EMB-Fem2GW-O

User Manual

Embit S.r.l.

Document information

Versions & Revisions

Revision	Date	Author	Comments
1.0	2021-02-09	Embit-AM	Initial release
1.1	2021-06-17	Embit-DL	Added installation guide
1.2	2022-11-21	Embit	Aligned to the new Hardware release with POE
1.3	2023-04-27	Embit	Minor Fixes
2.0	2025-08-10	Embit-DB	New OS Structure & New UI
2.1	2025-10-24	Embit-DB	Gateway Connections (HTTPS & SSH)
2.2	2025-11-06	Embit-DB	LLMNR Protocol

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1 Introduction

The EMB-Fem2GW-O gateway is a multi-service platform designed to meet the requirements of IoT (Internet of Things) and M2M (Machine-to-Machine) scenarios. It integrates the EMB-LR130x-mPCIe card and the Semtech Packet Forwarder to provide LoRaWAN® 868/915 MHz connectivity, acting as a fully compliant LoRaWAN® Gateway.

This robust device, with an IP67-grade plastic enclosure, supports IoT implementations that demand worldwide interoperability and the management of battery-powered end devices over long distances.

Key Features:

- **LoRaWAN® Connectivity**: Based on the EMBIT Mini PCI-express board, EMB-LR130X-mPCIe, it offers LoRaWAN® packet forwarder functionality.
- **Network Connectivity**: Provides TCP/IP connection via Ethernet or LTE, with the latter enabled through a SIM card slot and an LTE Mini PCI Express module.
- **Localization**: Includes integrated GPS connectivity for device geolocation.
- **Radio Performance**: Thanks to the Semtech® SX130X performance and efficient Embit RF design, it achieves radio ranges of up to 15 km in rural areas and up to 3 km in urban environments.
- **Operating System**: Linux-based, offering an integrated web interface for managing and configuring network protocols.
- **Power Supply**: The gateway is powered via PoE (Power over Ethernet) compliant with IEEE 802.3af/at standards.

This guide explains how to start using the EMB-Fem2GW-O and will describe its functionalities in detail in the following paragraphs.

2 Hardware Specification

- Processor: CPU ARM Cortex-A72 quad-core a 64 bit da 1,5 GHz
- RAM Memory: 1/2/4 GB, LPDDR4 DRAM
- Flash Memory: 8/16/32 GB, eMMC Flash Memory
- LAN Connection: Ethernet RJ45 10/100/1000 Base-T
- LoRa® Connectivity: EMB-LR130X-mPCIe
- Receiver Sensitivity: down to -141 dBm @ SF12 BW 125kHz
- 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-EUX mPCIe
- Power Source: IEEE 802.3af/at Power Over Ethernet
- Ports: Ethernet 10/100/1000 RJ 45 / N-Type antenna connector / Air Port
- Power Consumption: 5 Watt (average)
- Operating System: Debian 13 “Trixie” based Operating System
- Dimensions: L: 165 mm W: 165 mm H: 45 mm
- Weight: 1.0 kg
- Certifications: CE, RED - Absolute Maximum Ratings

2.1 Power Consumption

The power consumption of the **EMB-Fem2GW-O** has been tested in two different conditions: outside the thermal chamber and inside the thermal chamber. The results are represented on the following tables:

2.1.1 Outside Thermal Chamber:

LTE Transmission	
Idle Condition in LTE Mode	**Connection in LTE Cell in LTE Mode**
405 mA peak	700 mA peak

Table 1 - Outside Thermal Chamber - LTE Transmission

GSM Transmission	
Idle Condition in GSM Mode	**Connection in GSM Cell in GSM Mode**
405 mA peak	1110 mA peak

Table 2 - Outside Thermal Chamber - GSM Transmission

2.1.2 Inside Thermal Chamber:

LTE Transmission	
Idle Condition in LTE Mode	**Connection in LTE Cell in LTE Mode**
400 mA peak	690 mA peak
Send LoRa® Packet in LTE Mode	**Switch from LTE to GSM Mode**
700 mA	1600 mA peak

Table 3 - Inside Thermal Chamber - LTE Transmission

GSM Transmission	
Idle Condition in GSM Mode	**Connection in GSM Cell in GSM Mode**
400 mA peak	1200 mA peak
Send LoRa® Packet in LTE Mode	**Switch from LTE to GSM Mode**
1200 mA peak	1600 mA peak

Table 4 - Inside Thermal Chamber - GSM Transmission

***Note**: the peak values are reached for a period of <1 ms and do not represent the continuous current consumption.*

2.2 Thermal Tests

The **EMB-Fem2GW-O** has been tested by using the Embit Thermo Camera and for three different supply voltage values.

All the temperatures were read 1 hour after switching on with Wi-Fi, LTE, LoRa® and GPS ***turned on.***

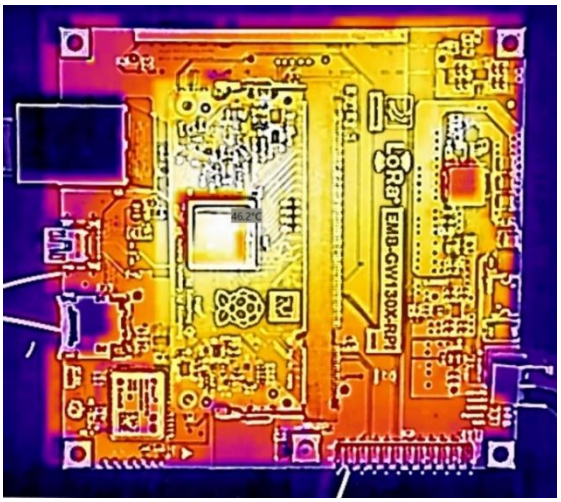

Figure 1 - Thermal stress test

The maximum temperature registered has been 46.2 °C on the MCU Core and the maximum current measured is 0.377 A.

3 Gateway Installation Guide

3.1 Pole mounting

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

The **EMB-Fem2GW-O** must be installed vertically, with the cables exposed on the lower side of the gateway (see Figure 3). Otherwise, the correct functioning of the product is not guaranteed.

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

Figure 2 - Mounting Bracket with Gateway

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

Figure 3 - EMB-Fem2GW-O on the pole

3.2 Ethernet connection

In order to exploit the Ethernet connection of the **EMB-Fem2GW-O**, you have to simply plug the proper cable (not provided) in the Ethernet port.

Once the cable is fixed, you have to screw the outdoor IP68 socket adapter (Figure 4) to avoid water leaks.

Figure 4 - Waterproof outdoor socket adapter

3.3 Power supply & Grounding

The gateway must be powered by POE following the standard IEEE 802.3af/at. We recommend to use certified Power Injectors, capable to provide at least 20 Watts.

The **EMB-Fem2GW-O** does not require ground connection.

Note: *The external power supply, of course, must be grounded since it provides the ground reference. Please check that your power supply is properly grounded.*

4 LoRaWAN® Features Overview

In this network Architecture, three main roles are defined:

- **End-Device**: endpoints with sensors embedded;
- **Gateways**: they provide LoRaWAN® 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.

***NOTE**: nowadays the most common Network Server, such as The Things Network, Chirpstack, and more, also integrates the Application Server functionalities and configurations in their web interface.*

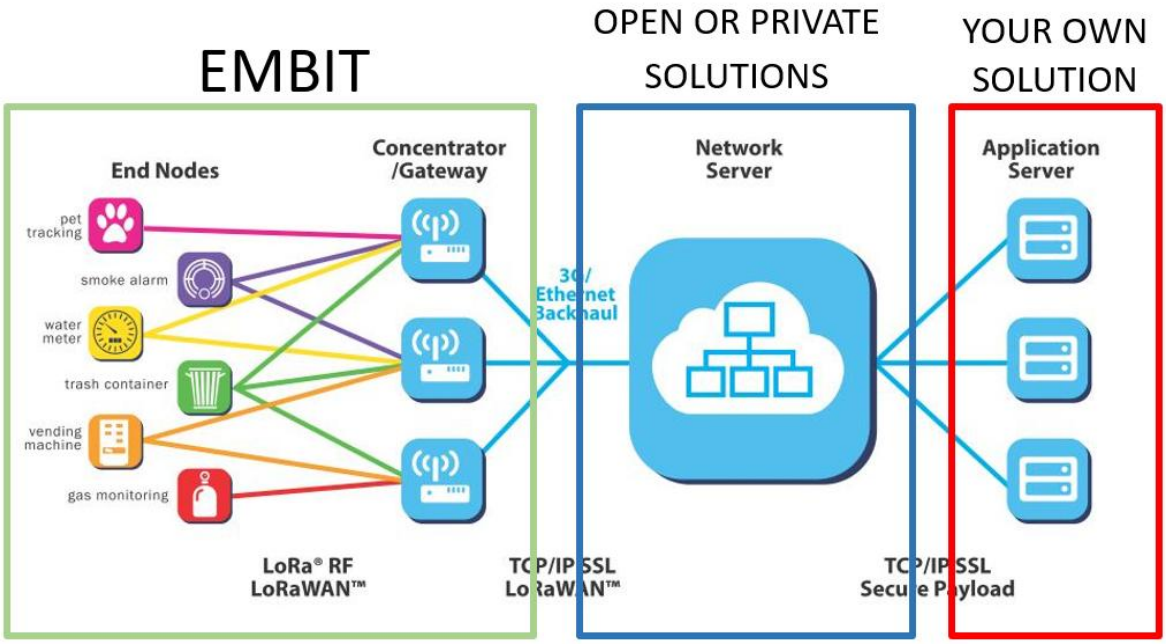

Figure 5 - LoRaWAN® Network Architecture

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 analyzed 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 provides LoRaWAN® 868/915 MHz connectivity up to 3 km in urban area and up to 15 km in rural environment.

The RF path is fully compliant to Semtech® specifications and it is able to achieve a Receiver Sensitivity up to -141 dBm.

5 Gateway Features & Web User Interface

The **EMB-Fem2GW-O** runs a Debian Linux–based operating system, customized by Embit to optimize both peripheral management and device power consumption.

The system provides a Web User Interface (Web UI) that allows monitoring, management, and configuration of all aspects related to radio communication protocols. In addition, the Web UI enables the user to perform basic system administration tasks.

The interface can be accessed from any web browser at the following address:

https://[gateway_IP_address]:10000

5.1 Network Connections

The **EMB-Fem2GW-O** supports two kinds of backhaul IP connection:

- Ethernet connectivity through the Ethernet RJ45 port.

  In this case the IP Adress is assigned through DHCP.

- LTE connectivity through a Quectel LTE Modem.

EMB-Fem2GW-O 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.

The **EMB-Fem2GW-O** is accessible by default through:

- HTTPS connection at port 10000 – Cockpit Interface.
- SSH connection at standard port 22, with username and password.

The device has LLMNR enabled (it exposes port 5355) to allow name resolution in local networks without a DNS server.

IMPORTANT NOTE *– The EMB-Fem2GW-O is also available in a "NO LTE" version; in this case, only Ethernet IP connectivity will be available.*

5.2 Users & Password Management

5.2.1 Standard User: user

The default customer account is ***user***, which is created with the password ***embit***.

On the first login, the user will be required to change this password to one that complies with the system's minimum-security requirements:

- Minimum length: 8 characters
- At least 1 uppercase letter
- At least 1 lowercase letter
- At least 1 number
- At least 1 special character

The user account is intended for customer operation through the Cockpit web interface. From the CLI, the account has only the permissions granted to non-privileged Linux users and cannot perform administrative tasks.

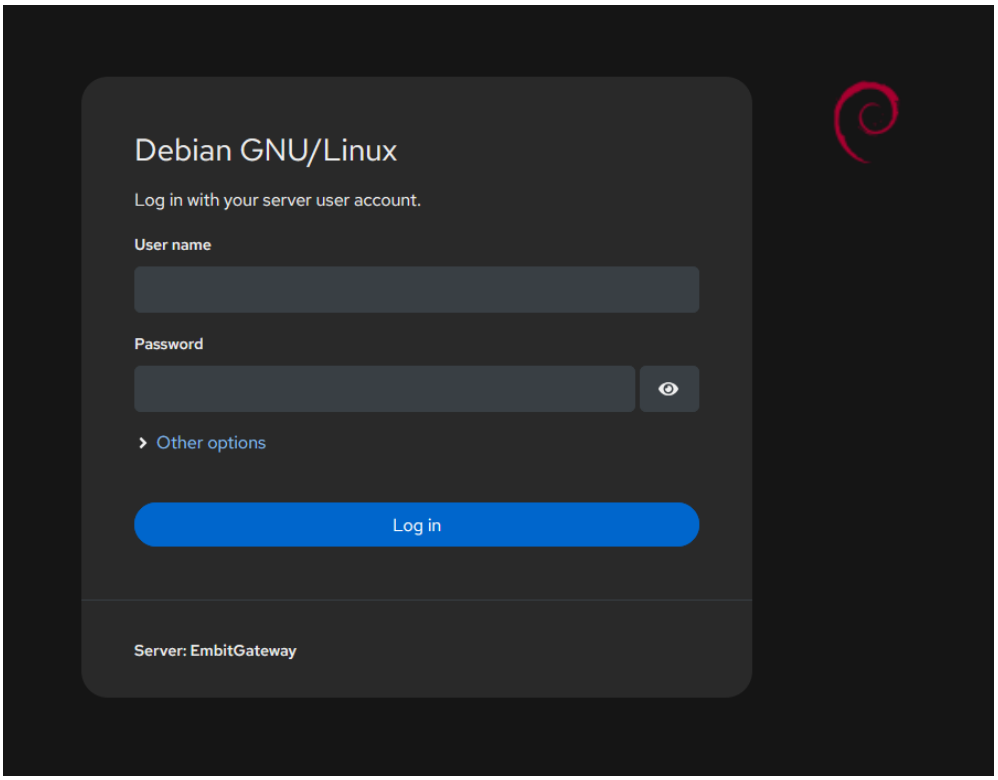

Figure 6 - Login Page

5.2.2 Full Root Access

If advanced access is required (e.g., for development purposes), an **administrator** user with full root capabilities can be provided, upon explicit agreement with *Embit S.r.l.*

- The admin account is created by Embit during factory testing with username and password provided by the end customer, that must comply with the same minimum-security requirements listed above for the "Standard User".
- The administrator user can escalate privileges and become root, granting full control over the system through *sudo* command.

5.2.3 Password Change in Cockpit Web UI

You can change your password as a Standard User from the "Accounts" Tab.

(If you have the *administrator* account, you can manage also other users' passwords).

When changing a password through the Cockpit web interface, the system enforces predefined security requirements.

- If the entered password does not meet these requirements, Cockpit will display a warning and ask whether the user wants to "*force the use of an insecure password.*"

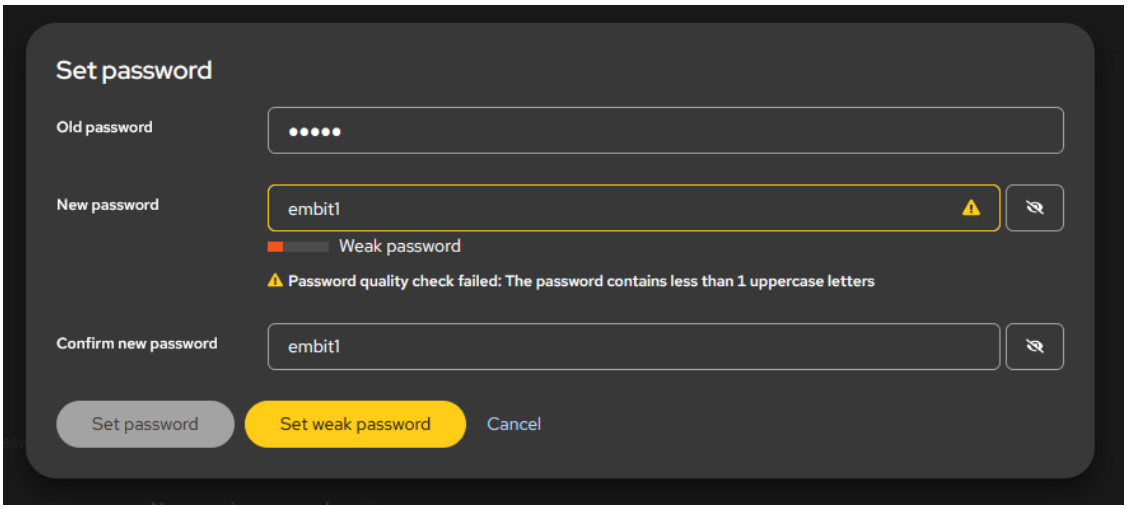

Figure 7 - "Set week password" warning

- Cockpit also provides a password strength indicator. Please note that this indicator is independent from the system's actual requirements. For example, a password such as *Test123!* fully meets the minimum requirements and will be accepted, even though the indicator may classify it as "weak"; this indicator shows the actual strength of the password.

Administrator behavior: The *administrator* user can override Cockpit's warnings and set any password, even if it does not comply with the system requirements.

User behavior: The *user* account cannot force the setting of a weak or non-compliant password. Even if Cockpit displays the option, the system will reject such passwords.

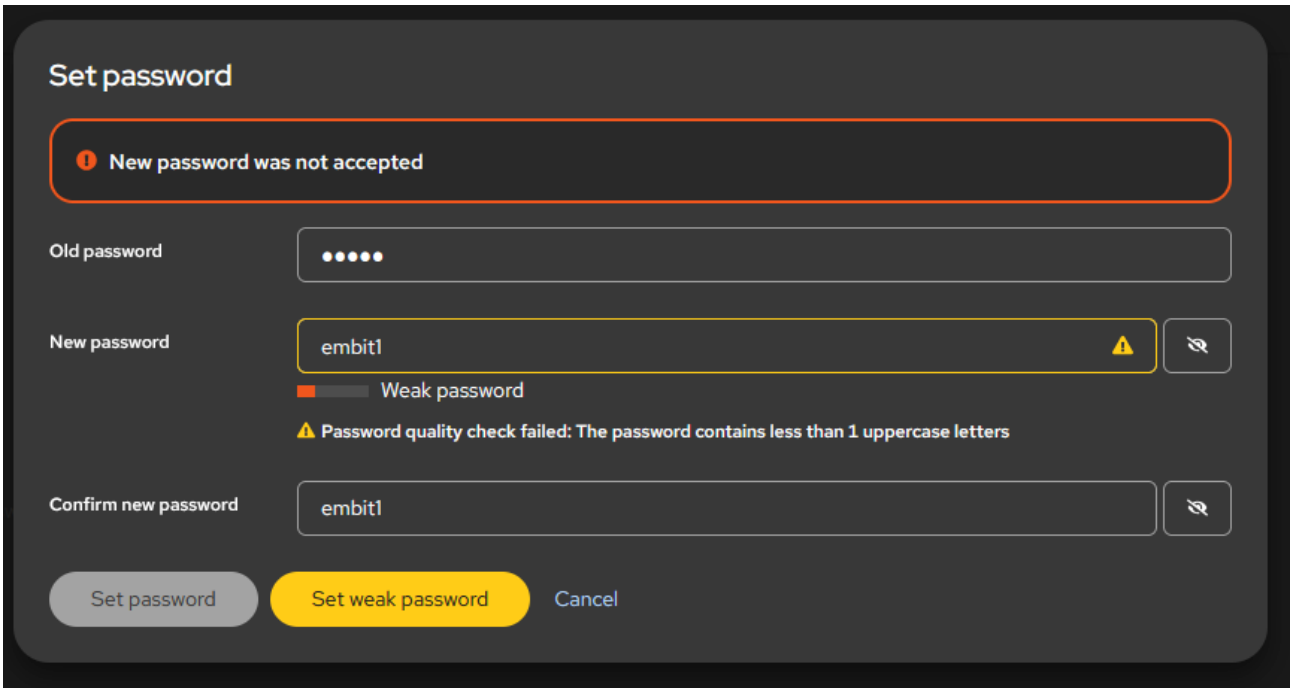

Figure 8 - Week password enforcement error

5.3 Embit Page – Gateway Configuration

All configurations related to the Gateway's functionalities are available to the user in the "Embit" tab, located on the left side of the Cockpit interface.

5.3.1 LoRaWAN

Figure 9 - LoRaWAN Configuration

This section serves as your central control panel for configuring and managing the LoRaWAN connectivity of your gateway. At the top-right, you'll find a toggle switch that allows you to easily enable or disable the entire LoRaWAN functionality of the device, giving you immediate control over its operation. You'll also see essential identifiers displayed, such as the **Gateway EUI**, which is your device's unique 64-bit identifier necessary for registration with any LoRaWAN Network Server, and the **LoRaWAN Region**, indicating the specific frequency plan (e.g., EU868) your gateway is configured to operate within. The **LoRaWAN Card** field provides information about the installed LoRaWAN module.

Below these identifiers, you can define your connection to a LoRaWAN Network Server.

- **Network Server** field: hostname or IP address of the LoRaWAN Network Server your gateway will communicate with. By default this field is set to *eu1.cloud.thethings.network.*
- **Network Server Port** specifies the UDP port number used for this communication, commonly set to 1700.

***NOTE**: It is recommended to turn off the packet forwarder before configuring new parameters, and turn it back on afterwards.*

5.3.2 LTE APN Configuration & Watchdog

***IMPORTANT NOTE**: For the "NO LTE" version of the EMB-Fem2GW-O, this section will not appear in the Web UI, as the device is not equipped with the Quectel LTE Modem.*

Once the SIM card has been inserted into the gateway, the only parameter required to enable LTE connectivity is the correct APN. Upon successful SIM card detection, the ICCID will automatically appear.

To check if the LTE connection is active, navigate to the "LTE Interface" link located in the bottom-left corner of this section.

Figure 10 - LTE & Watchdog Configuration

This section also allows you to configure and manage the "LTE Watchdog," a system service that periodically checks the LTE connectivity status by pinging user-specified IP addresses and reboots the modem if malfunctions are detected. By default, the watchdog is disabled to prevent periodic reboots caused by unreachable IP addresses (e.g., due to private APN services). If enabled without specifying any IP addresses, the service will attempt to ping major public DNS servers (1.1.1.1, 8.8.8.8, 1.0.0.1, 8.8.4.4).

5.3.3 GPS

The gateway is equipped with a U-Blox GNSS module that provides the positional data required to locate the gateway itself, including altitude, latitude, and longitude.

These data are transmitted to the LoRaWAN Network Server directly by the LoRa radio module and are displayed in the dedicated panel under the "Embit" tab of the Web UI.

Note: *If the GPS signal is not available (for example, in certain geographical areas), the interface will display "None." The unavailability of GPS signal will not affect the transmission of LoRaWAN data; LoRaWAN packets will still be transmitted to the Network Server and it will not report the gateway's location.*

5.3.4 Support VPN

The device includes a "Support VPN" feature, which provides a secure VPN interface to Embit's private VPN support server. This functionality is disabled by default. It can be explicitly enabled by the customer upon request to facilitate remote assistance and troubleshooting by Embit R&D Team, ensuring secure access to the device for diagnostic and support purposes.

Figure 11 - Support VPN Connection Toggle

5.3.5 System Updates

Standard *user* is able to update system packets to keep the system up to date and protected from security bug in system packages.

The "Software updates" tab, provides a clear overview of available updates, categorized into "security" and general updates. While this interface displays the updates, users without root privileges are prevented from directly utilizing the update buttons for security reasons.

Instead, to ensure a controlled and secure update process, such users must execute the appropriate update commands via the terminal:

- **sudo apt update**: Refreshes the list of available software packages from repositories, showing what *can* be installed or upgraded.
- **sudo apt upgrade**: Installs newer versions of *already installed* packages without removing or installing new ones.
- **udo apt dist-upgrade**: Performs a full system upgrade, intelligently handling dependency changes by installing new packages or removing old ones as needed.

This approach enhances system integrity by requiring explicit command-line execution for all system modifications.

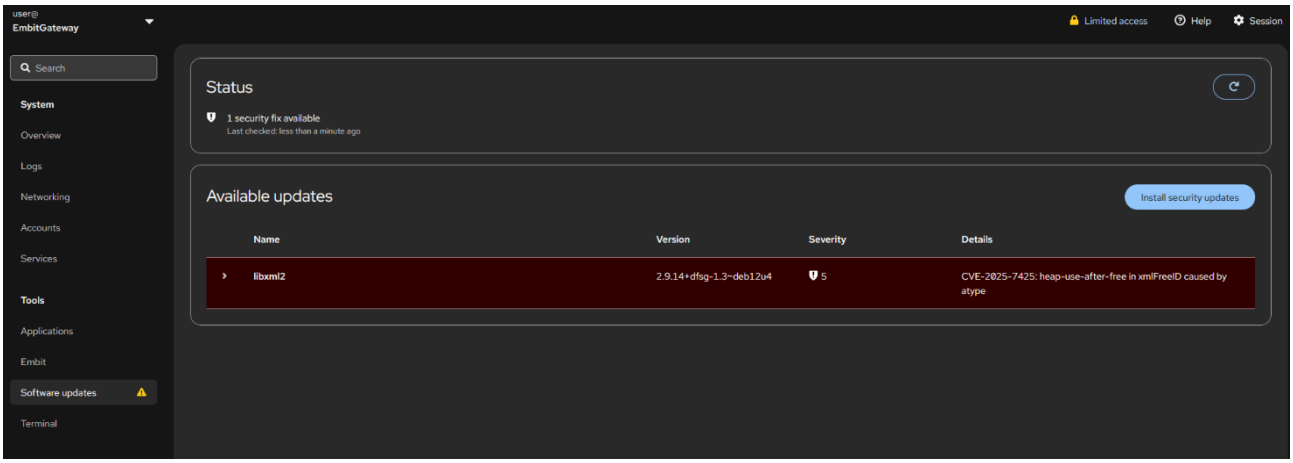

Figure 12 - Software Updates Tab

5.3.6 Gateway Registration on LoRaWAN Network Server

You can find every information about "Gateway Registration" on The Things Industries Network Server following the video-guide at: The Things Industries

6 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.).

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.

6.1 Handling Precautions

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

6.2 Warranty

Any operation involving a modification to the device's internal components will void the warranty.

Furthermore, in the event of unlocked root access, Embit S.r.l. will not be held responsible for any operating system malfunction caused by customer modifications, whether reversible through remote intervention or irreversible without on-site maintenance by Embit S.r.l.

6.3 Trademarks

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