VERSION: 1.0.0

LORAWAN SERVER FOR INDUSTRIAL EDGE

USER MANUAL

THETAPHI LTD.
WWW.THETAPHI.CO.UK

[LEFT BLANK ON PURPOSE]

TABLE OF CONTENTS

VESION HISTORY

Version	Date	Comments
1.0.0	24/08/2023	First Release

1. Introduction

The LoRaWAN Server application is a packaged Chirpstack server offering connectivity for LoRa devices. This document describes how to deploy and configure the server and details the steps on how to add new LoRa Devices so that they can be automatically detected by the LoRaWAN-connector from ThetaPhi.

With the LoRa server and devices configured as described in this document the device details are automatically picked up by the connector and the data from the devices is streamed to the Data Service application from Siemens.

1.1 LoRaWAN

LoRaWAN is a wireless communication protocol that uses LoRa, a proprietary radio modulation technique, to connect low-power devices to the internet over long distances. LoRaWAN defines the network architecture, security, and data rates for different applications and regions. LoRaWAN operates in license-free sub-gigahertz frequency bands and supports bi-directional, multicast, and geolocation features. LoRaWAN is an official ITU-T standard and is managed by the LoRa Alliance, a non-profit organization that promotes the adoption of LoRaWAN technology.

It is ideally suited for low volume and low velocity data i.e., infrequent measurements. The LoRaWAN server application supplied by ThetaPhi and described in this document uses Chirpstack server.

Chirpstack is an open source LoRaWAN technology stack that offers the following benefits:

1. Private LoRaWAN Network
2. Data encryption and device management
3. Multi-Tenant / Application architecture
4. No limit on the number of messages that can be transmitted / processed.
5. Scalability (no limit on devices / gateways)

Although having a private LoRaWAN network makes it necessary to deploy your own gateways the benefits listed make it ideal for industrial applications.

A pre-packaged application is available from the company's GitHub page. The package includes:

1. A docker-compose file specifically created for deployment to the Siemens industrial Edge.
2. Pre-packaged configuration files for the Chirpstack gateway bridge and application server

To use the package the gateway must be configured to suit the edge device and the environment variables listed in the docker file must be updated to suit the edge device configuration. See section 2 for details.

ThetaPhi's GitHub repository: https://github.com/Theta-Phi/ie-chirpstack-docker

1.2 Use Cases

In the industrial context often, a parameter does not have a direct impact on the operation of a process but is vital for its optimum performance. Such parameters are often measured manually which can be labor intensive depending on the number of measurement points, for example filters blockages, water quality, pipework pressure etc.

Another common use case is where the desired end effect of a process is located far from the actual equipment controlling it, for example a boiler installed in one part of a building supplying hot water to a process located in a different part. In such cases installing a sensor at the location of interest and wiring it back to the control system for the boiler would be cost-prohibitive.

LoRaWAN is also ideally suited for infrequent measurement on assets that do not belong to a single control system making data aggregation. Using LoRaWAN devices the data from all the assets, for example power consumption, current, voltages can be collected at a single point.

LoRaWAN is ideally suited for such application, due to the low power and long-range nature of the protocol. The sensors can be installed with batteries and require minimal infrastructure in the form of a LoRaWAN gateway to serve as the bridge between LoRa devices and the Industrial internet. Depending on the frequency of measurement a device can operate for years without the need for a battery replacement.

1.3 Architecture

Figure below show the typical architecture for a LoRaWAN deployment using the Siemens industrial edge and the LoRaWAN connector from ThetaPhi:

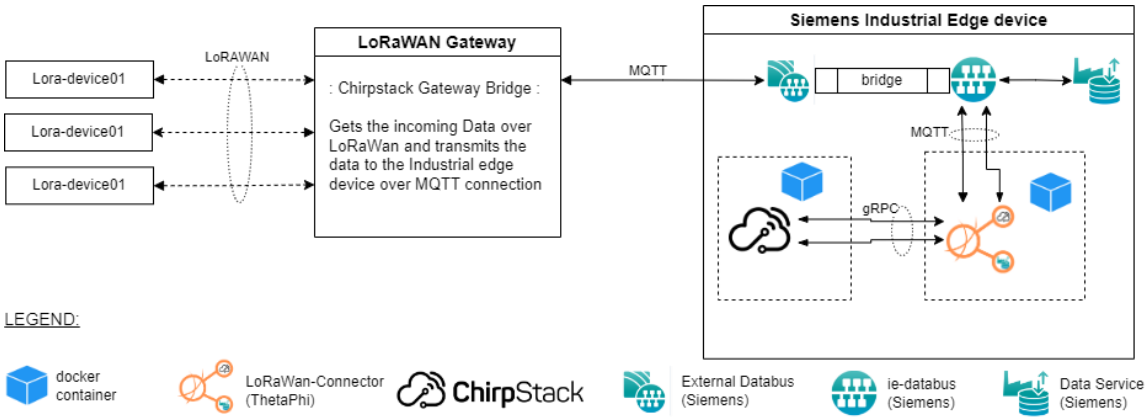

Figure 1-1: LoRaWAN for Industrial Edge – Architecture

1.4 Pre-Requisites

To deploy the server, the following pre-requisites must be met:

1. Simens IE Hub Access.
2. Siemens Industrial Management System deployed.
3. Siemens Industrial Edge Device deployed and onboarded.
4. IE-Databus deployed along with the configurator.
5. External Databus deployed along with the configurator.

2. Deployment

There are two main parts of the LoRaWAN deployment:

1. LoRaWAN gateway
2. LoRaWAN application server

2.1 LoRaWAN Gateway

The LoRaWAN gateway forms the bridge between the LoRa devices and the Siemens Industrial Edge Device. The gateway receives the signals from the LoRa device using the LoRaWAN protocol and transmits the messages to the LoRa application server.

To establish communications, the gateway needs to be configured for the operating region and the industrial edge device it needs to connect to. The LoRaWAN server application supplied by ThetaPhi is pre-configured for the eu868 region. Additional regions can be added if required. The installed gateway must meet the regional requirements and the configurations in the LoRaWAN server application.

The messages from the gateway bridge are transmitted to the edge device over MQTT, therefore a user must be added to the External Databus with publish and subscribe permissions for the topic: Gateway/#.

All event and command signals from/to the gateway are transmitted over this topic to the LoRaWAN server. This topic must also be bridged to the ie-databus so that the LoRaWAN server application can receive the signals.

A pre-packaged application can be downloaded from the company's GitHub repository. The example configurations available in the package assume that the deployed gateway uses a Semtech UDP packet forwarder. This can be modified to suit the actual gateway deployed.

More information regarding the Chirpstack-Gateway-Bridge and the configurations can be found here: https://www.chirpstack.io/docs/chirpstack-gateway-bridge/index.html

2.2 LoRaWAN Application Server

The LoRaWAN server application must be configured to communicate with the ie-databus. The signals from the gateway are received by the LoRaWAN application server, processed and re-transmitted to the ie-databus with the device and signal details. A user must be configured on the ie-databus with publish and subscribe permissions for the following topics:

1. Gateway/# (for messages from the gateway)
2. Application/# (for messages published by the application server)

The user credentials are configured for the application server in the environment variable listed in the docker compose file.

3. Usage

Once configured and deployed to the industrial edge device the application server is available on port 8080 (according to the default configurations). All further configuration for the application server can be done through this web server. Click on the application in the edge device to navigate to the web server.

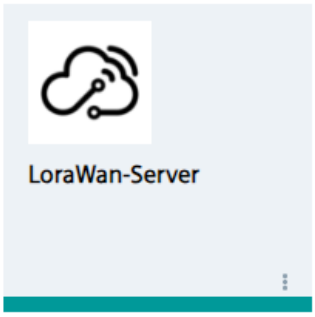

Figure 3-1: Chirpstack Server deployed to Edge Device

Follow the steps detailed in the section below to setup the server and devices.

3.1 Updating user credentials

When the application server is first deployed a default user is created with the following credentials:

- User: admin
- Password: admin

For securing the application server it is best to create a new user with administrative rights and to delete the default user.

Follow steps below to do this:

1. Login to the server with the default user and go under Network Server go to Users and click Add user and add in the user details. Enable “Is Active” and “Is admin”:

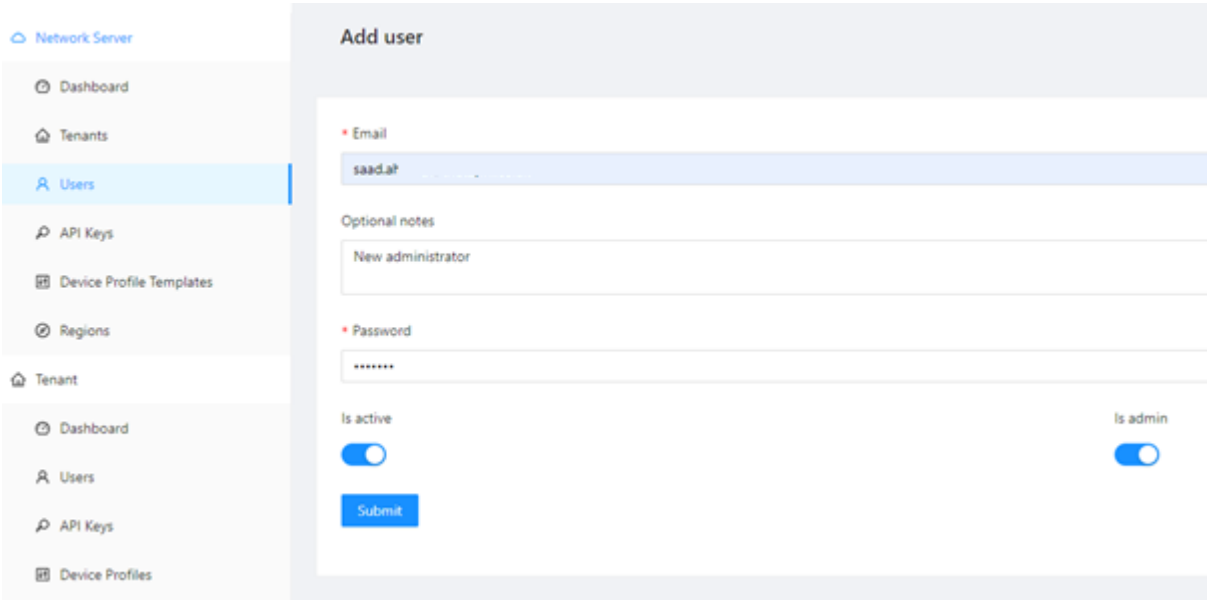

Figure 3-2: Add new Admin user.

2. Logout and Log back in using the new user credentials. Go back to the “Users” tab in Network server and select admin then click the Delete user button to delete the default user:

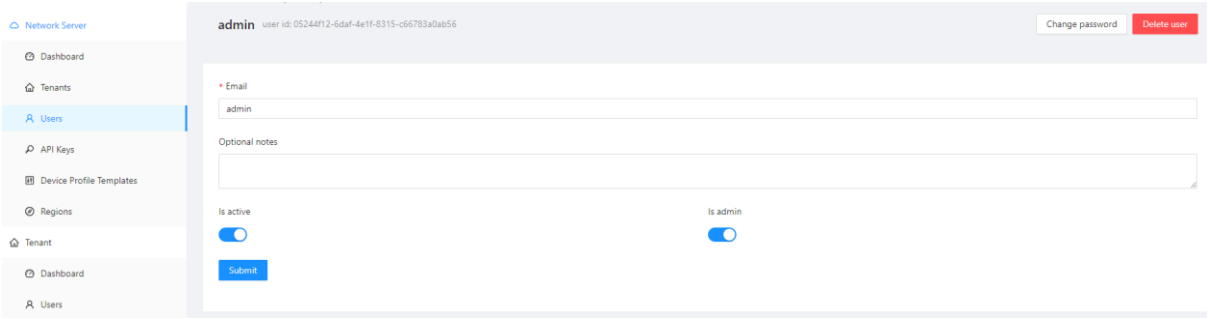

Figure 3-3: Delete default admin.

3.2 Creating a new tenant

Similarly, a default tenant (Chirpstack) is created when the server is first deployed. You should create a new tenant for you organisation and delete the default tenant. To do this:

1. Go to Tenants underuser server and click add tenant enter the details and set the settings as shown below and click submit:

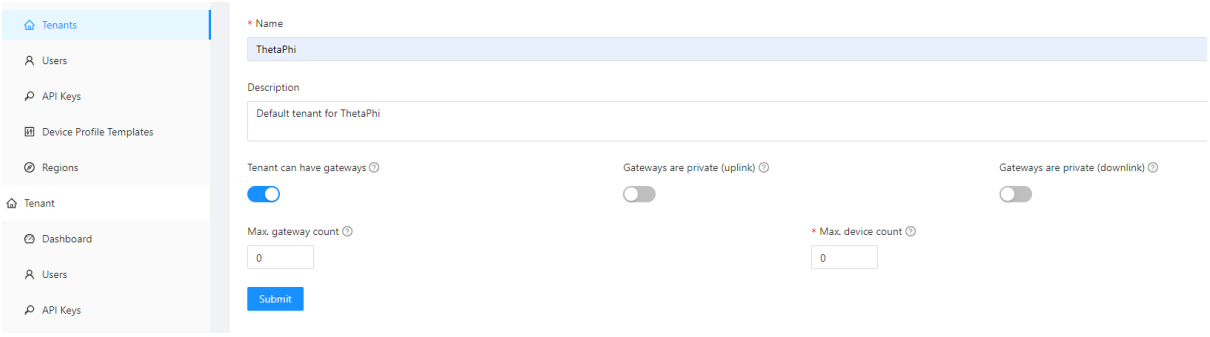

Figure 3-4: Add a new Tenant.

2. With the new tenant added the default tenant can now be deleted from Tenants tab under network server.

3.3 Adding Gateway(s)

To enable communications with the LoRaWAN devices the first step is to add the gateway to the server. Follow the steps below to add the gateway(s).

1. Make sure that the correct tenant is selected in from the dropdown list in the top left-hand corner:

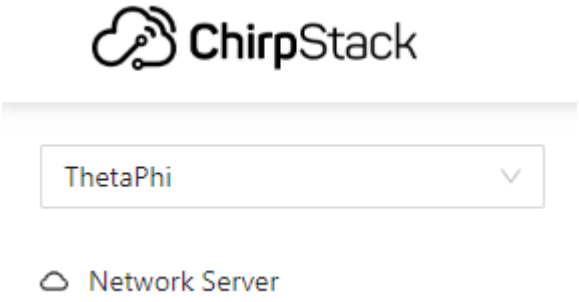

Figure 3-5: Tenant Selection

2. Go to the Gateways tab under Tenant and click Add Gateway. Enter the gateway details (the Gateway ID is supplied with the gateway):

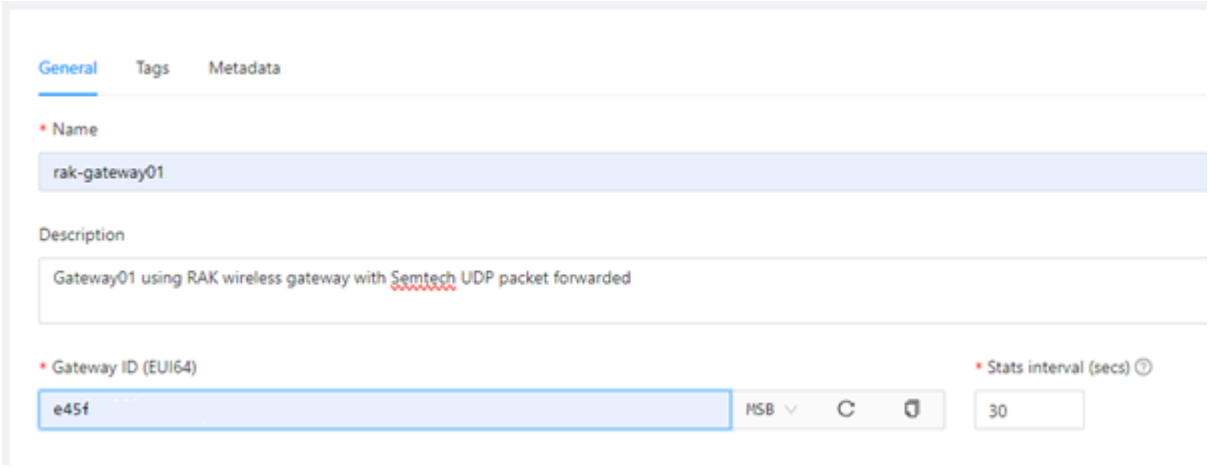

Figure 3-6: Adding a Gateway

3. Once the gateway is added is communicating with the application server you should see it as active on the dashboard for the tenant:

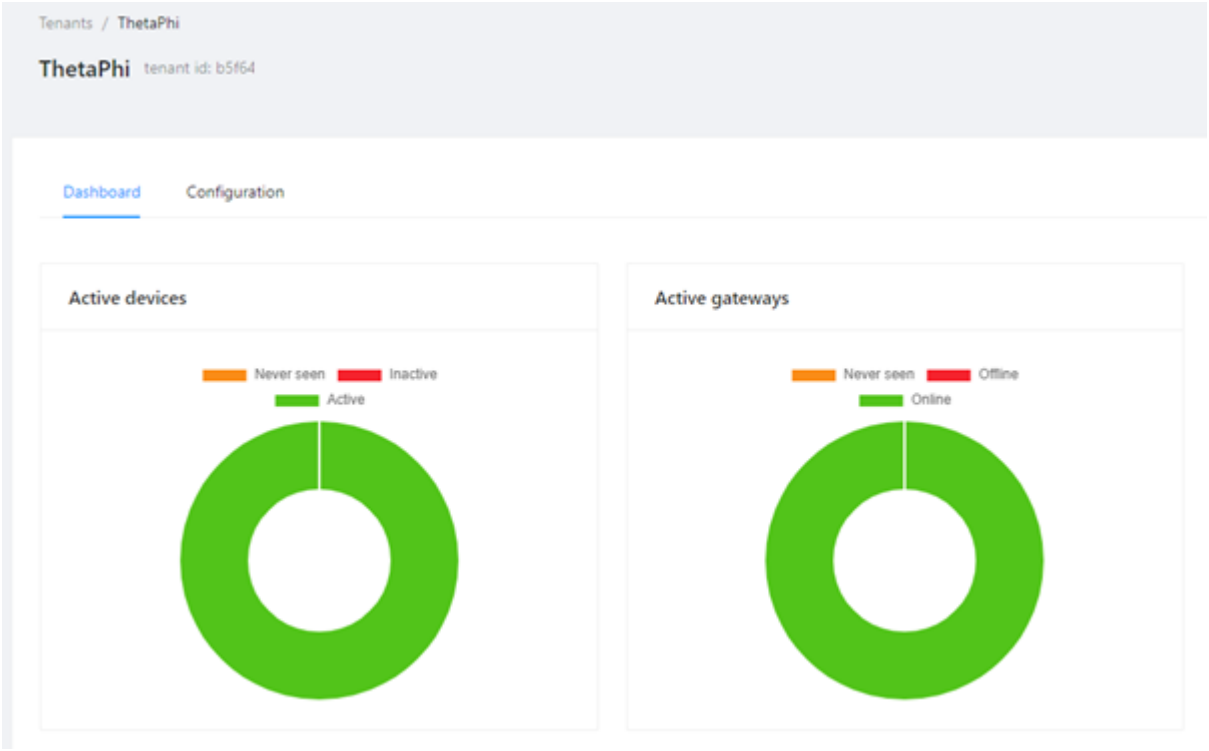

Figure 3-7: Active Gateways

3.4 Adding Applications

On the Chirpstack server, devices must be added to applications. Therefore, before a new device can be added an application must be created. Follow steps below to do this:

1. Make sure you have the correct tenant selected and go to Application under Tenant. Click Add application. Enter the application name and description.

3.5 Adding Devices

Adding a device to the application server is a 2-step process. First the application profile must be created. This defines how the device gets registered by the application server to allow communication and how the messages to/from the device are processed so they can be transmitted to the MQTT server in a readable format.

3.5.1 Create a Device Profile

To create a new device profile, go to the "Device Profile" tab under Tenant and click Add device Profile.

1. Enter a name for the device profile and the device details supplied by the manufacturer:

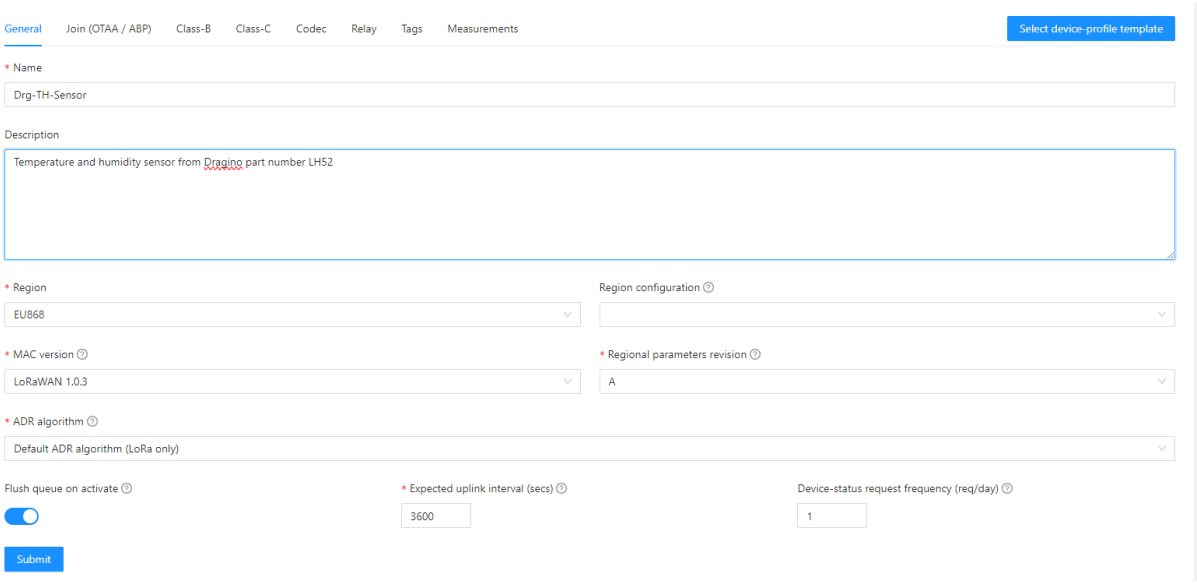

Figure 3-8: Add a device profile (General)

2. In the join tab select where the device supports OTAA (Over the Air Activation) or not. This is device dependent.
3. Enter the encoder/decoder information in the Codec tab, see next section.

3.5.1.1 Encoders/decoders

As LoRaWAN communication is designed for low bandwidth usage all data to/from the LoRaWAN devices is sent and received as bytes. These bytes must be decoded by the application server according to a set format defined in encoders/decoders. These encoders/decoders are supplied by the device manufacturers as JavaScript functions. These functions can be expanded to include additional information by further supplementing the decoded signals for example, given a fixed range for a signal a percentage value for the signal can generated.

Note:

The data sent to the data service (using the LoRa-connector) follows the following format:

{applicationName}::{deviceName}.{signalName}

Signal names are defined in the decoders. The {deviceName}.{signalName} combination should be unique. Following the reference designation standard for device name is recommended.

3.5.1.2 Measurements and Tags

In the measurements Tab activate “detect measurement keys”. Once the device with the configured profile starts sending data the measurements (signals) available in the message are automatically picked up by the server and add to this tab.

For signals that you want to trend in the server application select the “measurement-kind” and the name once the measurements are available in the tab:

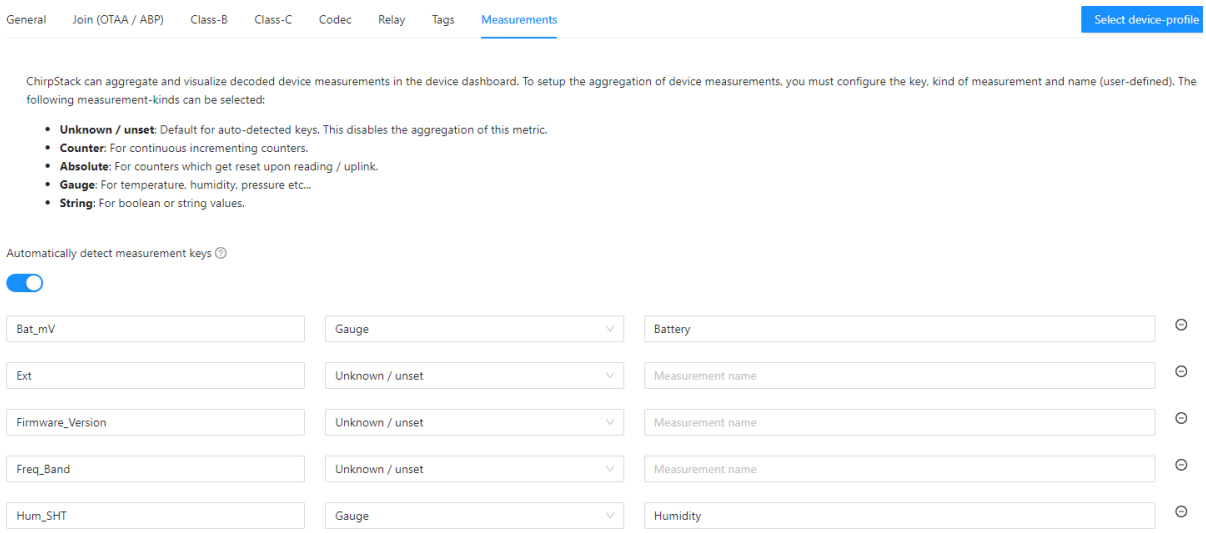

Figure 3-9: Device Profile Measurements

Once the tab has been populated and you have configured the signals that you would like the application server to log the function can be switched off.

In the Tags tab add the signals that you would like the LoRaWAN-connector app to pick up automatically and transmit to the data service. The Name must match the name of the signal configured in the codec. You can also get these names from the measurements tab once you

have started receiving data from the device. For each signal define the datatype as per siemens industrial edge datatypes (Real, bool, INT etc.)

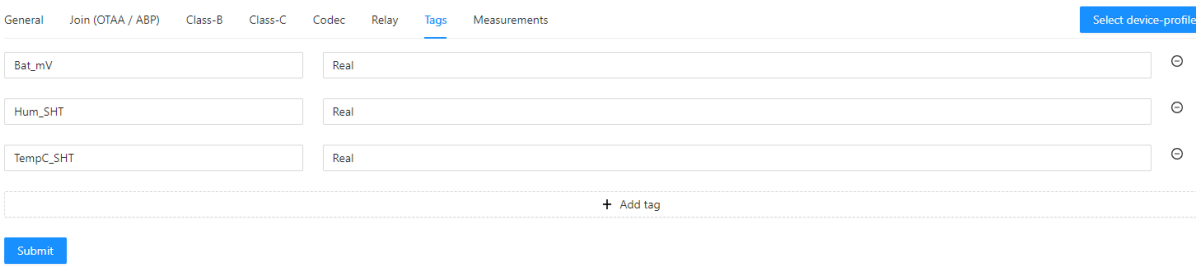

Figure 3-10: Device Profile Measurements

Once all the information is entered, click submit to create the device profile.

3.5.2 Add a Device

To add a new device, navigate to the application where you would like to add the device and click Add device.

Enter the device details as required and select the Device Profile to use.

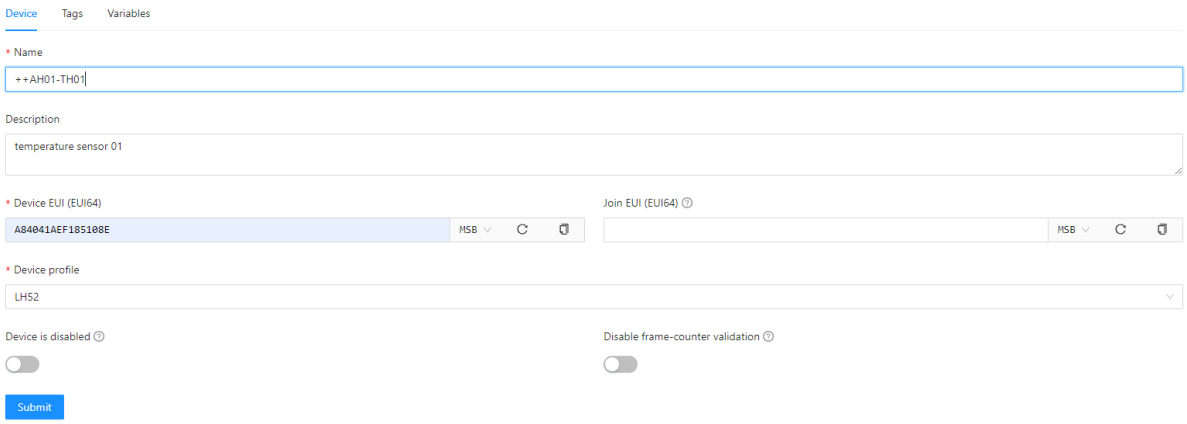

Figure 3-11: Add a device general.

In the Tags tab additional information related to the sensor can be added so that filtering devices for a particular asset (function group) and location is easier:

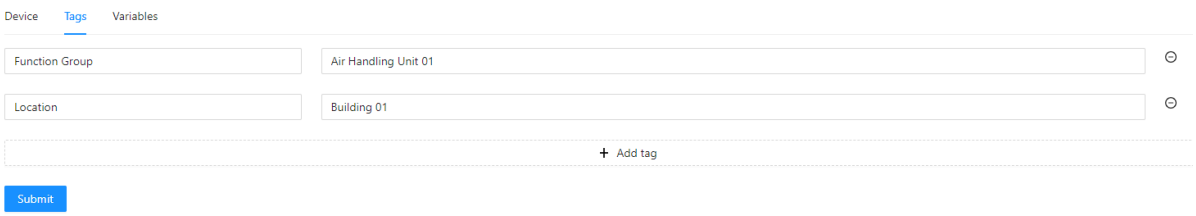

Figure 3-12: Add a device (Tags)

Once Done click submit to create the device.

3.6 Monitoring the devices

Once the devices are added to the location. The overall status of the configured devices is available on the dashboard:

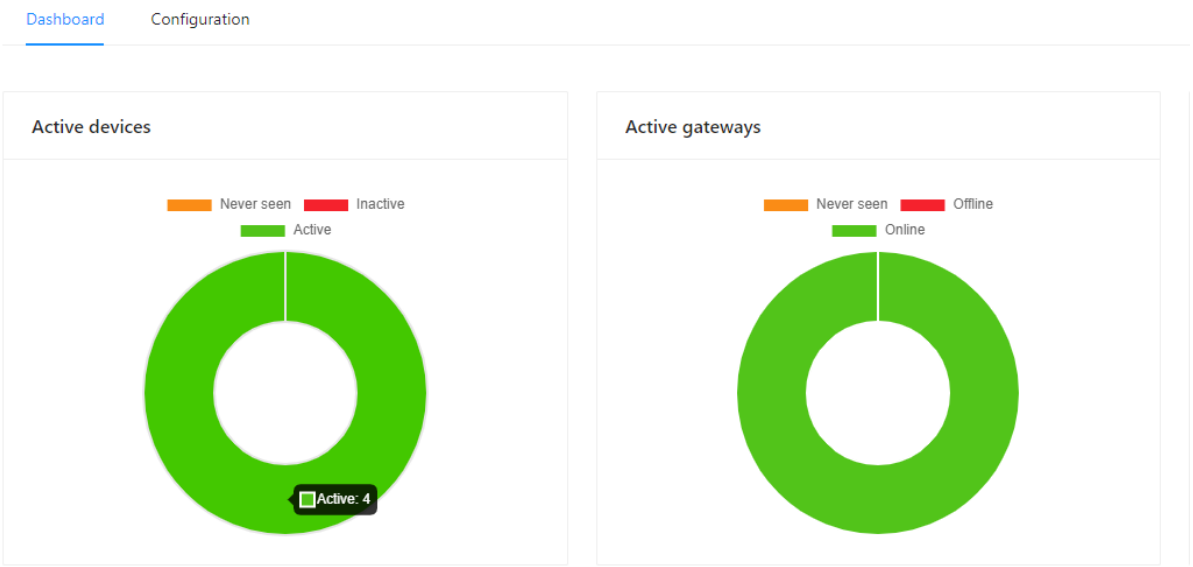

Figure 3-13: Tenant Dashboard

You can monitor individual devices by opening the device link in the respective application. Here you can monitor the trends for the configured measurement from the Device metrics tab:

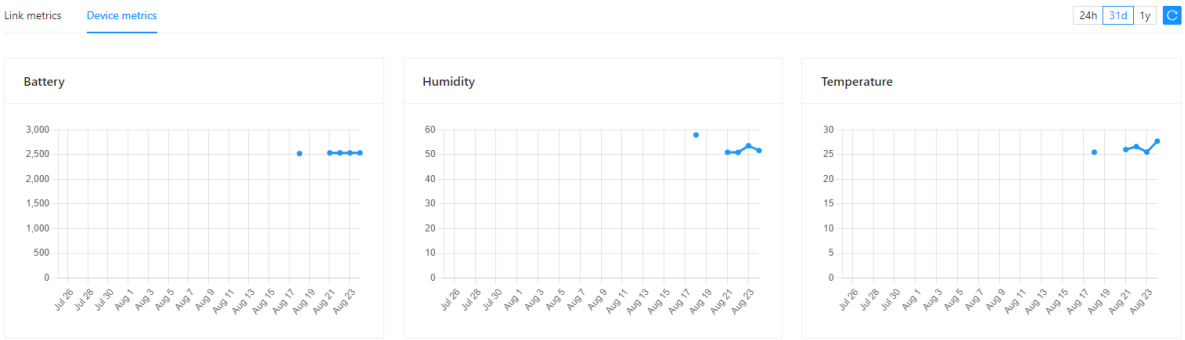

Figure 3-14: Device Metrics

You can also monitor individual events for the device. When the device sends data it is an “Uplink” event shown as an “Up” in the Events Tab. Clicking on an event shows the complete message received by the application server including individual signal values in the “object” key. The event details can also be downloaded.

4. Using the Published App

A pre-packaged LoRaWAN server application is available from the company's website for download. The server service is configured as shown below:

```
services:
  chirpstack:
    image: chirpstack/chirpstack:4
    command: -c /etc/chirpstack
    restart: unless-stopped
    mem_limit: 500mb
    volumes:
      - ./configuration/chirpstack:/etc/chirpstack
      - ./lorawan-devices:/opt/lorawan-devices
    depends_on:
      - postgres
      - redis
    environment:
      - MQTT_BROKER_HOST=ie-databus
      - MQTT_BROKER_PORT=1883
      - MQTT_USER=chirpstack
      - MQTT_PASSWORD=chirpstack
      - REDIS_HOST=redis
      - POSTGRESQL_HOST=postgres
    networks:
      - chirpstack-net
      - proxy-redirect
    ports:
      - 8080:8080
```

It includes a Postgres server and a Redis server as well. These are not exposed on the docker network and are only used by the Chirpstack application server.

The application creates a user defined bridge docker network called chirpstack-net. This is the network that the LoRaWAN-connector app from ThetaPhi uses as well.

To use the application, you will need to create a new user on the ie-Databus with the following credentials:

- Username: chirpstack
- Password: chirpstack

With publish and subscribe permissions for:

1. Gateway/# (for messages from the gateway)
2. Application/# (for messages published by the application server)