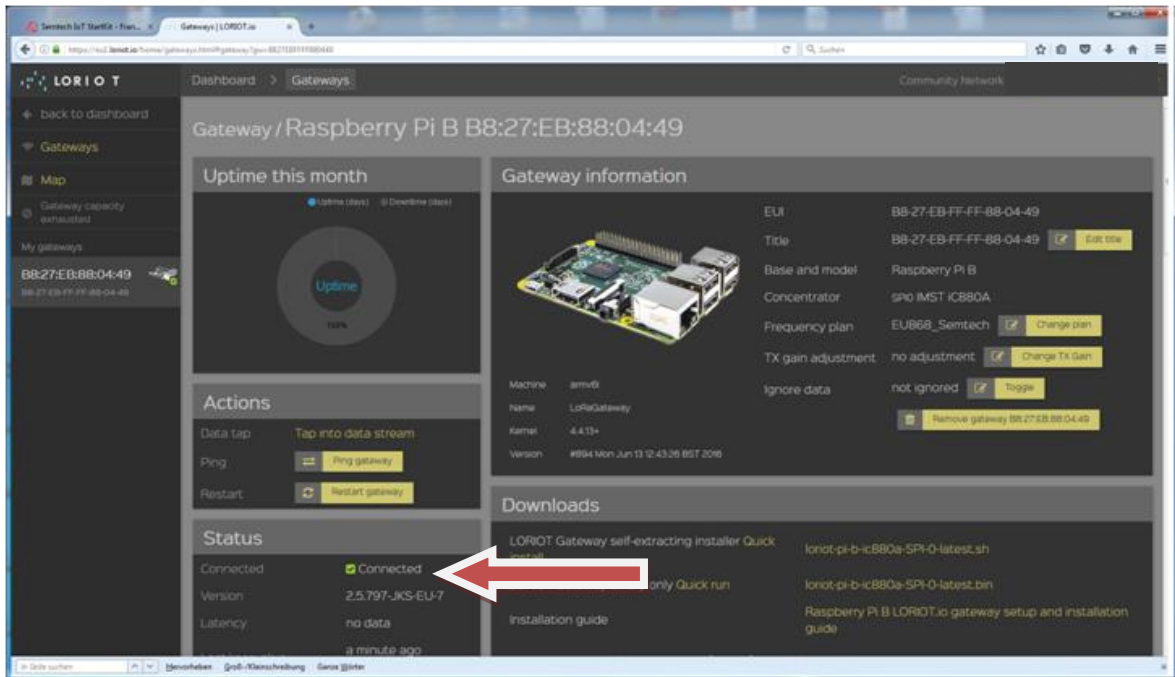
- Finish the gateway registration process by pressing the "Register Raspberry Pi B gateway" button

4.1.3 Power up your Gateway

- Connect the antenna to the LGW, then connect the LGW with an Ethernet cable to the internet and power it up.



- By default the Lite Gateway is configured to use DHCP to obtain a valid IP configuration.
- On delivery the system will boot-up **without** starting any of the pre-installed LoRa (client) packages. The user has to choose one and activate it manually.
- For a detailed information, please refer to the LGW QuickStartGuide at <https://wireless-solutions.de/products/long-range-radio/lora-lite-gateway.html> under "General Information"
- Wait until the gateway status on the website changes to "connected".

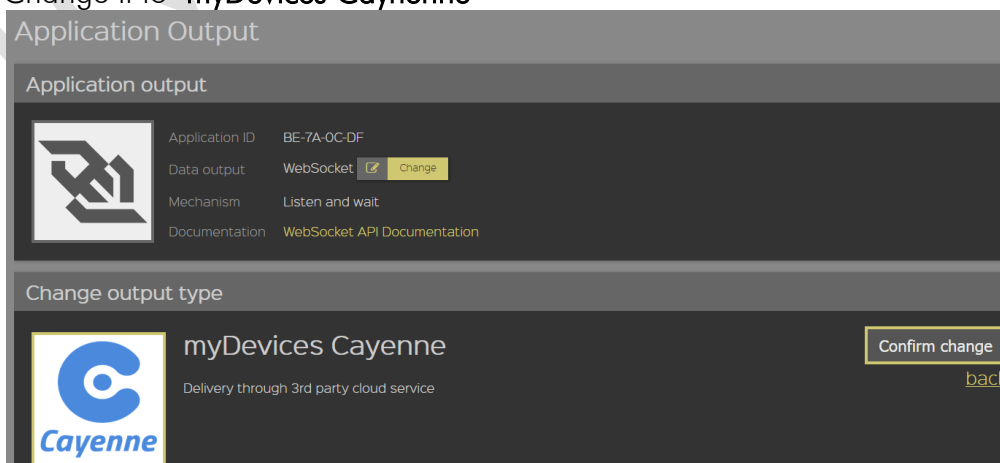


4.1.4 Setup a Sample Application @ Loriot.io

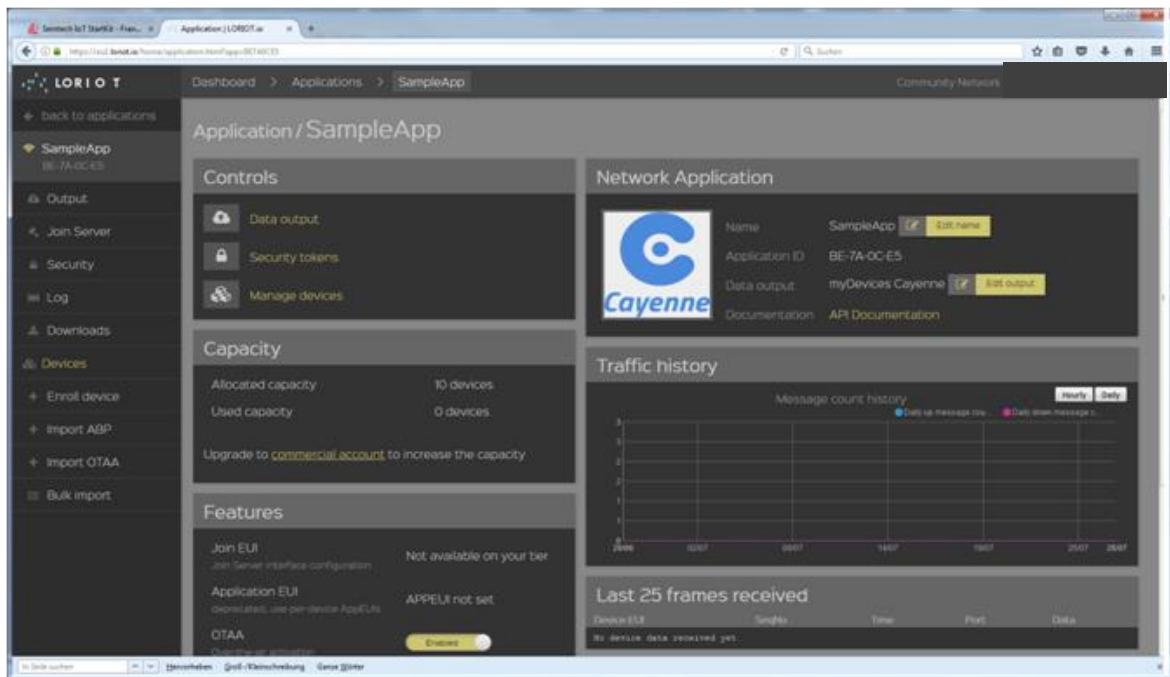
- Go back to the "Dashboard" on loriot.io website
- Click on "Sample App"

4.1.4.1 Setup the Network Application Parameters

- Click on "Data Output = WebSocket"
- Change it to "myDevices Cayenne"



- Confirm the change

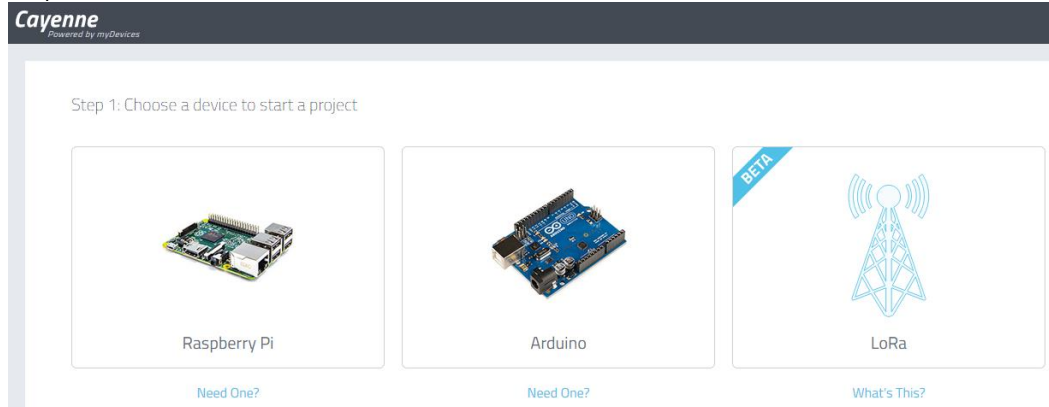


Please note that both the “Sample App ID” and the “Security Token” will be needed for further configurations at the myDevices / Cayenne server. So it is recommended to copy those parameters in a txt file or write it down. Please refer to 6.3.

4.1.5 Create an Account on myDevices Cayenne

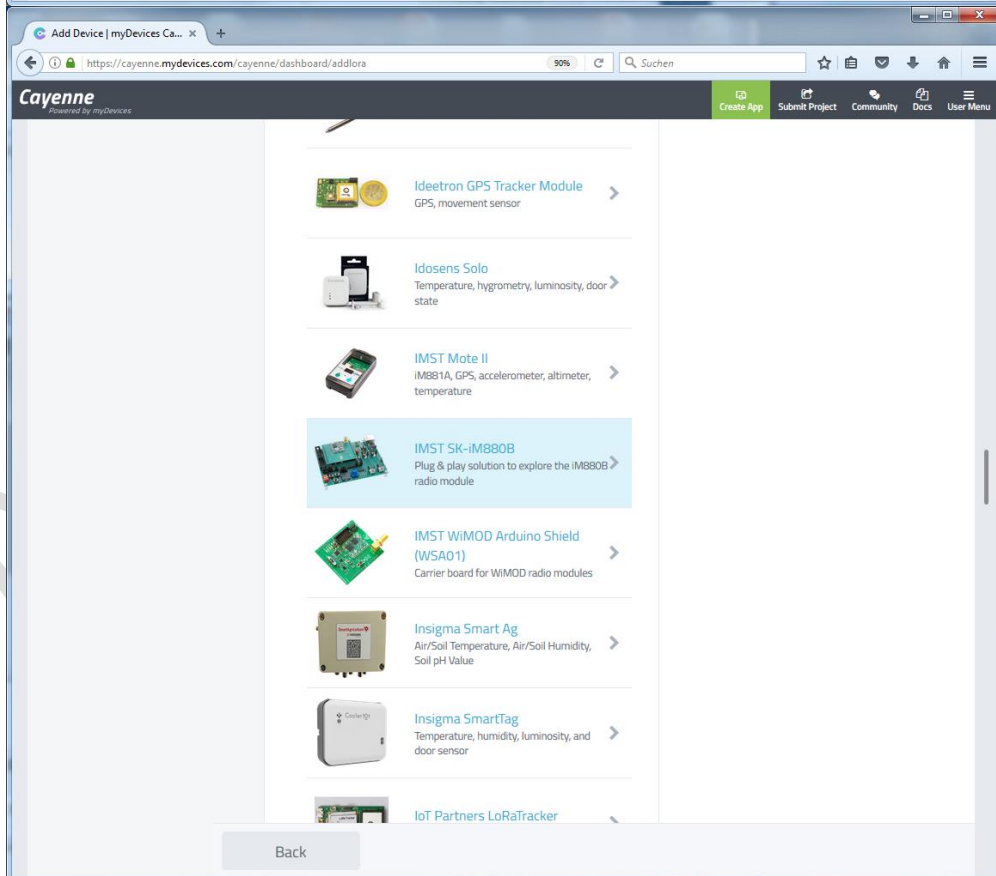
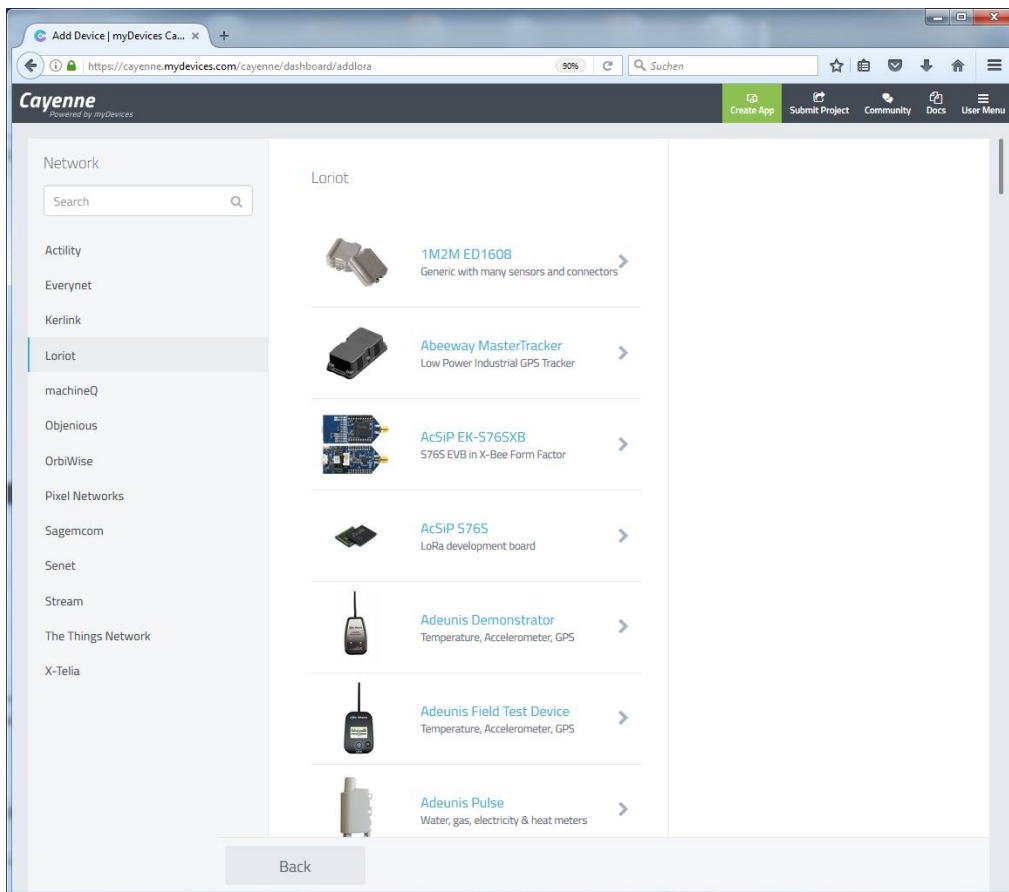
- Create an account at the <https://myDevices.com> website
- Upon registration follow the setup guide:

1. Step 1: Select "LoRa"



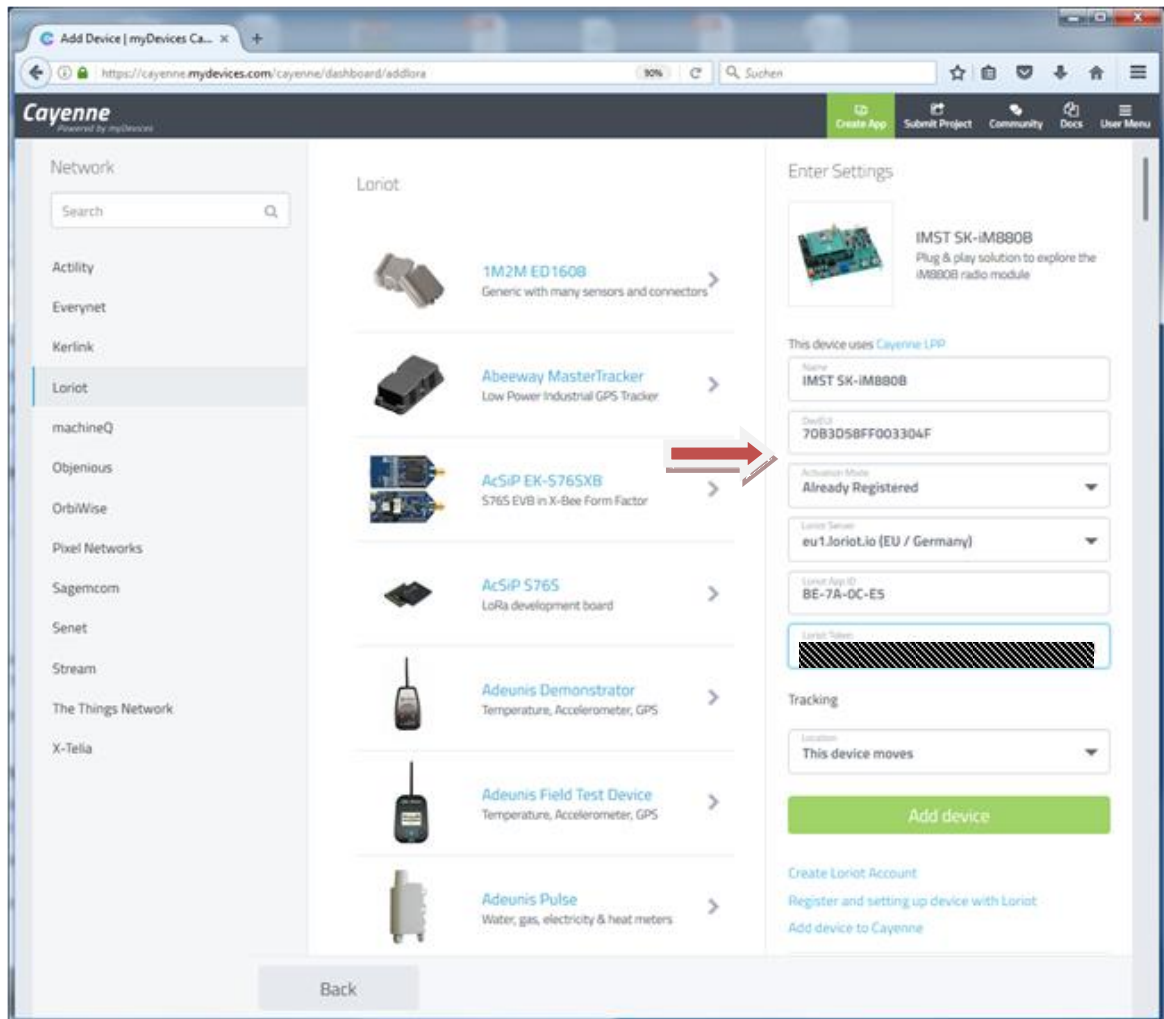
- #### 2. Step 2: Select "Loriot" as Network Type and select "IMST SK-iM880B" as device Type.

¹ In this case SK-iM880B (Demo Board + iM880B) is setup as the first device from the IoT Starter Kit.



4.1.6 Configure Settings for this End Device @ myDevices Cayenne

- Enter the following information into the corresponding input fields:



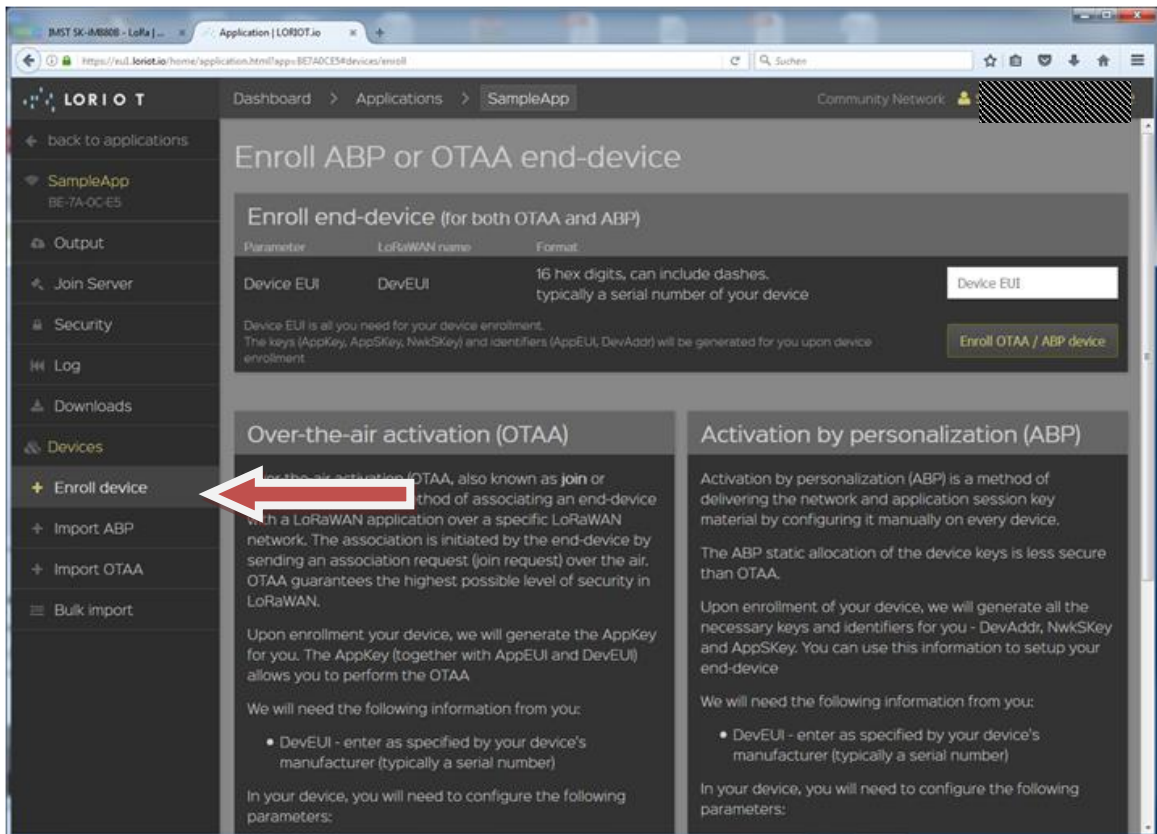
- For DevEUI please refer to 6.5
- Loriot Server Location: e.g. „eu1.loriot.eu (EU / Germany)“
- For Loriot Sample APP-ID and Security Token please refer to 6.3.
- Location of device: "This device moves"
- Click on the "Add Device" button.

Now the device is ready for usage on the myDevices / Cayenne platform.

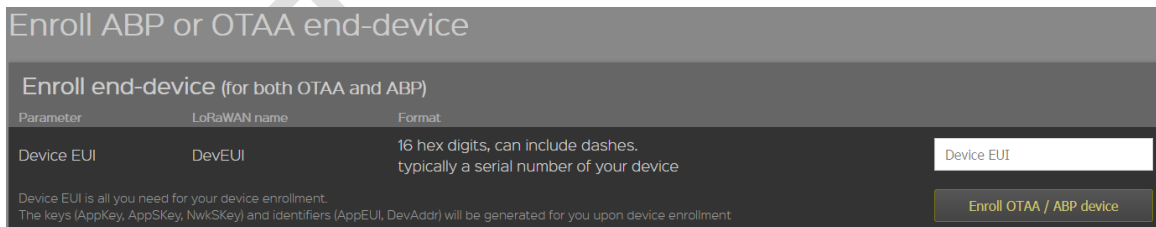
4.1.7 Device Setup – Add (enroll) a new Device @ Loriot.io

In order to use a device it must be registered and configured at the loriot.io server. The server provides the necessary settings for this device.

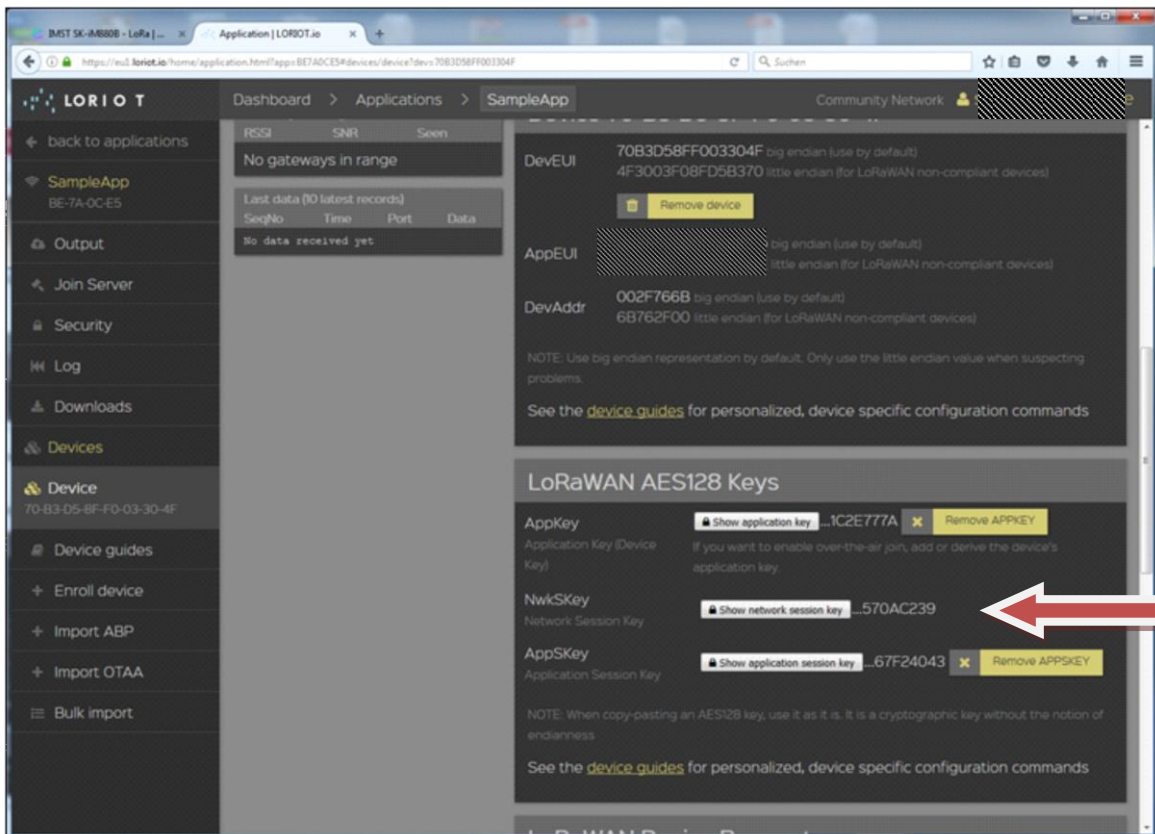
- Go to the loriot.io website and click on "Enroll Device" within the "Devices" category on the left hand side.



- Enter the DeviceEUI of the corresponding LoRa module and press on "Enroll OTAA / ABP device". For DevEUI please refer to 6.5.



- Go to the new device page on the loriot.io website



- Note the keys and parameters presented there. Please refer to 6.6

4.1.7.1 SK-iM880B / Demoboard

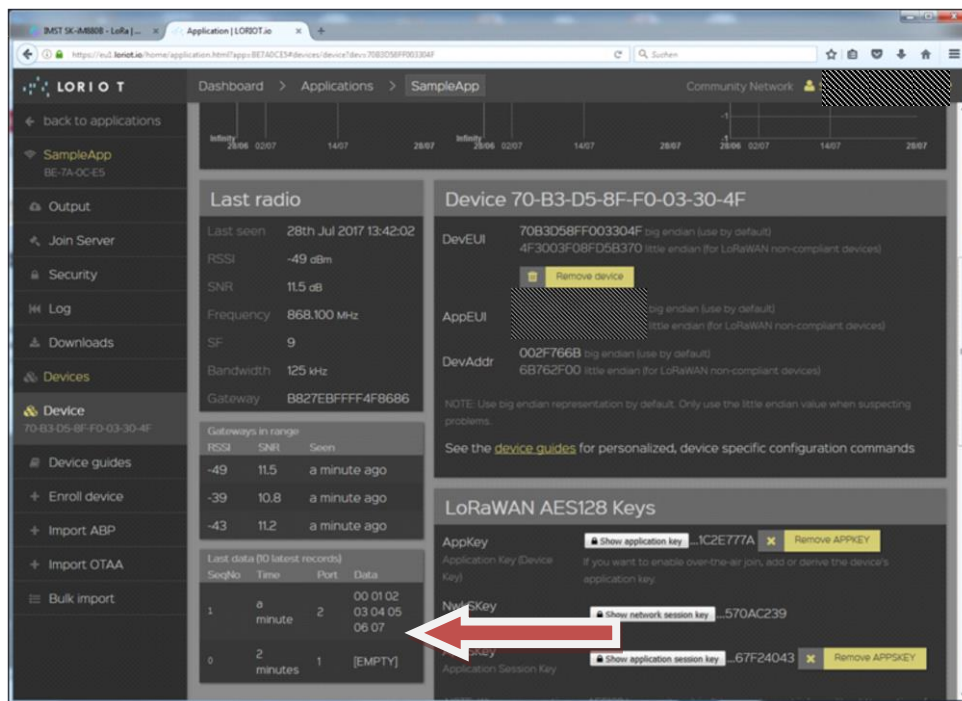
In order to use the iM880B mounted on the Demoboard the values given above must be entered in the corresponding field within the IMST LoRaWAN_EndNode_Studio. Therefore connect the Demoboard to your PC via the USB cable and start the LoRaWAN_EndNode_Studio by clicking the corresponding exe file.



The screenshot displays the LoRaWAN Services configuration page. The left sidebar shows the 'Radios' section expanded to 'Radio COM57'. The main content area shows the configuration for this radio. The 'Device Network Status' section shows the device is inactive. The 'Device Activation by Personalization (ABP)' section shows the device address as 0x00ABC107. The 'Device Activation Over The Air (OTAA)' section shows the application EUI and application key.

- Enter the values Device Address, Network Session Key and Application Session Key in the corresponding fields. (The Device Address must be given with the prefix "0x"). Please refer to 6.6.
- Next click on the **"Activate Device"** button in the group **"Device Activation by Personalisation (ABP)"**. This step starts the ABP procedure to "register" the device at the loriot.io server.
- Optional: Send a test message "01 02 03 04 05 06 07" by using the **"Send U-Data"** button within the windows software. The myDevices / Cayenne server provides several opportunities to send data and provides support for different software IDEs. Please refer to 7.

On the loriot.io website the message reception looks like this:



4.1.7.2 WSA01 / Arduino Shield

The WSA01 / WiMOD Shield for Arduino is a "shield" that simply adds a LoRa Link to an Arduino board.

Within the IoT Kit only a simple demo is being presented that "simulates" some temperature values in a sine wave fashion. For real live applications real sensors can be connected to the Arduino board. A description of the data format for additional sensor is given in by the IPSO Alliance specification (<https://www.ipso-alliance.org/>).

- In order to add (enroll) a WSA01 Arduino based device follow the instructions to the loriot.io server. Please refer to 4.1.7.
- Next the device must be registered at the myDevices / cayenne platform, too:
 - Click on the "add new..." button on the cayenne dash board (upper left corner)
 - Select "Device/Widget"
 - Select "Loriot" as server / platform
 - Search for "WSA01" and select the device.
 - Enter the requested values in the form

Enter Settings



**IMST WiMOD Arduino Shield
(WSA01)**
Carrier board for WiMOD radio modules

This device uses [Cayenne LPP](#)

Name

IMST WiMOD Arduino Shield (WSA01)

DevEUI

70B3D58FF0031822

Activation Mode

Already Registered

Loriot Server

eu1.loriot.io (EU / Germany)

Loriot App ID

BE-7A-0C-DF

Loriot Token

[Redacted Token]

Tracking

Location

This device moves

- As last step click on the green button to finish the process

- After having the device registered the loriot.io server will show the needed parameters DeviceAddress, AppSKey and NwkSKey that must but be copied into the demo sketch "LoRaWAN_CayenneDemo.ino" that is located in the examples section of the WiMOD library for the Arduino IDE.



```

LoRaWAN_CayenneDemo_IoTKit1 | Arduino 1.8.2
Datei Bearbeiten Sketch Werkzeuge Hilfe

LoRaWAN_CayenneDemo_IoTKit1
34 #include <math.h>
55
56 //-----
57 // constant values
58 //-----
59
60 /*
61  * ABP Parameters
62  */
63
64 const uint32_t DEV_ADR = 0x00; // TODO: add your device address here
65
66 // network session key (128bit)
67 // TODO: add your network session key here
68 const char NWKSKEY[] = { 0x00, 0x01, .... };
69
70
71 // application session key (128bit)
72 // TODO add your application session key here
73 const char APPSKEY[] = { 0x00, 0x01, .... };
74
75
76 //-----
77 // user defined types
78 //-----

```

- The given parameter values have to be entered in the sketch like the following example:

LoRaWAN_CayenneDemo.ino

```

//-----
// constant values
//-----

/*
 * ABP Parameters
 */

const uint32_t DEV_ADR = 0x00A775AE; // defined by loriot.io

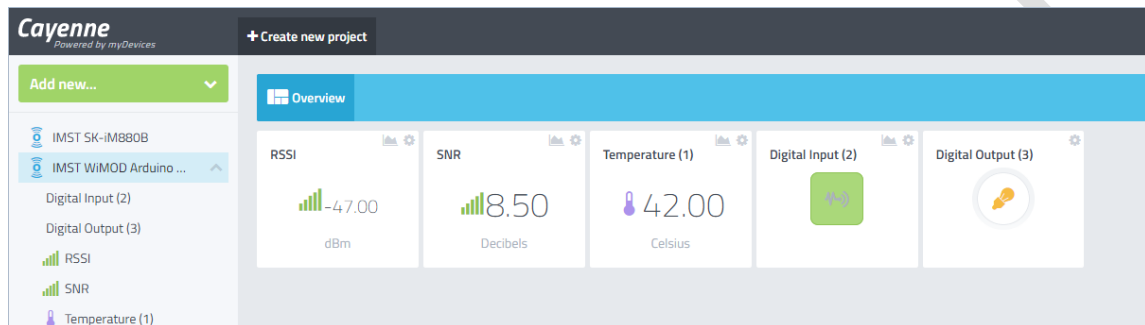
// network session key (128bit)
// defined by loriot.io
const char NWKSKEY[] = { 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB,
0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB };

// application session key (128bit)
// defined by loriot.io
const char APPSKEY[] = { 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB,
0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB, 0xAB };

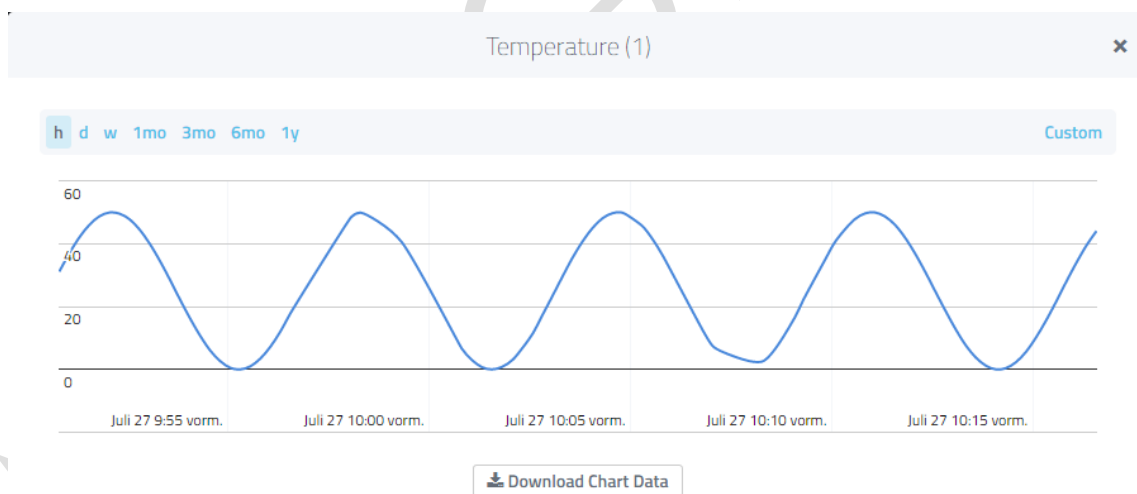
```

- Next the demo sketch can be compiled and loaded to the Arduino base board.

- After uploading the binary file to the Arduino board the board will automatically start the firmware.
- The firmware tries to do an ABP procedure at the loriot.io server. After that it will send every 30 sec one:
 - (simulated) temperature value (between 0 and 50 degree)
 - (simulated) Digital Input value
 - (simulated) Digital Output value
- After one minute the myDevices / Cayenne server should have recognized the data and the dash board looks like that



- After some time the (simulated) temperature value will form a sine wave like this:



Optional Info:

See also your youtube videos about the WiMOD shield for Arduino
<https://www.youtube.com/channel/UCQYAj7hYbkZZIRJgE2akBHg>

4.1.7.3 Mote II

In order to use a Mote II the same steps for registering the device at the loriot.io and myDevices.com / Cayenne servers have to be done:

- Get the DeviceEUI of the LoRa Mote II to use:
 - Either: Read the DevEUI from the Display of the Mote II
 - Or use the "**LoRaMote config**" form Semtech to read out the DevEUI

- Go to the dash board of the loriot.io website and enroll a device by entering the DevEUI of the Mote II.
- Next go to the device detail site and note the parameters **NwkSKey**, **AppSKey** and **DevAdr** that are generated by the loriot.io server.
- Enter the values in the **LoRaMote config** tool and write these parameters into the Mote II
- After pressing the reset button on the hardware it takes a few seconds² until the loriot.io website shows the first packet from the Mote II.

² Please respect the Duty Cycle restrictions of your region / country.

Devices

Generate new device
 Enroll new device
 Import existing OTAA
 Import existing ABP

Devices in this application [3]

RSSI	SNR	SF	BAT	ADR	Class	Application EUI	Device EUI	Devaddr	Last data	SeqNo	SeqDn
-56	7.5	12	NA	ADR	A		32-38-38-30-73-34-6A-17	01-05-E6-9C	a few seconds ago	1	0
-54	9.2	9	NA	ADR	A		70-B3-05-8F-F0-03-18-22	00-A7-75-AE	an hour ago	600	43
-87	12.5	9	NA	ADR	A		70-B3-05-8F-F0-03-30-4B	00-AB-C1-07	6 hours ago	0	0

- Next the Mote II can be registered at the myDevices / Cayenne server:
 - Click on the "add new..." button on the cayenne dash board (upper left corner)
 - Select "Device/Widget"
 - Select "Loriot" as server / platform
 - Search for "IMST Mote II" and select the device.
 - enter the requested values in the form

Enter Settings



IMST Mote II
iM881A, GPS, accelerometer, altimeter, temperature

Name
IMST Mote II

DevEUI
3238383073346A17

Activation Mode
Already Registered

Loriot Server
eu1.loriot.io (EU / Germany)

Loriot App ID
BE-7A-0C-DF

Loriot Token
[Redacted]

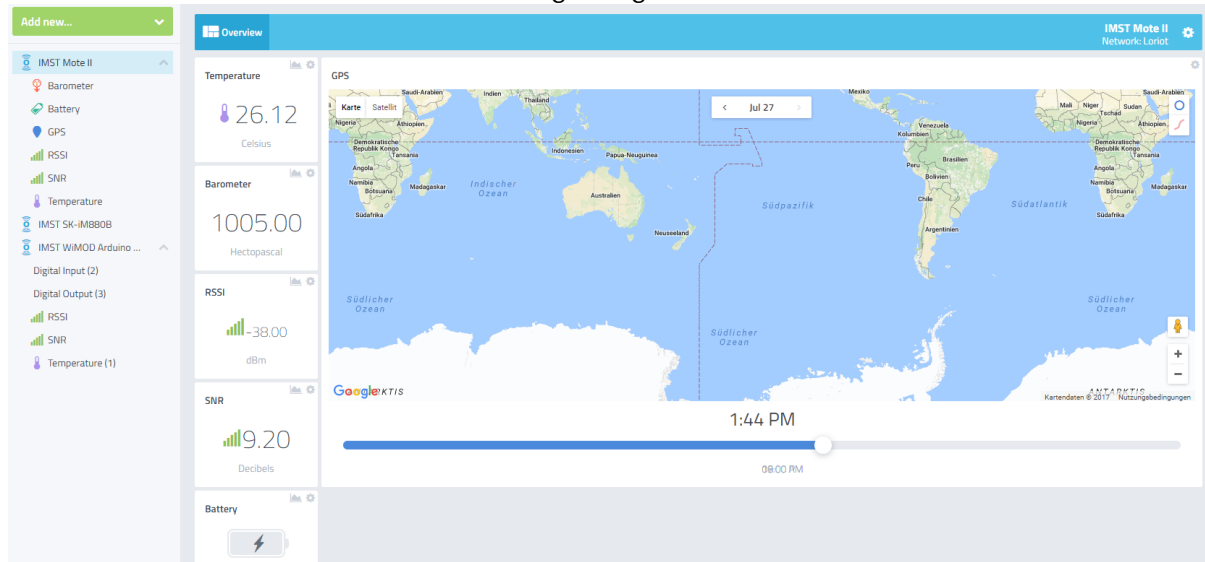
Tracking

Location
This device moves

Add device



- to finish the process click on "Add device"
- Now it takes a few minutes until the myDevices.com / Cayenne server recognizes the device data. After a that time the following Widgets can be seen on the screen

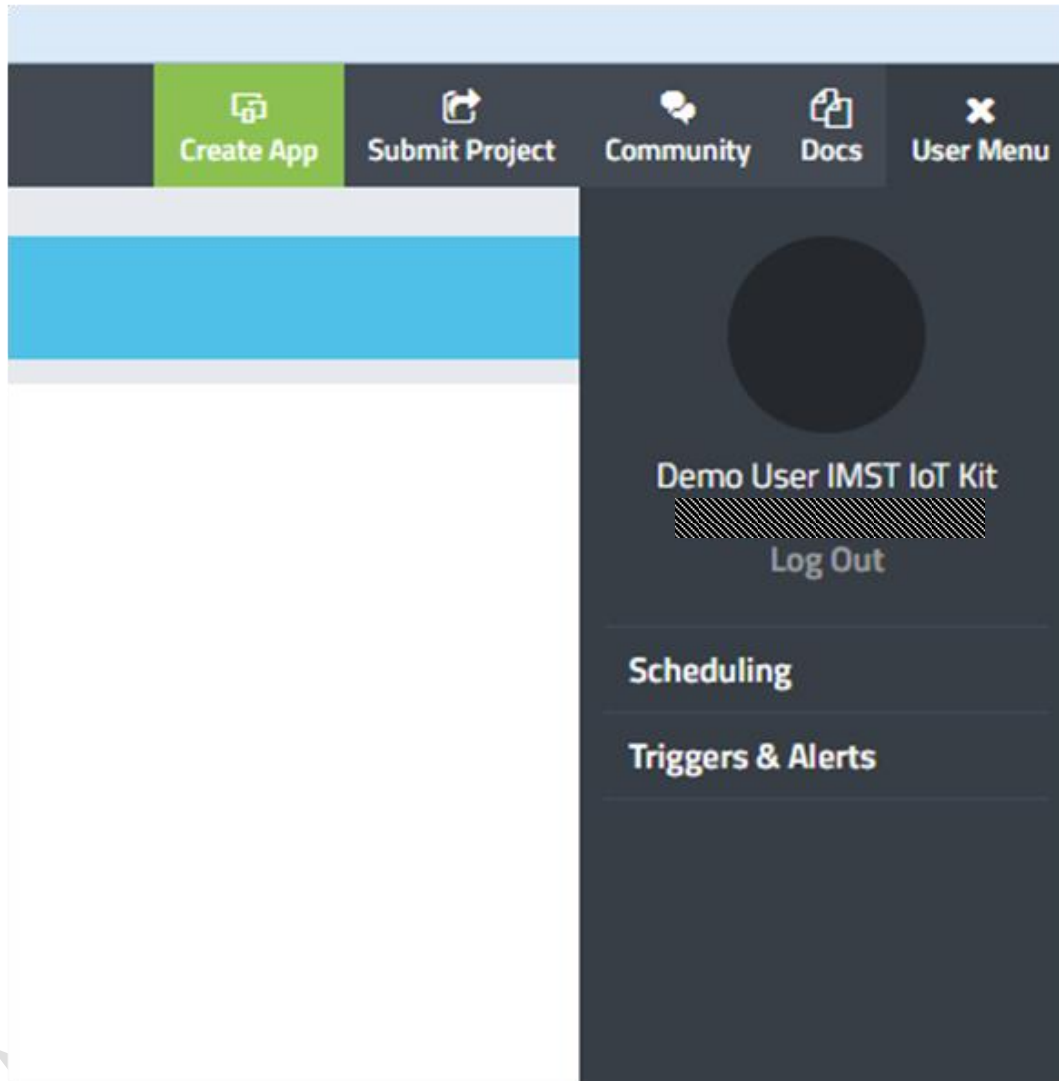


If the Mote II is able to receive valid GPS data, the map widget will point to the right location.

5 Time to Demo the LoRa Capabilities

5.1 Create Customized Triggers

- Click on the "user menu" button on the upper right corner of the Cayenne dash.
- Select the item "Triggers & Alerts"




- Click on New Trigger and configure your individual trigger event, e.g. like this:

Triggers

My Triggers New Trigger

LowTemperature

if  IMST Mote II
Demo - AnalogSensor - Channel 1

Temperature

10

Min: -500 Step: 1 Value: 10 Max: 500

Sensor above
 Sensor below

then notify...

[Add custom recipient](#)

Select All

Send Text Message
(requires mobile phone number)

Send Email

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6 Annex A

Within this annex all important parameters are listed or can be noted by the user. For better handling it is recommended to save those within a separated txt file.

6.1 Credentials for your Lorient Account

You can write down here your credentials for the Lorient.io server.

Email:
Password:
First Name:
Last Name:

6.2 MAC-Address of the Lite Gateway

You can find the MAC address of your Lite Gateway printed on a label on front plate of your gateway.

MAC Address:

6.3 Sample App ID and Security Token generated by Lorient.io

The following table can be used to notice the Sample App ID and the Security Token generated by the Lorient.io server.

Sample App ID:
Security Token:

6.4 Credentials for your myDevices Cayenne Account

You can write down here your credentials for the myDevices Cayenne server.

Email:
Password:
First Name:
Last Name:

6.5 DevEUI of your End Devices

For the registration of each device the DevEUI of the device is needed. You can find the DevEUI for SK-iM880B (Demo Board + iM880B) and WSA01-iM880B printed on a label on the device. Alternatively you can read out the DevEUI from the SK-iM880B (Demo Board + iM880B) with our LoRaWAN_EndNode_Studio, and from WSA01-iM880B with a special sketch.

The DevEUI from Mote II can be either read from the display after power up or by connecting the LoRaMoteConfigTool provided by Semtech on https://semtech.force.com/lora/LC_Resources.

SK-iM880B DevEUI:

Mote II DevEUI:

WSA01 (Arduino) DevEUI:

6.6 DevAddr, NwkSKey, AppSKey, AppEUI for your End Devices

SK-iM880B

AppEUI:

DevAddr:

AppKey:

NwkSKey:

AppSKey:

Mote II

AppEUI:

DevAddr:

AppKey:

NwkSKey:

AppSKey:

WSA01 (Arduino):

AppEUI:

DevAddr:

AppKey:

NwkSKey:

AppSKey:

7 Annex B

The Cayenne Low Power Payload (LPP) provides a convenient and easy way to send data over LPWAN networks such as LoRaWAN. The Cayenne LPP is compliant with the payload size restriction, which can be lowered down to 11 bytes, and allows the device to send multiple sensor data at one time. For more information, please visit

<https://mydevices.com/cayenne/docs/lora/#lora-cayenne-low-power-payload-reference-implementation>.

7.1 Example of a Virtual Temp.-Sensor

This example shows how to send a virtual temperature sensor value with the SK-iM880B (Demoboard + iM880B) and the LoRaWAN_EndNode_Studio.

The payload structure used in LPP is:

Bytes	1	1	N	1	2	M	...
Explanation	Data1 Ch.	Data1 Type	Data1	Data2 Ch.	Data2 Type	Data2	...

Data Ch. is the number of the channel.

Data Type specifies the data type.

Data1 is the sensor data of channel 1.

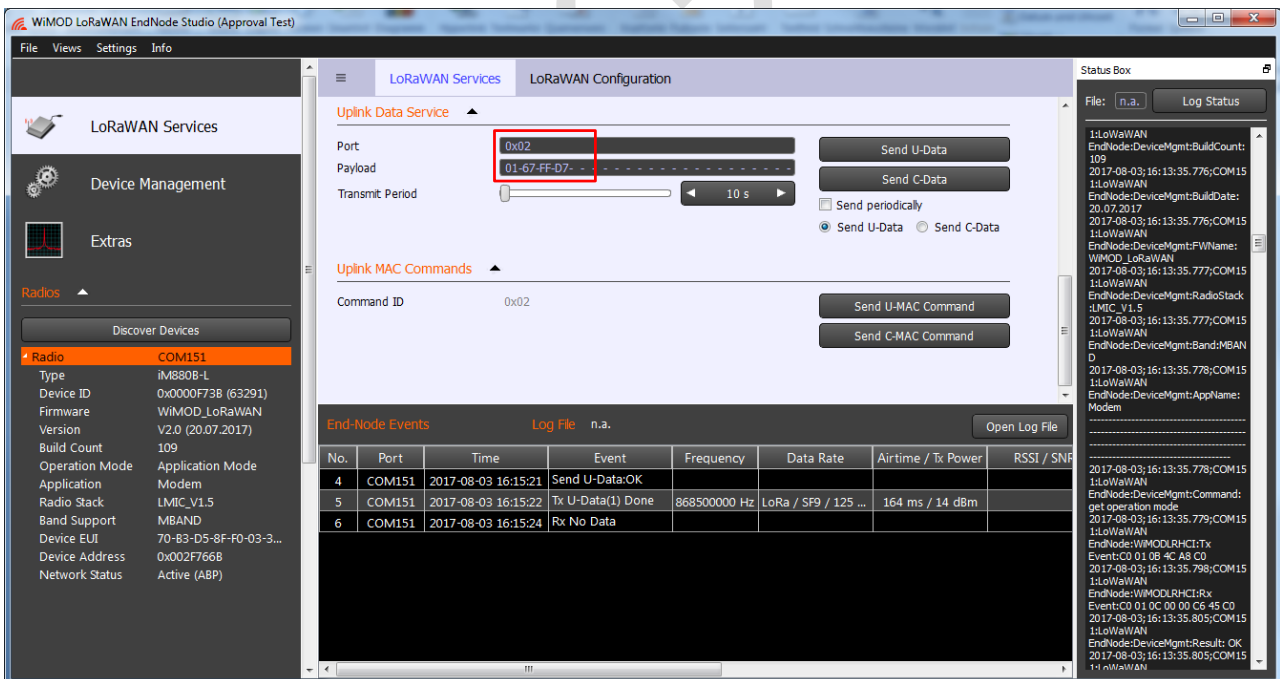
For further information on the data format please refer to the myDevices cayenne description.

Examples:

Payload (hex)	01 67 FF D7	
Channel	Type	Value
01	67: Temperature Sensor	FFD7 = -41 ⇒ -4.1°C

Payload (hex)	01 67 01 10	
Channel	Type	Value
01	67: Temperature Sensor	0110 = 272 ⇒ 27.2°C

Payload (hex)	01 67 00 FF	
Channel	Type	Value
01	67: Temperature Sensor	00FF = 255 ⇒ 25.5°C



The screenshot shows the Cayenne IoT dashboard interface. The browser address bar displays the URL: <https://cayenne.mydevices.com/cayenne/dashboard/lora/bab7f550-7377-11e7-a87d-cd42fea15>. The dashboard header includes the Cayenne logo and navigation options like 'Create n...', 'Create App', 'Submit Project', 'Community', 'Docs', and 'User Menu'. On the left, a sidebar lists devices: 'IMST Mote II', 'IMST SK-IM880B' (selected), 'RSSI', 'SNR', 'Temperature (1)', and 'IMST WIMOD Arduino ...'. The main content area, titled 'Overview', displays three data cards for the selected device: 'RSSI' with a value of -61.00 dBm, 'SNR' with a value of 8.80 Decibels, and 'Temperature ...' with a value of -4.10 Celsius. A status bar at the bottom indicates 'Last data packet sent: August 3, 2017 4:15:22 PM'. A search bar at the bottom left contains the text 'In Seite suchen', and a footer contains the text 'Hervorheben Groß-/Kleinschreibung Ganze Wörter'.

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8.2 Contact Information

IMST GmbH

Carl-Friedrich-Gauss-Str. 2-4
47475 Kamp-Lintfort
Germany

T +49 2842 981 0 E wimod@imst.de
F +49 2842 981 299 I www.wireless-solutions.de