EMB-Fem2GW-O-2G4-2G4

DOCUMENTATION

Rev 1.0

Embit s.r.l.

Document information

Versions & Revisions

Revision	Date	Author	Comments
1.0	2021-02-09	Embit-AM	Initial release

Index

1 Introduction

The **EMB-Fem2GW-O-2G4** uses LoRa® technology and complies with the Semtech 2.4GHz protocol stack which aims to emulate LoRaWAN® behaviour. It enables IoT (Internet of Things) implementations mandating worldwide interoperability and battery-powered end devices over long-distance connectivity. Thanks to the absence of duty cycle restriction on 2.4GHz ISM Band, it is perfectly suitable for applications which needs a continuous exchange of data, such as real time monitoring. The gateway is an IP67-grade outdoor product, with a plastic case.

This guide explains how to start using the **EMB-Fem2GW-O-2G4**. The **EMB-Fem2GW-O-2G4** gateway is a multi service up-gradable platform, designed to meet IoT (Internet of Things) and M2M (Machine-2-Machine) scenarios. It enables LoRa® 2.4 GHz connectivity, having the role of fully compliant Gateway. It provides the LoRa® 2.4 GHz packet forwarder functionality: it has 3 Semtech SX1280 radio transceivers dedicated to the reception and 1 Semtech SX1280, reserved for the transmission. The radio section is based on the EMBIT MiniPCI-express board, EMB-LR1280-mPCIe-4x. It starts to operate as a LoRa® 2.4GHz base station, receiving radio packets and forwarding them to a LoRa® 2.4GHz Network Server. It has a TCP/IP connection through Ethernet, or via 4G connection, available through SIM card and 4G mini PCI express module. In the latter case, high latency could lead to the LoRa® 2.4 GHz network performance decrease. Its functionalities will be described in details in the following paragraphs. It includes GPS connectivity to locate the device.

Thanks to the Semtech SX1280 performances and the efficient Embit RF design, the possible radio ranges are up to 7 km in the country side and up to 400 m in urban areas.

The OS system is Linux based, and the customer can configure it according to his needs, with a complete root access. The **EMB-Fem2GW-O-2G4** provides a web interface to manage and configure the connectivity with the different network protocols.

The gateway must be powered from +9 to +28 VDC. With a different voltage, its functionalities may stop irretrievably. It has a peak of consumption less than 20 Watt.

2 Hardware Specification

- Processor: Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.2GHz
- RAM Memory: 1 GB, LPDDR2 SDRAM
- Flash Memory: 8 GB, EMMC Flash Memory
- LAN Connection: Ethernet RJ45 10/100/1000 Base-T
- LoRa® Connectivity: EMB-LR1280-mPCIe-4x, 3 LoRa® 2.4GHz Rx Channels, 1 LoRa® 2.4GHz Tx Channel
- Receiver Sensitivity: down to -129 dBm @ SF12 BW 812.5kHz
- Connectivity: GPS Module U-Blox NEO-M8-Q
- Cellular Connectivity: 4G LTE / 3G UMTS / 2G GPRS through Mini Size SIM embedded inside
- Cellular Module: Quectel EC21-E Mini PCIe
- Power Source: from +9 to +28 VDC
- Ports: Ethernet 10/100/1000 RJ 45 / 1 N-Type Antenna Connector for 2.4 GHz / Air Port
- Power Consumption: 20 W
- Operating System: Linux 9.8 Stretch
- Dimensions: L: 165 mm W: 165 mm H: 45 mm
- Weight: 1.0 kg
- Certifications: WIP

Figure 1 EMB-Fem2GW-O-2G4

3 Power Supply

The gateway must be powered from +9 to +28 VDC. It has a 2 poles male connector.

The female part is represented in the Figure below.

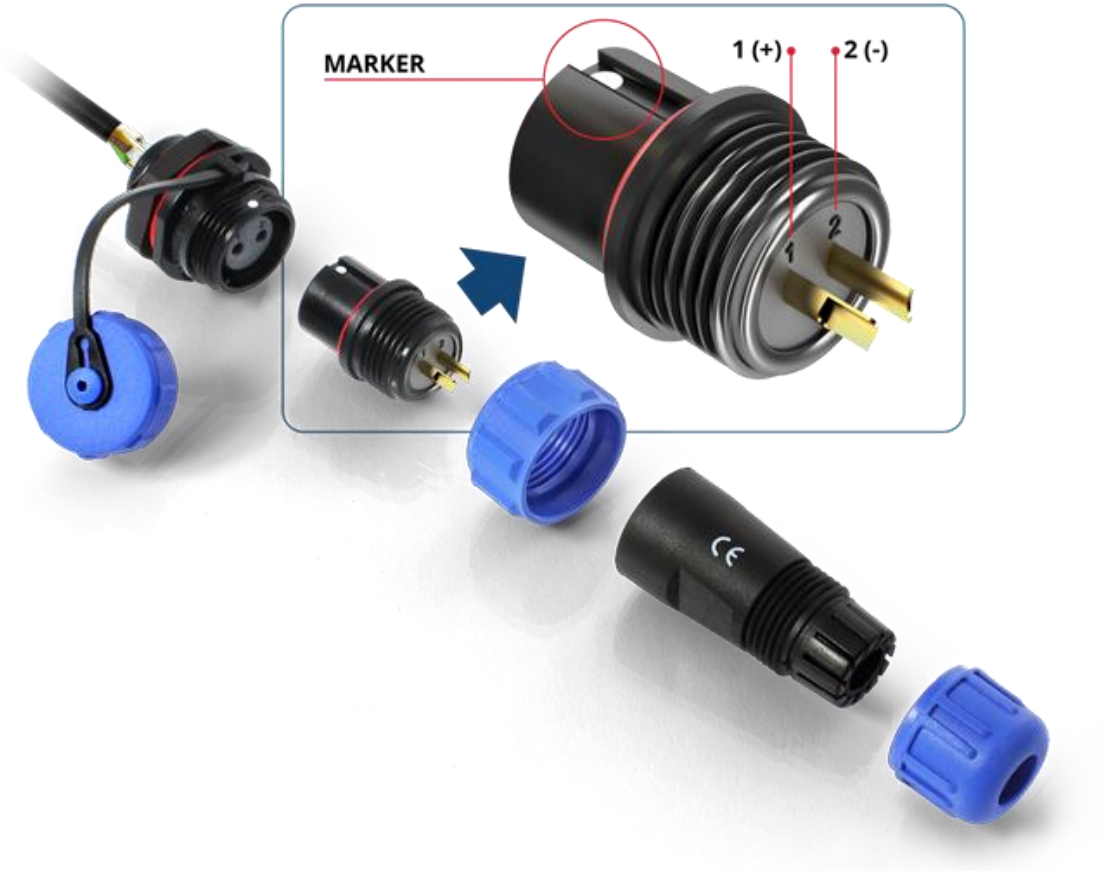

Figure 2 Power Connector Scheme

Pole 1 is **Vin** and Pole 2 is **GND**. A higher voltage than +28 VDC may stop its functionalities irretrievably.

4 Operating System

EMB-Fem2GW-O-2G4 Operating System is Linux 9.8 Stretch.

It is allowed full SSH root access to the final user, using as username and password:

Username: root

Password: raspberry

The final user can install, unistall, upgrade every single program.

Pay attention, each action may stop irretrievably the functionalities of the system.

5 Antenna Configuration

EMB-Fem2GW-O-2G4 has 1 N-Type Antenna Connector. In the same side of the Ethernet connector, SMA connector is placed.

Antenna has to be screwed on the connector.

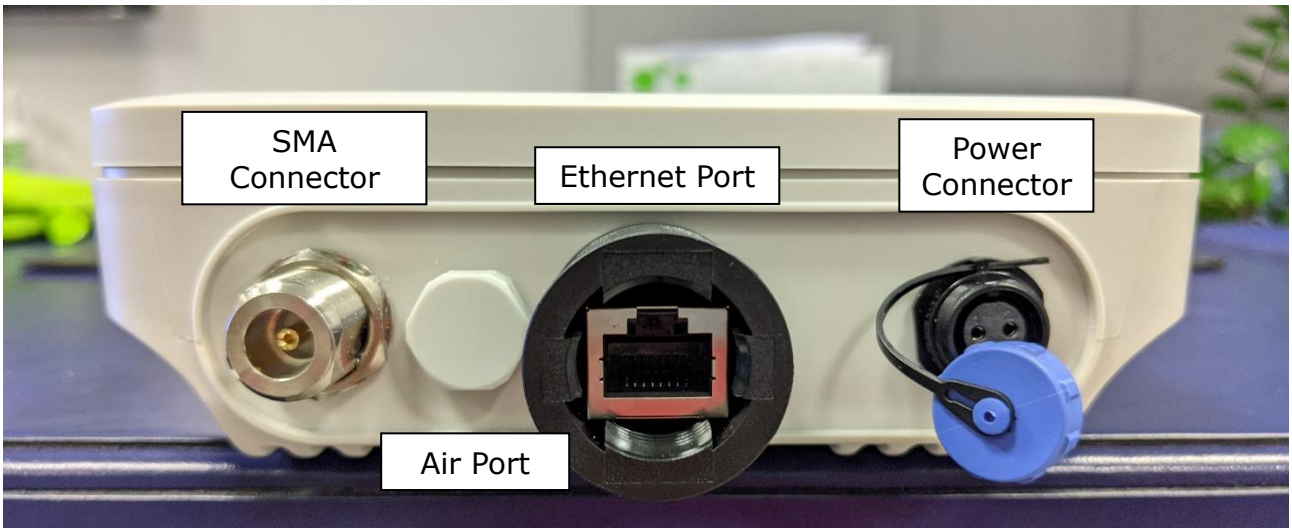

Figure 3 Side View of the EMB-Fem2GW-O

6 LoRa® 2.4 GHz Feature

LoRa® 2.4 GHz is the physical layer utilized to create the communication link. It is based on Chirp Spread Spectrum (CSS) modulation, which combines low power characteristics and increases the communication range. It exploits 2.4 GHz RF properties to achieve higher data rate and deep indoor penetration. 2.4 GHz ISM Band is extremely crowded, but high interference immunity is guaranteed thanks to the LoRa® modulation.

LoRa® 2.4 GHz protocol stack emulates LoRaWAN® behavior, put on top the LoRa® physical layer. It is supported by an established ecosystem of LoRa® 2.4 GHz devices that are available from multiple vendors.

In this network Architecture, three main roles are defined:

- **End-Device**: endpoints with sensors embedded;
- **Gateways**: they provide LoRa® 2.4GHz wireless connectivity to the devices. They are the connection between the devices and the IP backhaul network to the Network Server;
- **Network Server**: the intelligence of the network. It is centralized radio controller, which performs radio management, the provisioning and authentication of devices, and the delivery of the data to one or multiple application servers through a set of Application Programming Interfaces (APIs).

Another role is the **Application Server**. It is managed by the final customer and it is put on top of the Network Server. Full Network Image follows.

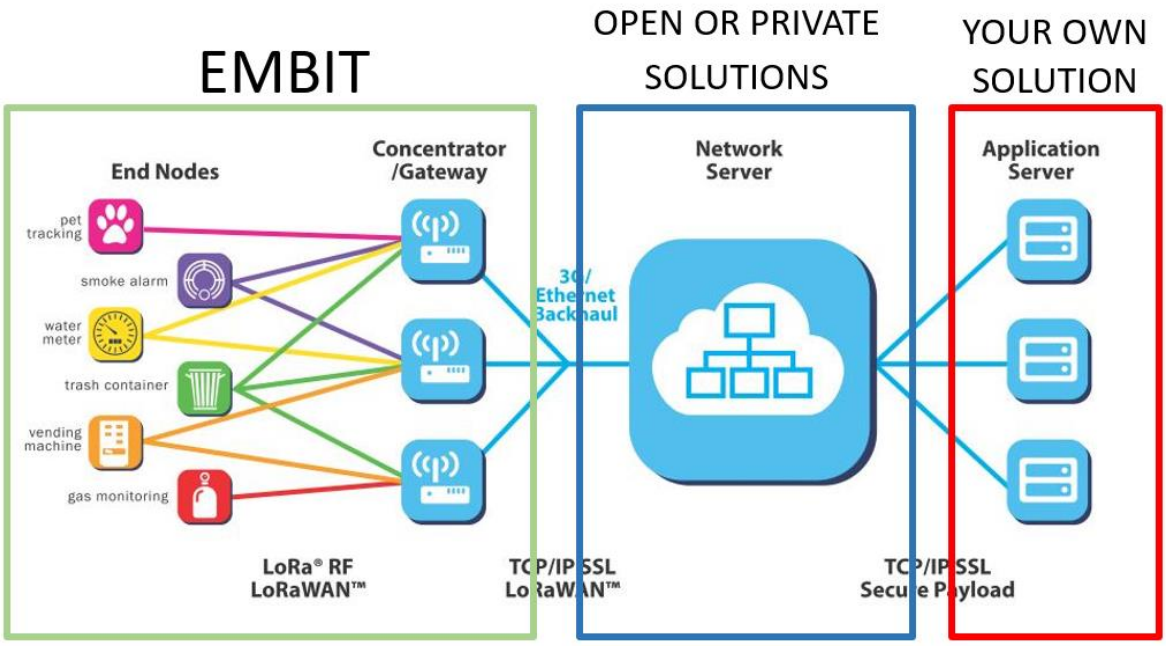

Figure 4 LoRa® Network Architecture

Each communication is fully encrypted with three keys, each one with a length of 128 bits. The algorithm used for it is AES-128. These algorithms have been analysed by the cryptographic community for many years, are NIST approved and widely adopted as a best security practice for constrained nodes and networks.

EMB-Fem2GW-O-2G4 provides LoRa® 2.4 GHz connectivity up to 2-3 km in urban area and up to 15 km in rural environment. It adds SF5 and SF6 to the well-known list of Spreading Factor. The Bit Rate varies from 1.2 kbps to 63 kbps.

The RF path is fully compliant to Semtech specifications and it is able to achieve a Receiver Sensitivity up to -129 dBm.

7 LoRa® 2.4 GHz Gateway Configuration Web Interface

EMB-Fem2GW-O-2G4 provides a web interface, which allows to select and configure the desired LoRa® 2.4 GHz packet forwarder.

It is reachable at *https://[gateway_IP_address]:10000*. The default data access is:

username: root

password: raspberry

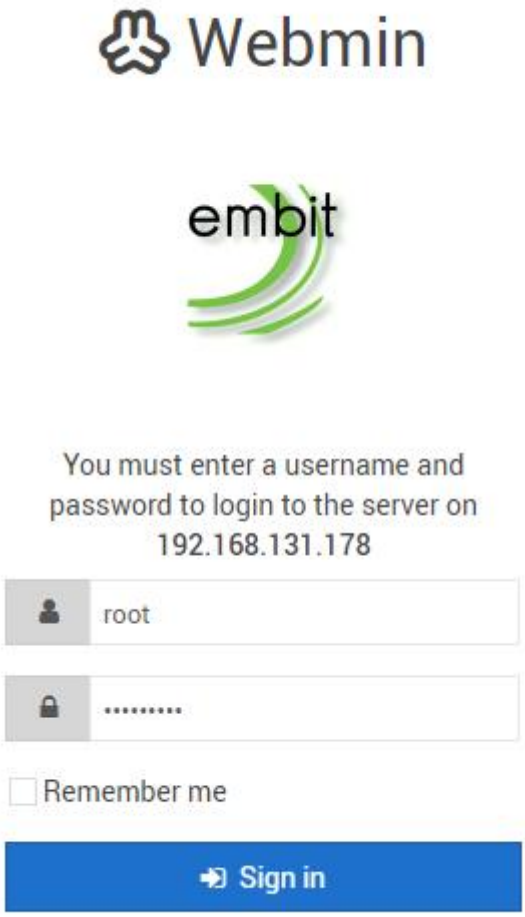

Figure 5 Log In Page

"Embit Gateway Configuration" is located in the left menu, in the category Networking.

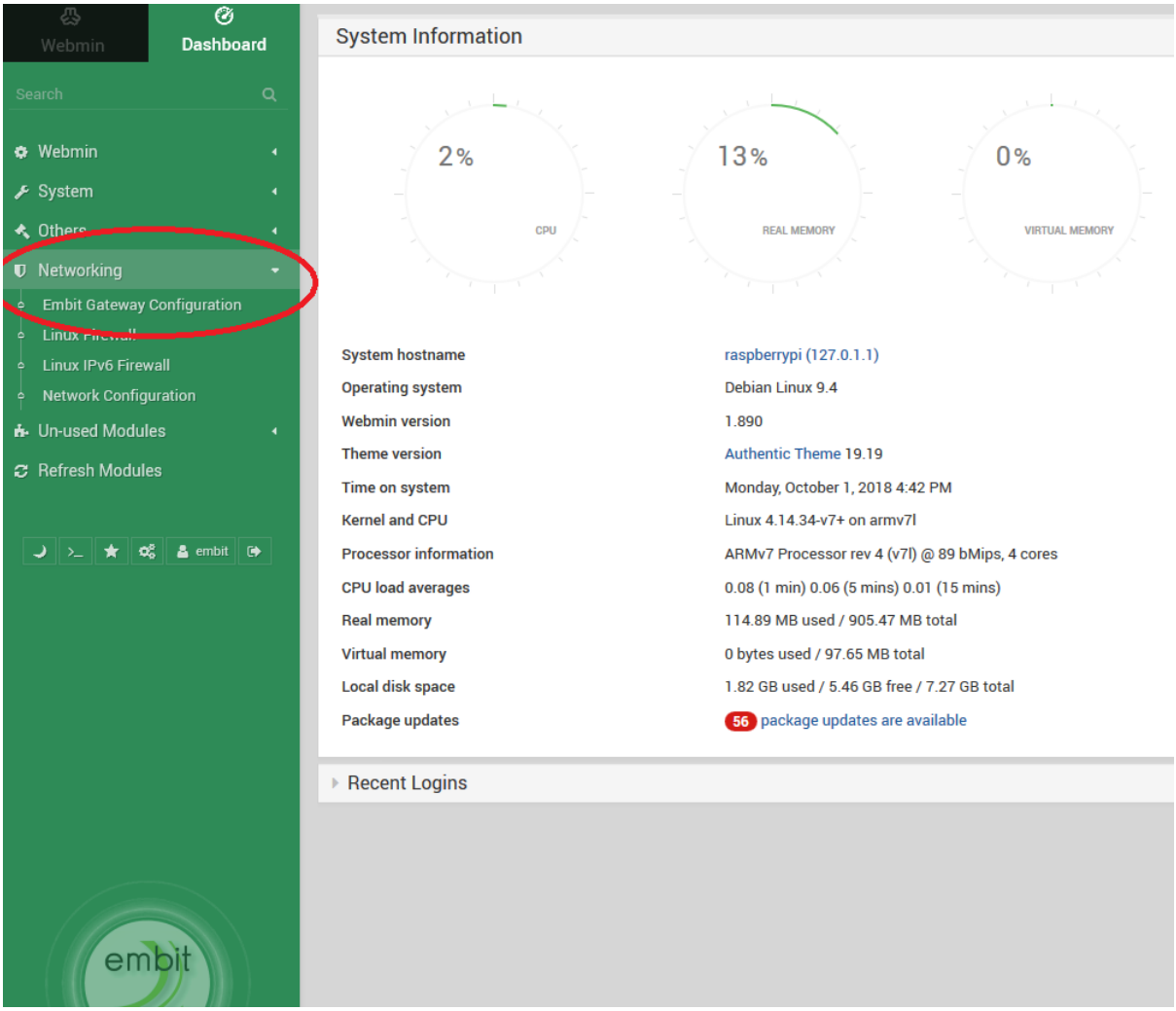

Figure 6 Main Page

In the "*Packet Forwarder*" tab, the system state information is reported. In this page is possible to select the LoRa® 2.4 GHz packet forwarder among the installed ones, from the drop-down menu. Once selected, the chosen LoRa® 2.4 GHz packet forwarder starts running.

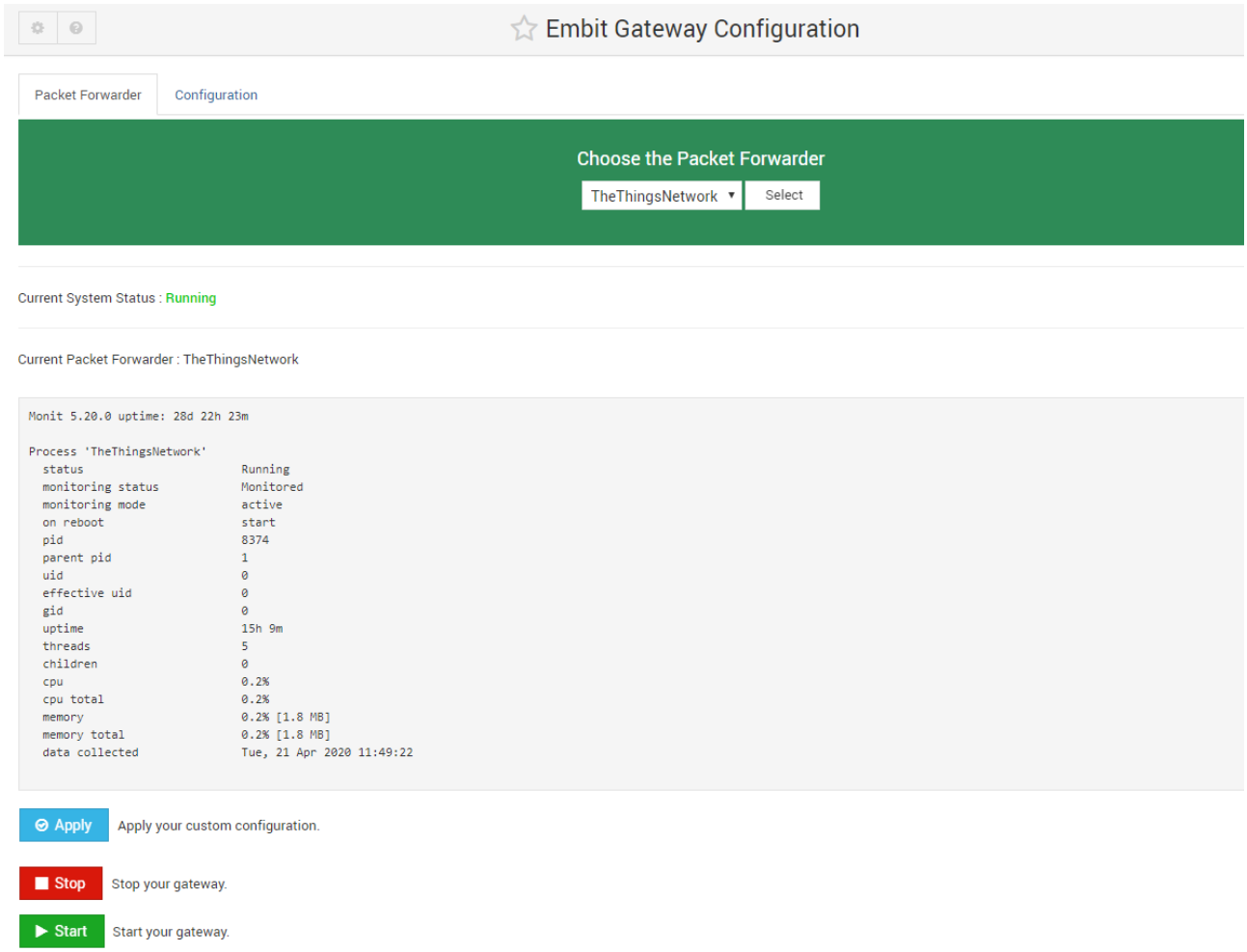

Figure 7 Embit Gateway Configuration Main Tab

In the configuration tab, it is possible to customize the network parameter of the LoRa® 2.4 GHz packet forwarders.

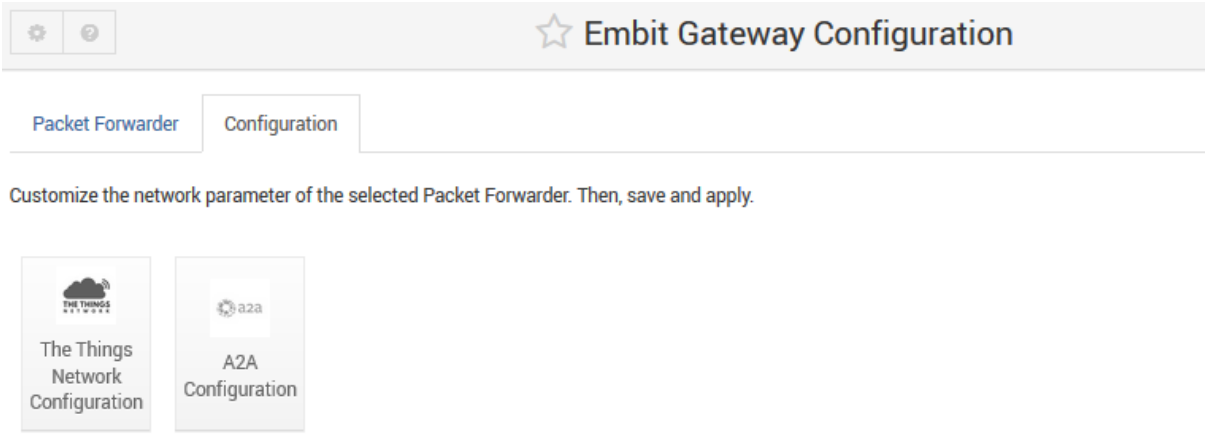

Figure 8 Embit Gateway Configuration Tab

The following parameters can be changed in the **The Things Network** packet forwarder.

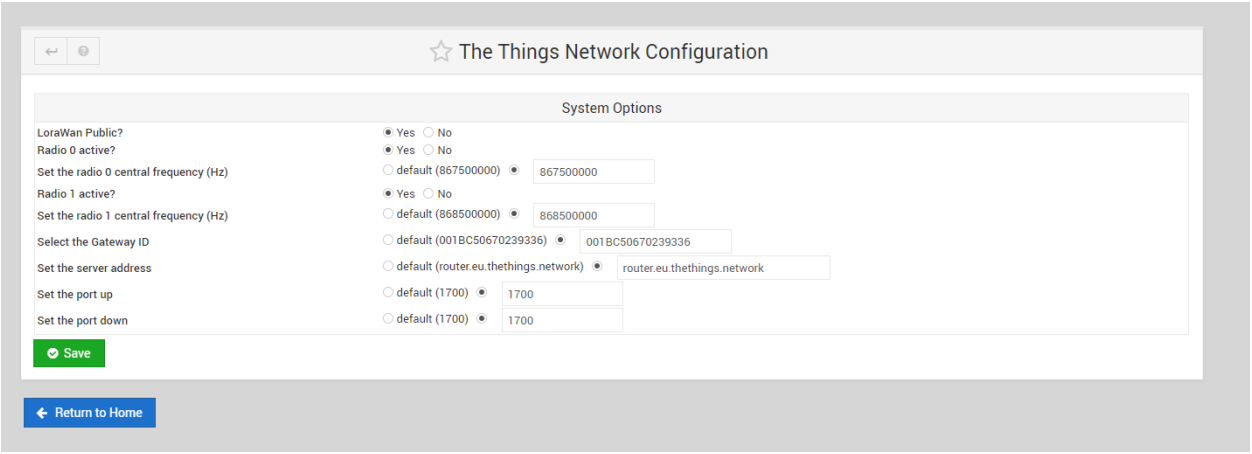

Figure 9 Embit Gateway Configuration Page

The changes are applied through the "*Apply*" button in the main tab.

8 LoRaWAN® Gateway EUI

EMB-Fem2GW-O-2G4 connects to the LoRa® 2.4 GHz network with a Gateway EUI (Extended Unique Identifier) written in the label. Gateway EUI can be changed using the the LoRa® 2.4 GHz Gateway Configuration Web Interface.

9 Example: A2A Smart City LoRa® 2.4 GHz Network Server

In this section, it is explained how to register a gateway in a LoRa® 2.4 GHz Network Server. The LoRa® 2.4 GHz Network Server taken into account for this example is A2A Smart City Network Server.

It is important to know that the **EMB-Fem2GW-O-2G4** can support different packet forwarders.

Step 1: Take your Unique Gateway EUI

The Unique Gateway EUI is a number which allows the Network Server to identify your gateway. This parameter is written in the label of the **EMB-Fem2GW-O-2G4** Gateway. It can be changed, according to your preferences, through Embit Gateway Configuration Web Interface, under the "Configuration Tab". Once pressed the button related to the Network Server you would like to use, the field "Select the Gateway ID" can be filled with a 8-bytes (hex) value. Be sure your **EMB-Fem2GW-O-2G4** is running A2A Smart City packet forwarder, checking on Embit Gateway Configuration Web Interface. In case it is not running the wanted packet forwarder, select it from the drop-down menu and press "Apply".

Step 2: Sign Up with your A2A Smart City Account

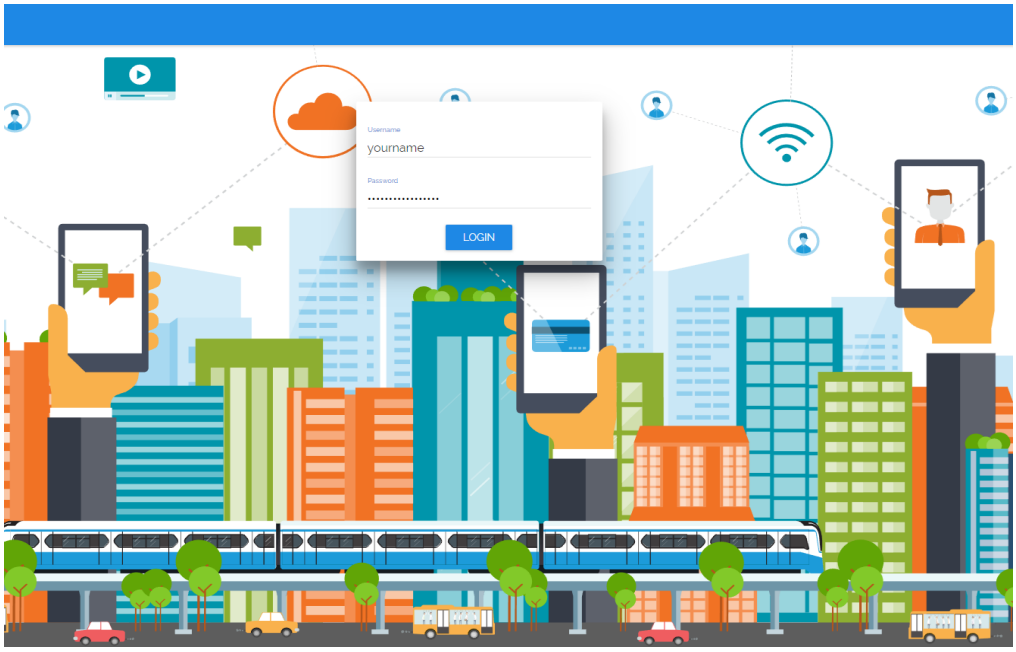

Figure 100 A2A Log In Page

Step 3: Create a Gateway

In "Gateway" Tab, press "+ INSERT" to add your gateway to the Gateway List (Figure 15).

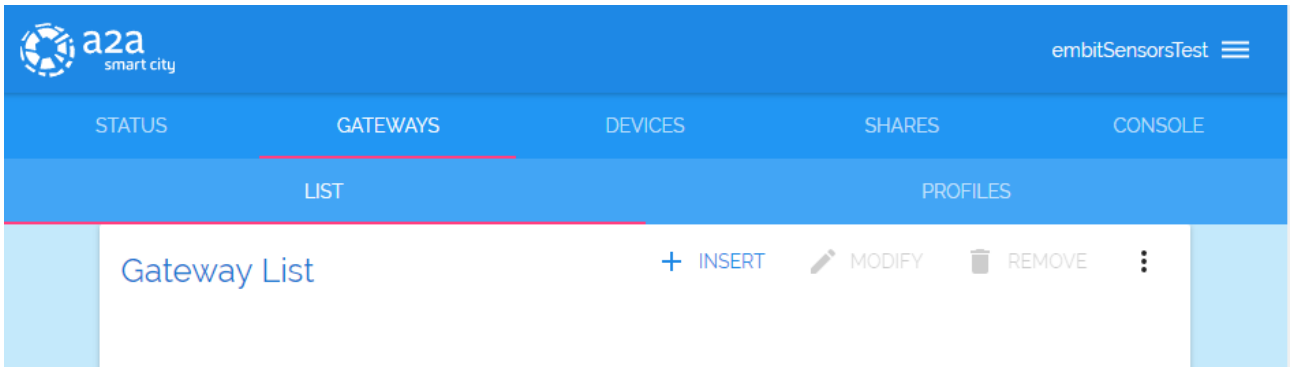

Figure 11 Gateway List Web page

Step 4: Register your Gateway Data

Add your Gateway EUI to the Address field and select the Profile among the available ones.

Note: if there are no profiles available, you can create your own profile, under "Profiles" tab, pressing "+ INSERT". At the end of each registration, pay attention to press "SAVE".

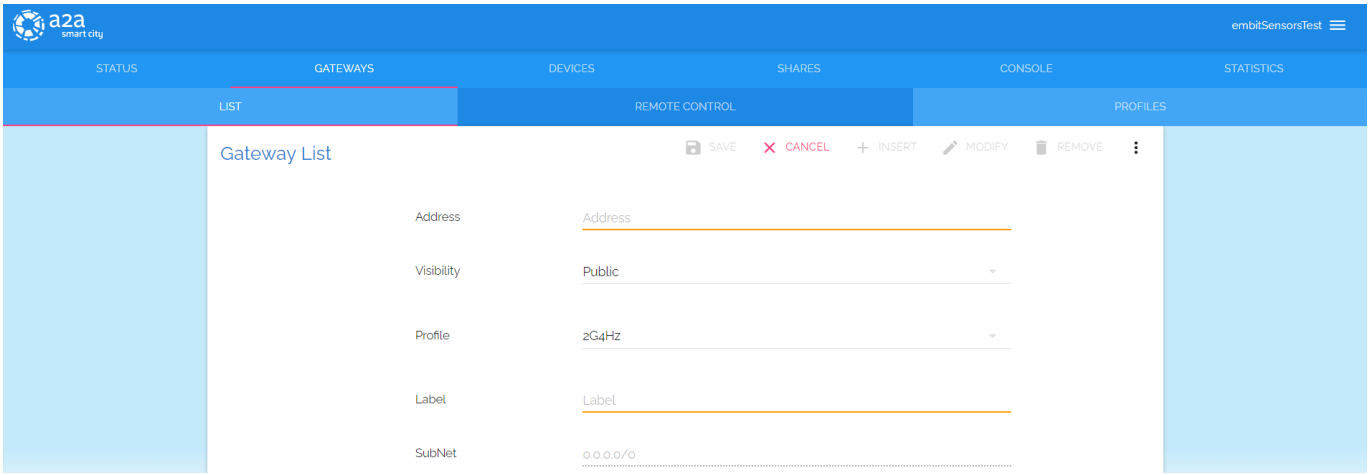

Figure 12 Gateway List - Profile

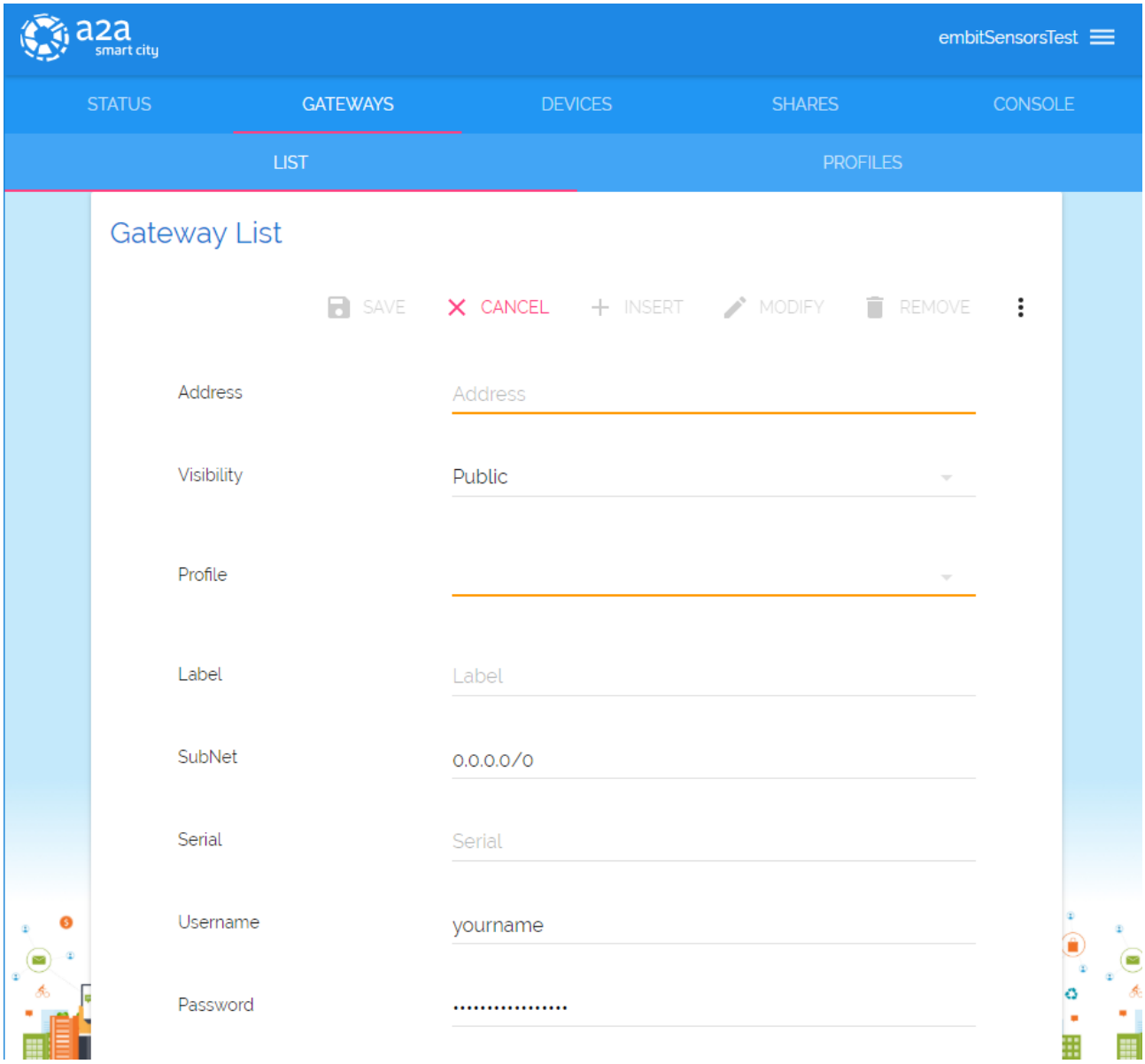

Figure 13 Gateway List - Add Gateway

Step 5: Look at the Data

At this point, your gateway is on the Gateway List page. Pressing on "Info", and then on "EVENTS" tab it is possible to look at the data which your gateway is transmitting and receiving (Figure 18). The payload is encrypted, to guarantee privacy and security.

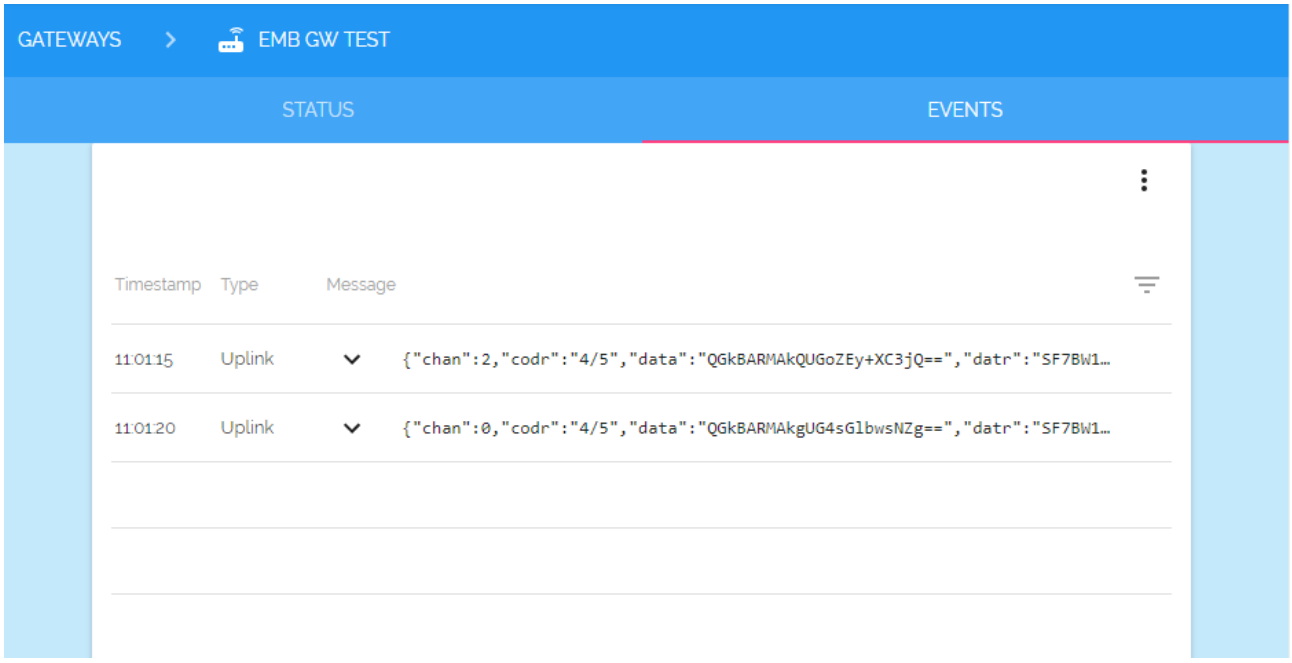

Figure 11 Gateway Events

Step 6: Create your own Application

To connect your devices to your gateway, you need to create your application in "Devices" tab (Figure 19). In the Application List, press "+ INSERT" and a configuration pop up will appear (Figure 20). In the ID and Label fields you can put values and text human readable. Join EUI field represents the App EUI, and it has to be set with a 8-bytes (hex) value.

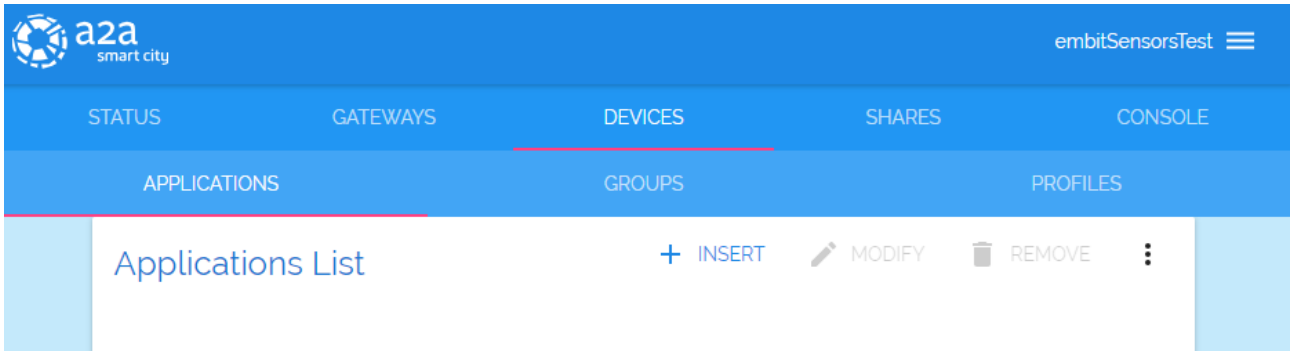

Figure 12 A2A Application List

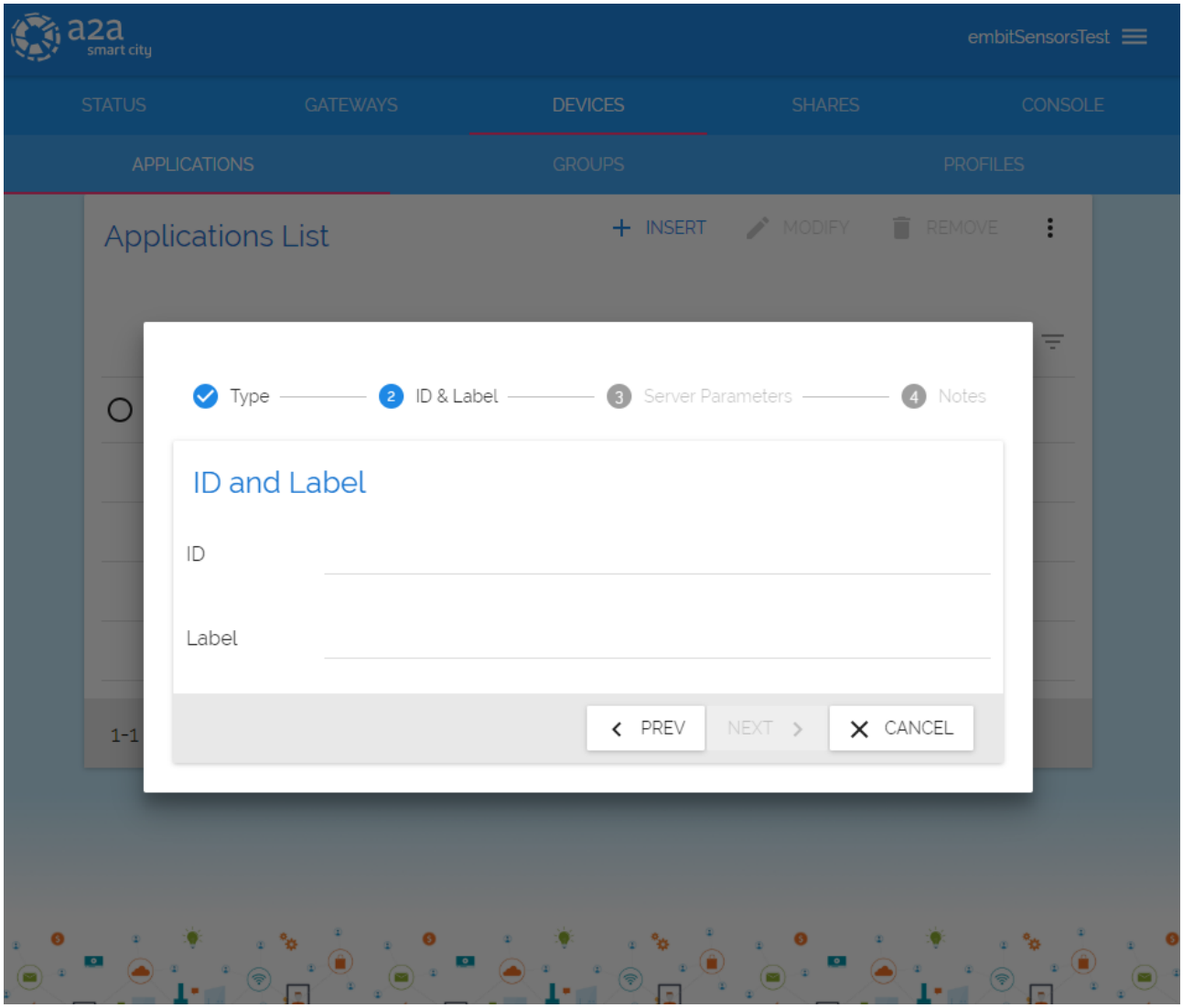

Figure 13 Device Configuration

Step 7: Register your Device

Selecting your new Application, "Applications Devices" menu appears (Figure 21), just below the Application List. Press "+ INSERT" and register your Device. In case of choosing OTAA activation, the Device EUI field has to be filled with a 8-bytes (hex) value and the App Key field with a 16-bytes (hex) value.

If ABP activation is chosen, DevEUI, DevAddr, Network Session Key and Application Session Key has to be set with 8-bytes (hex) value, 8-bytes (hex) value, 16-bytes (hex) value and 16-bytes (hex) value respectively.

Figure 14 Application Devices Web Page

Step 8: Let's Network Start

If OTAA activation mode is selected, your end-device has to be set with Device EUI, App EUI and App Key. These parameters must be the same configured in the Network Server Application. Then, the end-device has to send a Join Request. When a Join Accept message is received by the end-device, the network is started.

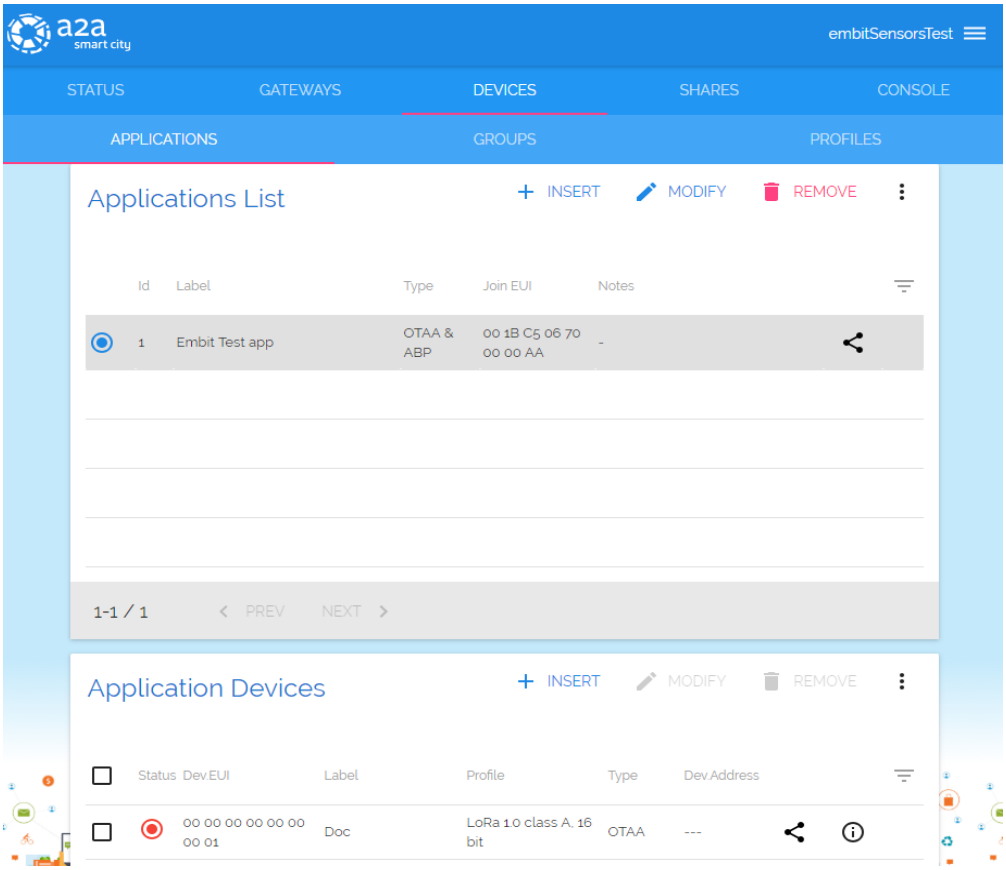

Figure 15 Applications List Web Page

The packets are visible under the Gateway Info Page, as described in Step 5, or pressing on the "Info" icon related to your Dev EUI in the Application Devices List.

In the "Console" tab of your device, it is possible to look at the data transmitted and to set downlink message which are to be sent by the Gateway to your device during the Rx windows. In "Logs" table data are showed without encryption, because only the account and application owner can access to this page.

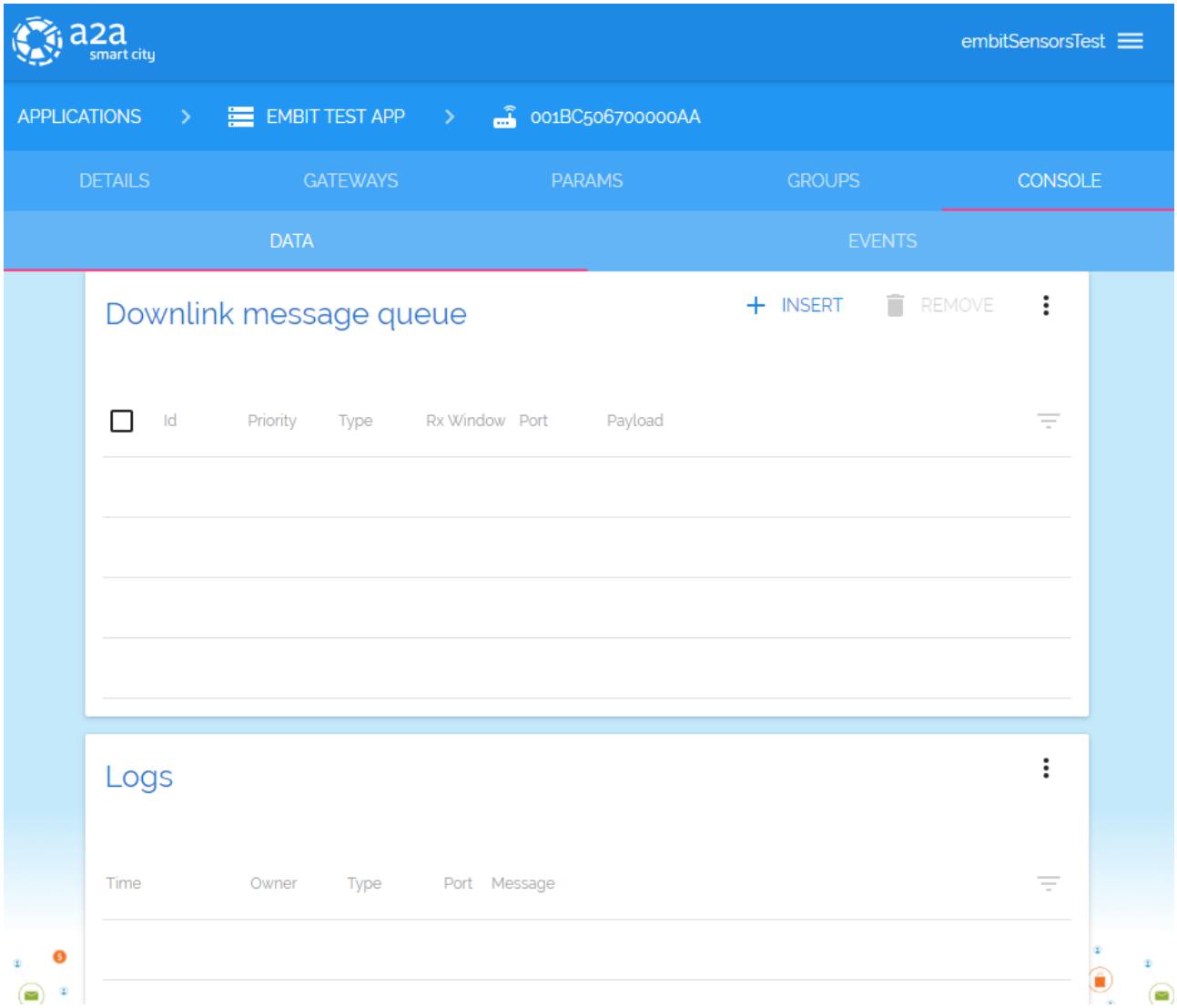

Figure 16 Device Data Web Page

If ABP activation mode is chosen, your end-device needs to be set with DevEUI, DevAddr, Network Session Key and Application Session Key. These parameters must be the same configured previously in the Network Server. In this case, the network starts when a packet with all these valid fields is received.

10 IP Backhaul Connection

EMB-Fem2GW-O-2G4 supports two kinds of backhaul IP connection:

- Ethernet IP connectivity;
- Cellular connectivity.

The system is connected to the Ethernet Network through Ethernet Cable. IP address is assigned through DHCP.

Cellular connectivity is achieved using Quectel LTE Module. **EMB-Fem2GW-O-2G4** supports mini SIM Size, with a Push-Push connector. It automatically guarantees LTE connectivity, and without it switches to 3G/UMTS or to GPRS connection according to the cellular coverage.

11 LTE Connection

In this section is described how **EMB-Fem2GW-O-2G4** manages the LTE pheripheral.

How to set up a LTE Network is explained. In Linux OS, LTE interface is called ppp0. We setup the OS to start the LTE module at boot time, according to the lte configuration file stored in /etc/ppp/peers.

This file is composed as follows:

#connect is the command to manage the script to launch LTE connection. The last name, in this case tre.it, is the APN server name.

connect "/usr/sbin/chat -v -f /etc/chatscripts/gprs -T tre.it"

#serial port adopted by the LTE Module

/dev/ttyUSB3

#With this option, the peer will have to supply the local IP address during IPCP negotiation (unless it specified explicitly on the command line or in an options file)

Noipdefault

#Add a default route to the system routing tables, using the peer as the gateway, when IPCP negotiation is successfully completed

defaultroute

replacedefaultroute

#Do not require the peer to authenticate itself

Noauth

Do not exit after a connection is terminated; instead try to reopen the connection

persist

Ask the peer for up to 2 DNS server addresses. The addresses supplied by the peer (if any) are passed to the /etc/ppp/ip-up script in the environment variables DNS1 and DNS2, and the environment variable USEPEERDNS will be set to 1. In addition, pppd will create an /etc/ppp/resolv.conf file containing one or two nameserver lines with the address(es) supplied by the peer.

Usepeerdns

Steps to modify this file follows:

1. Enter through SSH Connection in the Gateway using as username root and password raspberry
2. Move to the proper folder using the command
   cd /etc/ppp/peers
3. Open a Linux File editor to modify the file using the command
   nano lte
   The following screen appears

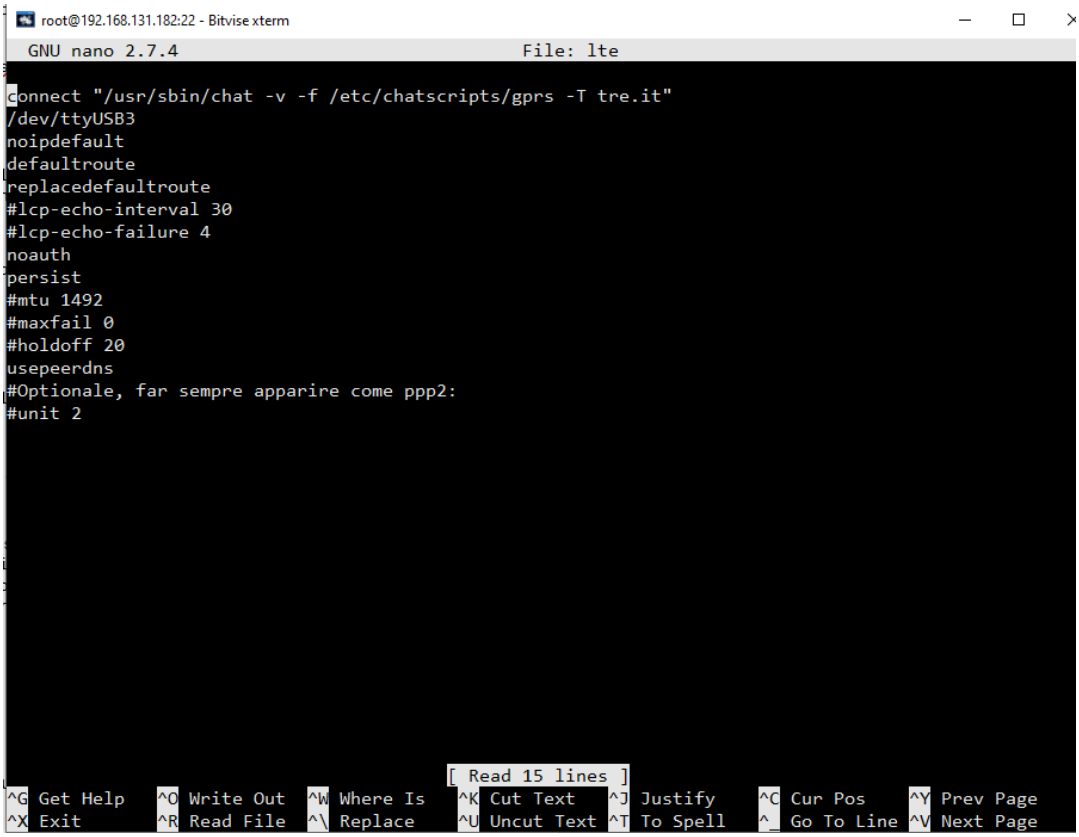

Figure 17 /etc/lte file view

4. Change tre.it with your APN address
5. Press Ctrl+O to save, confirming the name of the file pressing ENTER
6. Restart the LTE network using the commands

   ifdown lte

   ifup lte

12 Assembly

In this section, it is described how to mount the **EMB-Fem2GW-O-2G4** on a pole. It has to be in a position sufficiently high to guarantee a good communication range.

EMB-Fem2GW-O-2G4 is provided with the mounting bracket, shown in the following picture.

Figure 18 Mounting Bracket with Gateway

The mounting bracket has to be attached to the back of the **EMB-Fem2GW-O-2G4** using screws and washer and attached on the pole as the image below.

Figure 19 EMB-Fem2GW-O-2G4 on the pole

13 Disclaimer of liability

The information provided in this and other documents associated to the product might contain technical inaccuracies as well as typing errors. Regulations might also vary in time. Updates to these documents are performed periodically and the information provided in these manuals might change without notice. The user is required to

ensure that the documentation is updated and the information contained is valid. Embit reserves the right to change any of the technical/functional specifications as well as to discontinue manufacture or support of any of its products without any written announcement.

13.1 Disclaimer of liability

The user must read carefully all the documentation available before using the product. In particular, care must be taken in order to comply with the regulations (e.g., power limits, duty cycle limits, etc.).

13.2 Handling Precautions

This product is an ESD sensitive device. Handling precautions should be carefully observed.

13.3 Limitations

Every operation involving a modification on the internal components of the module will void the warranty.

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