LoRaWAN Stack for VAS sensors

- Overview of LoRaWAN Stack for VAS sensors -

Document version: 1.2
Last modified: 17/05/2024 12:08:00

Contents

Revision History

Version 0.1
Initial version: 25 April 2024
Version 1.0
Added Configuration and Usage Guide: 14 May 2024
Version 1.1
Updated Configuration and Usage Guide: 15 May 2024
Version 1.2
Updated Configuration and Usage Guide: 17 May 2024

1

Overview of the LoRaWAN Stack

A stack was implemented to connect the VAS sensors over the LoRaWAN network, collect data from these sensors, and visualise it. The main components of the stack are:

- GNU/Linux server (Debian);
- LoRaWAN Gateway (RAK7289CV2 WisGate Edge Pro);
- LoRaWAN Network Server (ChirpStack);
- IoT Platform (ThingsBoard);
- Reverse Proxy (Traefik).

1.1 GNU/Linux server

All software components are installed on a Debian GNU/Linux 12 (Bookworm) server.
The server is running with the following hardware configuration:

- 4 CPU cores;
- 8 GB RAM;
- 2 Hard disks (32 GB for system disk and 200 GB disk for data).
  - o NOTE: 2nd HDD is optional, everything can be stored on one hard drive.

All ChirpStack components, ThingsBoard, and Traefik are installed on Docker, running in rootless mode using Docker Compose.
The following firewall ports are opened:

- 22 for SSH;
- 443 for HTTPS;
- 8883 for MQTT.

The following firewall ports can be opened for debugging:

- 8080 for ChirpStack Web GUI without TLS;
- 9090 for ThingsBoard Web GUI without TLS.

1.2 LoRaWAN Gateway

RAK7289CV2 WisGate Edge Pro is used as a LoRaWAN Gateway [1]. The following hardware configuration is employed:

- 8 Channels;
- No LTE;
- EU868 Frequency Region.

The gateway communicates with ChirpStack using an MQTT v3.1 Bridge with TLS encryption on port 8883.

1.3   LoRaWAN Network Server

ChirpStack v4 is used as the LoRaWAN Network Server [2]. All of its components (chirpstack, chirpstack-rest-api, postgres, redis, mosquitto) are installed on Docker, which is running in rootless mode using Docker Compose. Only the EU region is enabled for LoRaWAN communication.

The LoRaWAN device repository has been imported into ChirpStack.

An MQTT connection with TLS encryption is enabled on port 8883. Port 1883 for external connections without encryption is disabled, although it can be used internally within the mosquitto container for testing and debugging.

1.4   IoT Platform

The ThingsBoard Community Edition is installed as an IoT platform for data collection, processing, and visualisation [3]. An instance with a Cassandra database and Kafka queue service is used, as recommended by ThingsBoard developers for a production environment [4]. 8 GB of RAM is recommended for this setup.

1.5   Reverse Proxy

Out of the box, ChirpStack and ThingsBoard do not have HTTPS capabilities – they only support unencrypted connections to access their Web Dashboards. Therefore, Traefik is used as a reverse proxy to implement connections with TLS encryption [5].

Self-signed certificates are utilized, however, there is also the option to use Let's Encrypt certificates with valid domain names.

The following domains are used:
- ChirpStack Dashboard: https://chirpstack.vas.internal/
- ThingsBoard Dashboard: https://thingsboard.vas.internal/
- Traefik Dashboard: https://traefik.vas.internal/

The Traefik Dashboard is password-protected using the basicAuth middleware from Traefik.

1.6   Mandatory configuration and requirements

- The LoRaWAN Gateway and ChirpStack must be on the same network.
- Static IP addresses are required.
- The correct IP address of the ChirpStack must be set on the LoRaWAN Gateway.
- Domains used for the reverse proxy must be configured on the DNS server, which is not included in this setup.

Confidential

2

Configuration of the LoRaWAN Network Server (ChirpStack)

Docker compose is used to run LoRaWAN Network Server (ChirpStack), therefore docker and docker compose should be installed on the system.

Installation instructions for various operating systems can be found at the following page: https://docs.docker.com/engine/install/

Installation example on Debian 12 using the apt repository is presented in chapter 2.1.

Also, as mentioned in the Chapter 1, ports 22, 443, 8883, 8080, 9090 should be open.

2.1 Example of Docker installation on Debian 12

Uninstall old versions, if installed:
```
for pkg in docker.io docker-doc docker-compose podman-docker containerd
runc; do sudo apt-get remove $pkg; done
```

Update apt package index
```
apt update
```

Install packages to allow apt to use a repository over HTTPS:
```
apt install apt-transport-https ca-certificates curl gnupg lsb-release
software-properties-common
```

Set up Docker's apt repository.
```
# Add Docker's official GPG key:

sudo apt-get update

sudo apt-get install ca-certificates curl

sudo install -m 0755 -d /etc/apt/keyrings

sudo curl -fsSL https://download.docker.com/linux/debian/gpg -o
/etc/apt/keyrings/docker.asc

sudo chmod a+r /etc/apt/keyrings/docker.asc

# Add the repository to Apt sources:

echo \
  "deb [arch=$(dpkg --print-architecture) signed-
by=/etc/apt/keyrings/docker.asc]
https://download.docker.com/linux/debian \
  $(. /etc/os-release && echo "$VERSION_CODENAME") stable" | \
  sudo tee /etc/apt/sources.list.d/docker.list > /dev/null

sudo apt-get update
```

Install latest version
```
sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-
plugin docker-compose-plugin
```

Verify that the installation is successful by running the hello-world image:

LoRaWAN Stack for VAS sensors

```
docker run hello-world
```

Install the Compose plugin
```
sudo apt update

sudo apt install docker-compose-plugin
```

Install Compose standalone.
```
sudo                               curl                               -SL
https://github.com/docker/compose/releases/download/v2.24.6/docker-
compose-linux-x86_64 -o /usr/local/bin/docker-compose

sudo chmod +x /usr/local/bin/docker-compose
```

Note that Compose standalone uses the `-compose` syntax instead of the current standard syntax `compose`.

For example type `docker-compose  up` when using Compose standalone, instead of `docker compose up`.

2.2 Clone LoRaWAN Stack for VAS applications example repository and start it

Configuration example of LoRaWAN Stack for VAS applications is provided in the following GitHub repository:
https://github.com/NEUROTECHLT/LoRa_WAN-Server-Deploy.git

Install git (if it is not already installed:
```
sudo apt update && sudo apt install git
```

Install git lfs
```
curl    -s    https://packagecloud.io/install/repositories/github/git-
lfs/script.deb.sh | sudo bash

sudo apt-get install git-lfs
```

Clone the repository
```
cd ~

git clone https://github.com/NEUROTECHLT/LoRa_WAN-Server-Deploy.git
```

Fetch LFS files:
```
cd ~/LoRa_WAN-Server-Deploy

git lfs pull
```

Delete all .gitkeep files, which were used to force git to track empty folders:
```
cd ~/LoRa_WAN-Server-Deploy

sudo find . -type f -name ".gitkeep" -exec rm -f {} +
```

Fix permissions of the ThingsBoard folders:
```
cd ~/LoRa_WAN-Server-Deploy

sudo chown -R 799:799 configuration/thingsboard-data

sudo chown -R 799:799 configuration/thingsboard-logs

sudo chmod 0700 configuration/thingsboard-data
```

Start LoRaWAN Stack for VAS applications:
```
cd LoRa_WAN-Server-Deploy

sudo docker-compose up
```
OR:
```
sudo docker-compose up -d
```

LoRaWAN Stack for VAS sensors

To stop LoRaWAN Stack for VAS applications:
```
cd LoRa_WAN-Server-Deploy

sudo docker-compose stop
```
OR:
```
sudo docker-compose down
```

NOTE: last command will discard the containers and the networks they were utilizing

All services should be accessible:
- ChirpStack Dashboard: https://chirpstack.vas.internal/
  - OR: http:/<IP_OF_THE_SERVER>:8080
- ThingsBoard Dashboard: https://thingsboard.vas.internal/
  - OR: http:/<IP_OF_THE_SERVER>:9090
- Traefik Dashboard: https://traefik.vas.internal/

As mentioned in Chapter 1, **all used *.vas.internal domain names should be resolvable to the IP address of the server**. System administrator must ensure that by editing settings of the used DNS server or host files or any other means. E.g. following steps can be used to edit hosts file on Linux if these domain names should be resolved to localhost (127.0.0.1):

Open /etc/hosts file in nano text editor:
```
sudo nano /etc/hosts
```

Append to the end of the file:
```
127.0.0.1        chirpstack.vas.internal        thingsboard.vas.internal
traefik.vas.internal
```

Following default usernames and passwords are used:
- ChirpStack:
  - User: admin
  - Password: LoRaChirpStack2)@$
- ThingsBoard:
  - System Administrator:
    - User: sysadmin@thingsboard.org
    - Password: sysadmin
  - Tenant Administrator:
    - User: tenant @thingsboard.org
    - Password: tenant
  - Customer User:
    - User: customer @thingsboard.org
    - Password: customer
- Traefik Dashboard:
  - User: vasuser
  - Password: LoRaChirpStack2)@$

NOTE:
Docker automatically resolves addresses of the services defined in the docker-compose file. But sometimes it does not work e.g. chirpstack can't resolve postgres address. As a workaround these names can be added to the hosts file of the server. E.g.:

Edit hosts file
```
sudo nano /etc/hosts
```

Append to the hosts file:
```
127.0.0.1 chirpstack mosquitto postgres
```

Confidential

2.3 Add LoRaWAN Gateway to the ChirpStack

Open Web GUI of the ChirpStack by loading following web page:
https://chirpstack.vas.internal/
OR:
http:/<IP_OF_THE_SERVER>:8080/

Navigate to: Tenant → Gateways

Press "Add gateway" button at the top right corner of the page.

Fill mandatory fields as shown in Figure 1:
- Name: can be any, e.g. WisGate_Edge_Pro_RAK7289V2
- Description: can be any, e.g.: WisGate Edge Pro (RAK7289-V2)
- Gateway ID (EUI64): should match EUI of the used LoRaWAN gateway.
  - In the case of the RAK7289CV2 WisGate Edge Pro, it can be found in the Overview page of its Web GUI, as shown at the end of the Chapter 3.1.
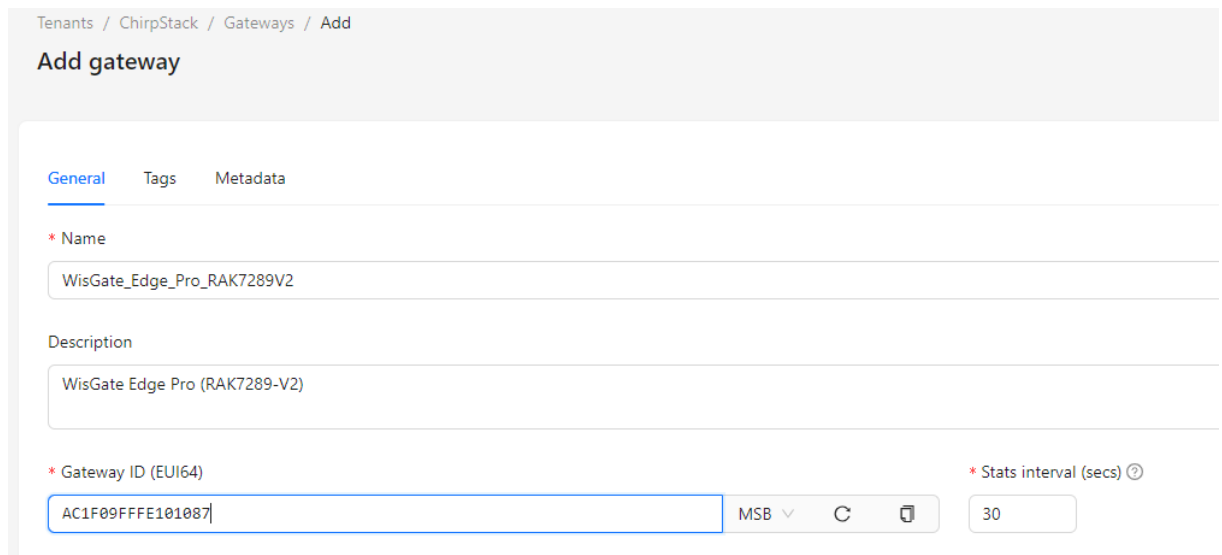
Figure 1. Add LoRaWAN Gateway

2.4 Create certificates for the LoRaWAN gateway

Certificates are needed to allow MQTT connection with TLS encryption.

Open Web GUI of the ChirpStack by loading following web page:
https://chirpstack.vas.internal/
OR:
http:/<IP_OF_THE_SERVER>:8080/

Navigate to: Tenant → Gateways → <GATEWAY_ADDED_IN _PREVIOUS_STEP> → → TLS certificate

Press "Generate certificate".

Following fields of the generated certificate should be shown (examples of these certificates are shown in Figure 2 and Figure 3):
- CA certificate
  - Copy everything, including "-----BEGIN CERTIFICATE-----" and "-----END CERTIFICATE-----" lines to the text file and save it as **ca.pem** file.

Confidential

- TLS certificate
  - Save everything, including "-----BEGIN CERTIFICATE-----" and "-----END CERTIFICATE-----" lines to the text file and save it as **client_cert.pem** file.
- TLS key
  - Save everything, including "-----BEGIN CERTIFICATE-----" and "-----END CERTIFICATE-----" lines to the text file and save it as **client_key.pem** file.

These three certificate files will be needed while configuring LoRaWAN gateway in Chapter 3.2.
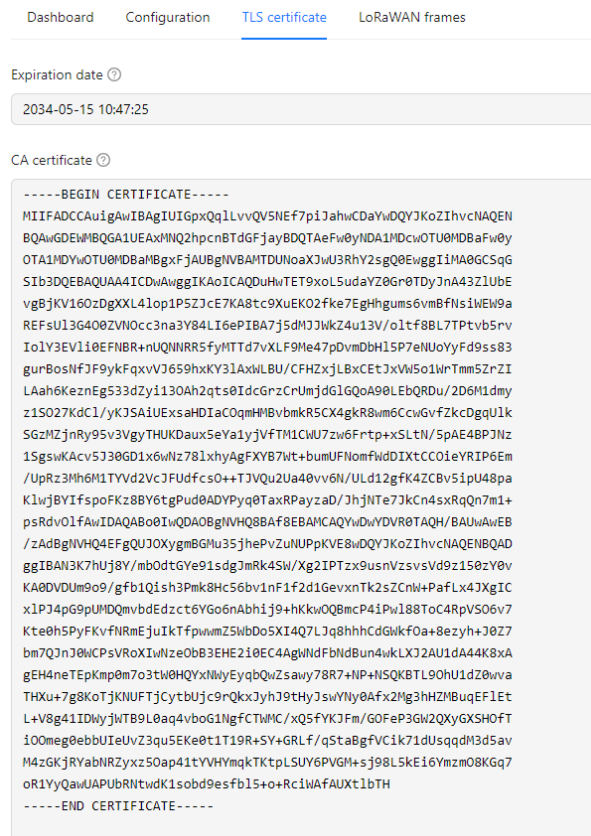
Dashboard   Configuration   TLS certificate   LoRaWAN frames

Expiration date ⓘ

2034-05-15 10:47:25

CA certificate ⓘ

-----BEGIN CERTIFICATE-----
MIIFADCCAuigAwIBAgIUIGpxQqlLvvQV5NEf7piJahwCDaYwDQYJKoZIhvcNAQEN
BQAwGDEWMBQGA1UEAxMNQ2hpcnnBTdGFjayBDQTAeFw0yNDA1MDcwOTU0MDBaFw0y
OTA1MDYwOTU0MDBaMBgxFjAUBgNVBAMTDUNoaXJwU3RhY2sgQ0EwggIiMA0GCSqG
SIb3DQEBAQUAA4ICDwAwggIKAoICAQDuHwTET9xoL5udaYZ0Gr0TDyJnA43ZlUbE
vgBjKV16OzDgXXL4lop1P5ZJcE7KA8tc9XuEKO2fke7EgHhgums6vmBfNsiWEW9a
REFsUl3G4O0ZVNOcc3na3Y84LI6ePIBA7j5dMJJWkZ4u13V/oltf8BL7TPtvb5rv
IolY3EVli0EFNBR+nUQNNRR5fyMTTd7vXLF9Me47pDvmDbHl5P7eNUoYyFd9ss83
gurBosNfJF9ykFqxvVJ659hxKY3lAxWLBU/CFHZxjLBxCEtJxVW5o1WrTmm5ZrZI
LAah6KeznEg533dZyi13OAh2qts0IdcGrzCrUmjdGlGQoA90LEbQRDu/2D6M1dmy
z1SO27KdCl/yKJSAiUExsaHDIaCOqmHMBvbmkR5CX4gkR8wm6CcwGvfZkcDgqUlk
SGzMZjnRy95v3VgyTHUKDaux5eYa1yjVfTM1CWU7zw6Frtp+xSLtN/5pAE4BPJNz
1SgswKAcv5J30GD1x6wNz78lxhyAgFXYB7Wt+bumUFNomfWdDIXtCCOieYRIP6Em
/UpRz3Mh6M1TYVd2VcJFUdfcsO++TJVQu2Ua40vv6N/ULd12gfK4ZCBv5ipU48pa
KlwjBYIfspoFKz8BY6tgPud0ADYPyq0TaxRPayzaD/JhjNTe7JkCn4sxRqQn7m1+
psRdvOlfAwIDAQABo0IwQDAOBgNVHQ8BAf8EBAMCAQYwDwYDVR0TAQH/BAUwAwEB
/zAdBgNVHQ4EFgQUJOXygmBGMu35jhePvZuNUPpKVE8wDQYJKoZIhvcNAQENBQAD
ggIBAN3K7hUj8Y/mbOdtGYe91sdgJmRk4SW/Xg2IPTzx9usnVzsvsVd9z15OzY0v
KA0DVDUm9o9/gfb1Qish3Pmk8Hc56bv1nF1f2d1GevxnTk2sZCnW+PafLx4JXgIC
xlPJ4pG9pUMDQmvbdEdzct6YGo6nAbhij9+hKkwOQBmcP4iPwl88ToC4RpVSO6v7
Kte0h5PyFKvfNRmEjuIkTfpwwmZ5WbDo5XI4Q7LJq8hhhCdGWkfOa+8ezyh+J0Z7
bm7QJnJ0WCPsVRoXIwNzeObB3EHE2i0EC4AgWNdFbNdBun4wkLXJ2AU1dA44K8xA
gEH4neTEpKmp0m7o3tW0HQYxNWyEyqbQwZsawy78R7+NP+NSQKBTL9OhU1dZ0wva
THXu+7g8KoTjKNUFTjCytbUjc9rQkxJyhJ9tHyJswYNy0Afx2Mg3hHZMBuqEFlEt
L+V8g41IDWyjWTB9L0aq4vboG1NgfCTWMC/xQ5fYKJFm/GOFeP3GW2QXyGXSHOfT
iOOmeg0ebbUIeUvZ3qu5EKe0t1T19R+SY+GRLf/qStaBgfVCik71dUsqqdM3d5av
M4zGKjRYabNRZyxz5Oap41tYVHYmqkTKtpLSUY6PVGM+sj98L5kEi6YmzmO8KGq7
oR1YyQawUAPUbRNtwdK1sobd9esfbl5+o+RciWAfAUXtlbTH
-----END CERTIFICATE-----

Figure 2. Example of the generated certificate for the gateway – CA certificate

TLS certificate ⓘ

```
-----BEGIN CERTIFICATE-----
MIIDUzCCATugAwIBAgIUDwDrndh+uWrdkIVXJr9mlmXySIgwDQYJKoZIhvcNAQEL
BQAwGDEWMBQGA1UEAxMNQ2hpcnBTdGFjayBDQTAeFw0yNDA1MTQxMjM1MjVaFw0z
NDA1MTUwNzQ3MjVaMBsxGTAXBgNVBAMMEDdlMwU5ZWQ0MGNkYWE4NDYwWTATBgcq
hkjOPQIBBggqhkjOPQMBBwNCAAQznNi4qTKXd0d7A2+T8KuHSTfIJHmOEFhtCPF/
EAA11FXhaB2xOmRrYDo5qxNVC41Y0Sbe/AB4FV5AkR0/yq4to10wWzAJBgNVHRME
AjAAMA4GA1UdDwEB/wQEAwIHgDAdBgNVHQ4EFgQUAT3+5G6BkXOwK3IwByM7Vx9K
ulEwHwYDVR0jBBgwFoAUJOXygmBGMu35jhePvZuNUPpKVE8wDQYJKoZIhvcNAQEL
BQADggIBANwqJ+I6jcGyvbMdNT67JzoOAG5HmJKxJKQ/dOUAdM+KLDCsyJmTID9g
LMUfWpi4l7Pb7jNL0+GvQyLYEetvbsp3+Mm4GoLNpwaPc9pflRq6LNLCMJ44pD3E
s0XQU5zyRD0NhVBlMKDoHPZE6lOcsHVCYZnFzuPc2tKMyFnBaFPqM3FdCupKKnDn
yKaUW/3w7wLrDZoUvsUVuHQ+oGLeH00a+UYW6DTOzn+ckJErS2AAWMJjMt4Pzhjr
8/gz9vr98UWhsUZ2rXTmoUOucfyv4PHa8wXMYbO0Pt342OjgeaY47OZ6V+kiskTN
kSQj+D07WCrFpmRvGGQ/yTAwvh0PIGxAudlvnomaGjmAcD+3/8AvISQ5Vm8GjY4e
laOWYNzQVvtfCTNb0shqkjKlRhghWR/geOMQakxEZXwX7vToecI8E13F6cjDidN0
oTZyPzzyw0HfcSTIRjVv0M84p51bd8L9DKkf/4SJoIiasPTjrSKJzxAYmQYujaTp
twhFsD8jRL63WzmpivMqM3GqWNfQOGygxkIsejgwAFBQLdUGOiwCm7JOVMj65FDg
K07HsP5RipgI8s5LHPv++/dxUdHfIUsHq0YdaFr4jkxYdDIhVJLsT3sPXtj0iFQF
IAV3pQIyEgjlTEvFrr2jGnKz14iFudoh2+Zkctd8g6RF/Eqp4qiA
-----END CERTIFICATE-----
```

TLS key ⓘ

```
-----BEGIN PRIVATE KEY-----
MIGHAgEAMBMGByqGSM49AgEGCCqGSM49AwEHBG0wawIBAQQgNchEQIKzLw0DTaMl
/+WszihdQE1QIT0B8gHZWAvUr4KhRANCAAQznNi4qTKXd0d7A2+T8KuHSTfIJHmO
EFhtCPF/EAA11FXhaB2xOmRrYDo5qxNVC41Y0Sbe/AB4FV5AkR0/yq4t
-----END PRIVATE KEY-----
```

Figure 3. Example of the generated certificate for the gateway – TLS certificate and TLS key

2.5 Add new VAS devices

By default, VAS devices are programmed to use Over-The-Air-Activation (OTAA). Following steps can be used to add VAS device using OTAA.

Open Web GUI of the ChirpStack by loading following web page:
   https://chirpstack.vas.internal/
   OR:
   http:/<IP_OF_THE_SERVER>:8080/

Navigate to: Tenant → Applications → VAS Application

Press "Add device" button as shown in the Figure 4.

Confidential
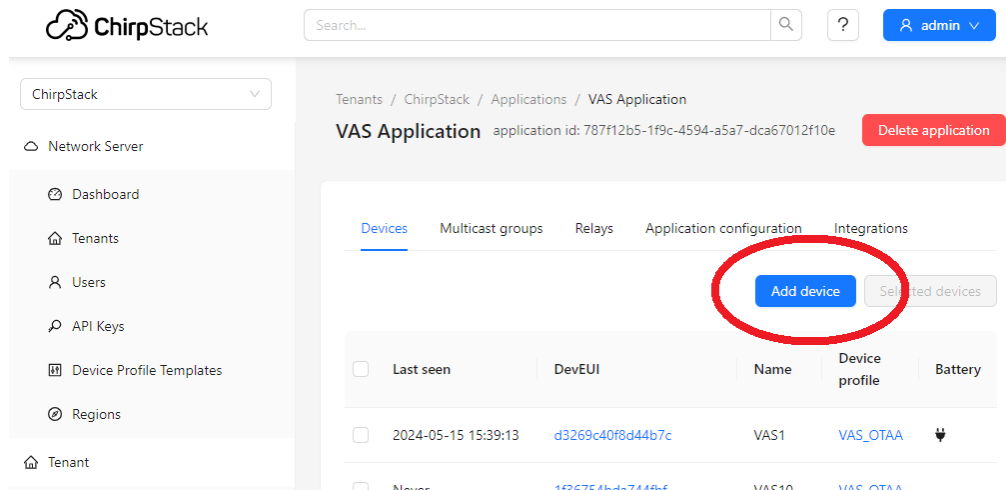
Figure 4. Add VAS device

Fill in mandatory fields, as shown in Figure 5:

- Name: could be any, e.g. VAS2

- Description: can be any, e.g. 2nd VAS device

- Device EUI (EUI64): Has to match DevEUI of the VAS device, e.g.:

    o 56bfa08c5b549e71

- Device profile: VAS_OTAA

Press "Submit" button after entering this information.

After that, "OTAA keys" menu should open automatically.

Enter following default Application key as shown in Figure 6 and press "Submit":

2b7e151628aed2a6abf7158809cf4f3c

After that, VAS device should connect and activity should be seen in the "Events" and "LoRaWAN frames" menu entries of the VAS device as shown in Figure 7 and Figure 8.

Confidential

Figure 5. Mandatory parameters of the VAS device

Figure 6. Default OTAA Application key

Figure 7. Events of the VAS device

Confidential
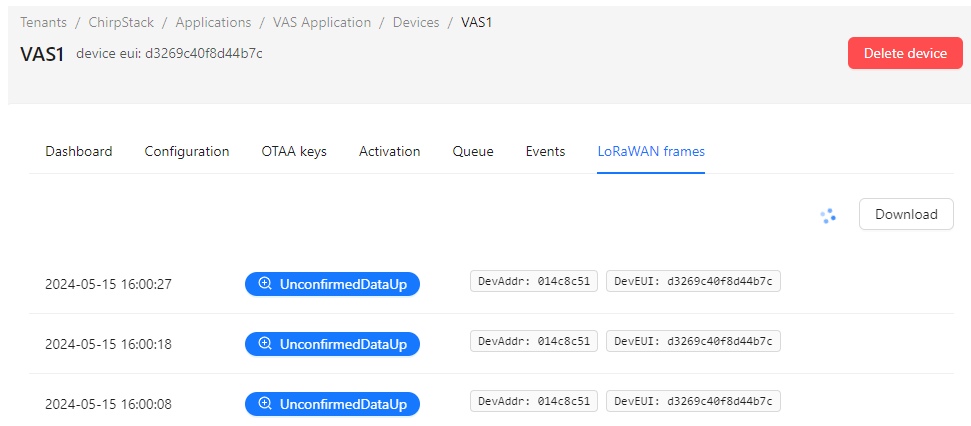
Figure 8. LoRaWAN frames of the VAS device

2.6   Connect ChirpStack device to the ThingsBoard

First, device has to be created in the ThingsBoard.

- Open Web GUI of the ThingsBoard by loading following web page:
  - https://thingsboard.vas.internal/
  OR:
  - http:/<IP_OF_THE_SERVER>:9090/

- Login with tenant account.

- Navigate to: Entities → Devices

- Press "+" icon in the top right corner and press Add new device as shown in Figure 9.

- "Add new device" menu should open, as shown in Figure 10.

- Enter name, e.g. VAS2, select "default" profile and press Add button.

- A window will open where you can check the device's connection to the ThingsBoard as shown in Figure 11. This step is not needed at the moment, therefore, simply close it.
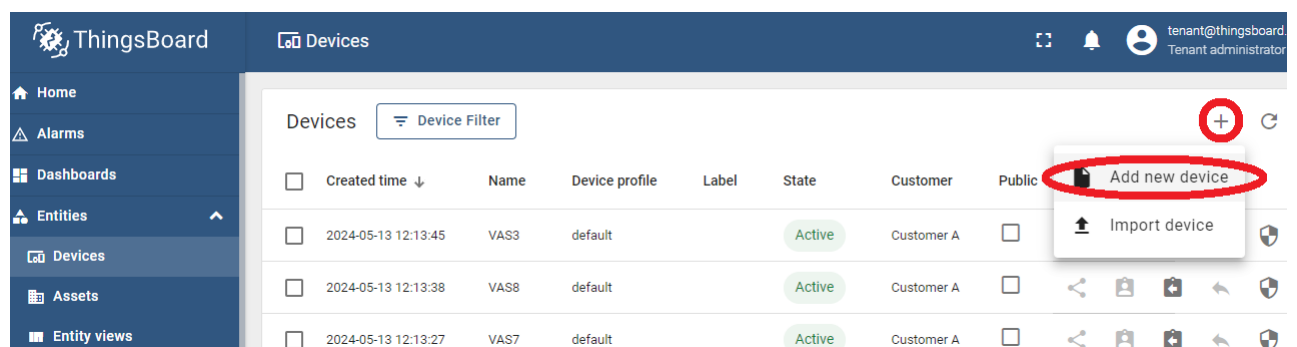
Figure 9. Add new device in the ThingsBoard

Confidential

Figure 10. Details of the new device

Figure 11. "Device created" window

LoRaWAN Stack for VAS sensors

Get access token of the ThingsBoard device

- Open Web GUI of the ThingsBoard.
- Navigate to: Entities → Devices
- Select previously created device (e.g. VAS2) i.e. click anywhere on the line of this device. After that, a window with details of this device should open, as shown in Figure 12.
- Press "Copy access token" button. Save it somewhere.
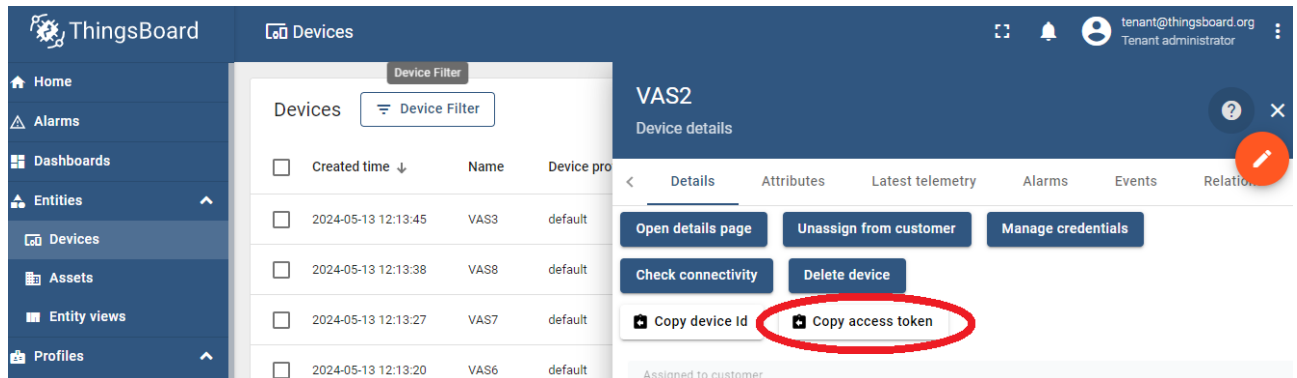- Example of the access token: AbA1NTFBYStefSgFVVXm

Figure 12. Details of the ThingsBoard device

Set Device access token in ChirpStack:

- Open Web GUI of the ChirpStack by loading following web page:
  - https://chirpstack.vas.internal/
  OR:
  - http:/<IP_OF_THE_SERVER>:8080/
- Navigate to the configuration of the VAS device, e.g.
  - Tenant → Applications → VAS Application → VAS device (e.g. VAS2) → Configuration
- Open Variables menu entry, as shown in Figure 13 and press "Add variable" button
- Create following variable:
  - Key: ThingsBoardAccessToken
  - Value: Access token of the ThingsBoard device, e.g. AbA1NTFBYStefSgFVVXm
- Press "Submit" button.

After that, device should connect to the ThinsBoard and its state should be "Active", as shown in Figure 14.
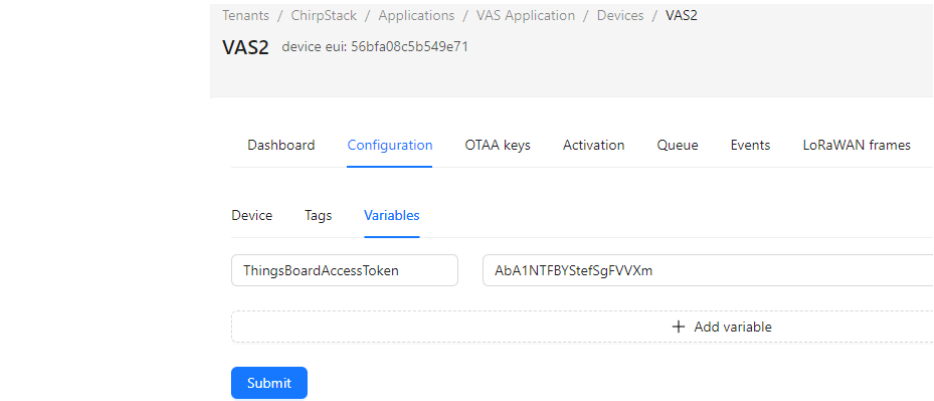
LoRaWAN Stack for VAS sensors

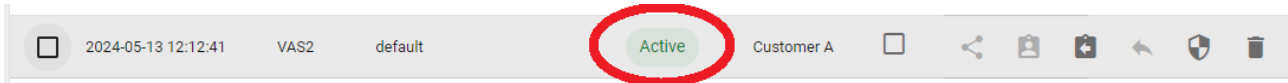

Figure 13. Variables of the ChirpStack device

Figure 14. Active ThingsBoard device

Confidential

3

Configuration of the LoRaWAN Gateway (RAK7289CV2 WisGate Edge Pro)

Manufacturer's quick start guide is available at:
https://docs.rakwireless.com/Product-Categories/WisGate/RAK7289-V2/Quickstart/

3.1 Initial configuration

Power on Gateway using included PoE Injector.

Wi-Fi AP Mode is used to make initial configuration of the gateway.

Connect to the gateway's default Wi-Fi network.

By default, gateway will create a Wi-Fi Network named RAK7289_XXXX, where "XXXX" is the last two bytes of the Gateway MAC address.

Open any Web Browser and navigate to the following address: https://192.168.230.1/

Web GUI of the Gateway should open.

Set password for access to the gateway's Web GUI as shown in Figure 15.
- Default user is: root
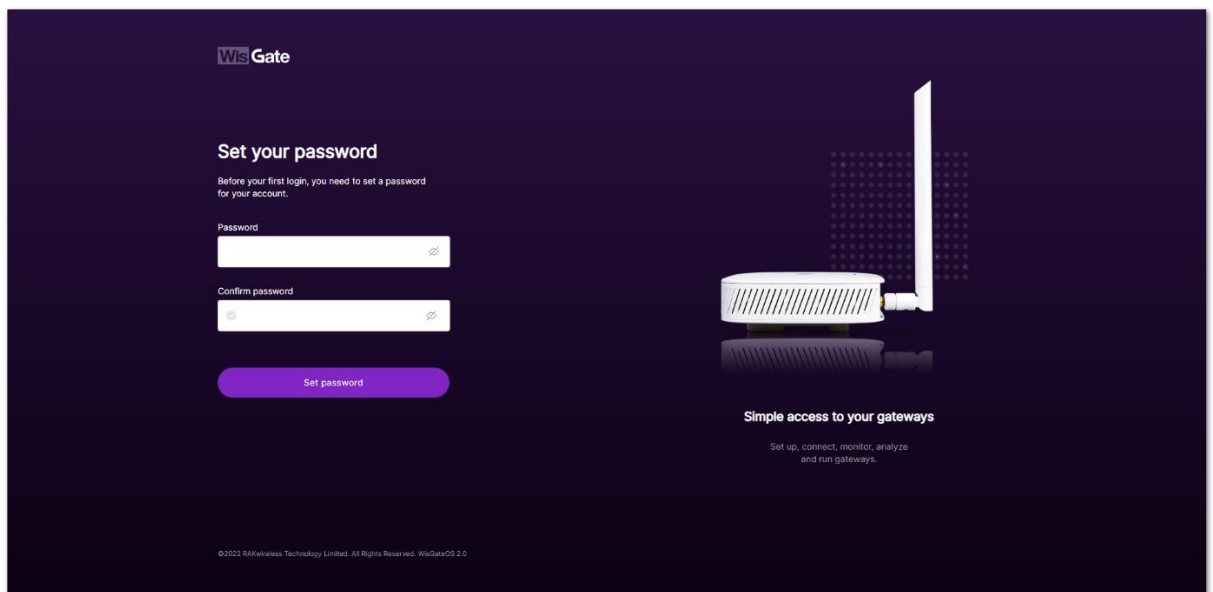
Figure 15. Set password on the RAK Gateway

After setting the password, the dashboard of the gateway should open.

LoRaWAN Stack for VAS sensors

If needed, you can click on the WisGate logo at the top left corner of the Web GUI, to show names of the menu entries, as shown in Figure 16.
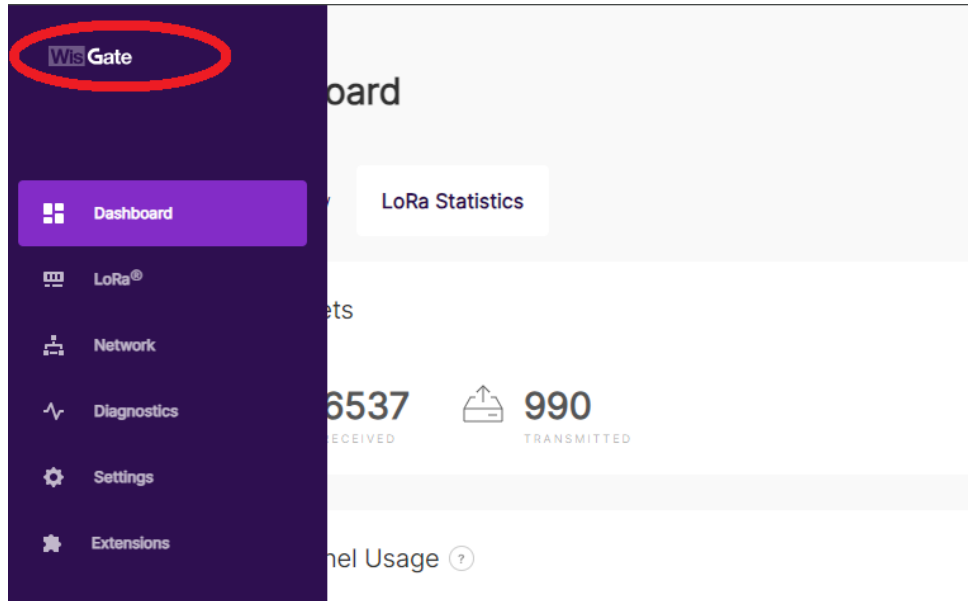

Figure 16. Press on WisGate logo, to show names of the menu entries

Set Wi-Fi password:
- Navigate to: Network → LAN (at the top of the network menu) → Expand (press arrow down) Wi-Fi entry → Settings
- Settings of the Wi-Fi interface should open, as shown in Figure 17. Change following settings:
  o Encryption: WPA2-PSK
  o Key: <YOUR_PASSWORD>

Figure 17. Settings of the Wi-Fi interface

Confidential

LoRaWAN Stack for VAS sensors

Set static IP on the LAN interface:
- Navigate to: Network → WAN (at the top of the network menu) → Expand (press arrow down) Ethernet entry → Settings
- Settings of the Ethernet interface should be opened as shown in Figure 18.
  - Enable WAN and disable LAN: enabled
  - Static address: selected
  - IPv4 address: <YOUR_IP>
  - IPv4 netmask: <YOUR_NETMASK>
  - IPv4 router: <YOUR_DEFAULT_GATEWAY>
  - DNS Server: <YOUR_DNS_SERVER>
    - NOTE: Don't forget to press Add button after entering DNS address.

Figure 18. Settings of the Ethernet interface

Update Firmware
- Navigate to: Settings → Firmware
- Check currently installed version of the firmware. In the example, shown in Figure 19, current version is 2.2.2. Also, the version of the firmware should be shown at the bottom of the Web GUI.

Figure 19. Current version of the firmware

Confidential

LoRaWAN Stack for VAS sensors

- Check latest available firmware and release notes at the following web page: https://downloads.rakwireless.com/#LoRa/WisGateOS2/
- If newer firmware is available download and unzip it.
- Then navigate to the firmware page on the Web GUI (Settings → Firmware) and upload the new firmware file (.rwi), enable "Keep setting after updating" option and make an update.
- Wait for the update to finish.

Take a note of the Gateway's EUI:
- EUI is needed to connect LoRaWAN gateway to the ChirpStack.
- Navigate to: Dashboard → Overview
- Various parameters of the gateway is shown, as can be seen in the example provided in Figure 20.
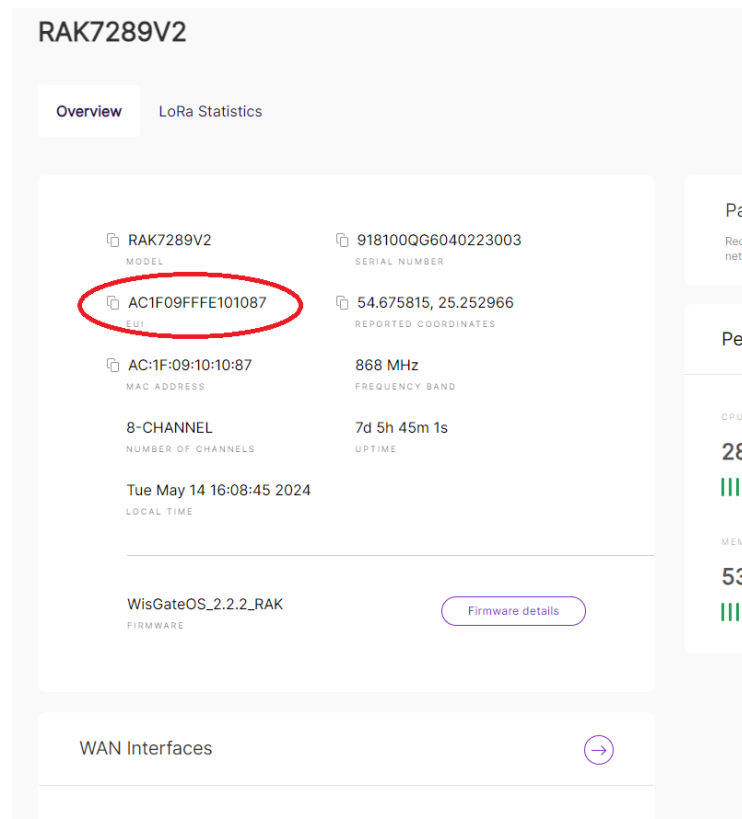
Figure 20. EUI of the Gateway in the Overview page

- As it is seen, in this example EUI is: AC1F09FFFE101087

3.2 Configure LoRa settings

Main LoRa settings are shown in Figure 21.

Open Web GUI of the Gateway.

Open LoRa settings
- Work mode: Packet forwarder
- Log Level: NOTICE
- Frequency Plan:
  - o Country: Lithuania
  - o Regio: EU868
- Protocol:

- o Protocol: LoRa Gateway MQTT Bridge
- o Statistic interval (s): 30
- o LoRa Gateway MQTT Bridge Parameters
  - ▪ MQTT Protocol: MQTT for ChirpStack 4.x (protobuf)
  - ▪ MQTT Broker Address: chirpstack.vas.internal
  - ▪ MQTT Broker Port: 8883
  - ▪ MQTT Version: 3.1.1
  - ▪ QoS: 1 - At Least Once
  - ▪ Keepalive interval (s): 10
  - ▪ Clean session: enabled
  - ▪ Retain: disabled
  - ▪ Enable User Authentication: disabled
  - ▪ SSL/TLS Mode: Self-signed server & client certification
  - ▪ TLS Version: TLS v1.2
  - ▪ CA certificate: uplad **ca.pem** generated in Chapter 2.4
  - ▪ Client certificate: upload **client_cert.pem** generated in Chapter 2.4
  - ▪ Client key: upload **client_key.pem** generated in Chapter 2.4

Figure 21. Main Settings of the LoRaWAN gateway

3.3   Edit hosts file on the gateway

At the moment of writing this document, there is a bug in the gateway's firmware – it does not use custom DNS server, therefore, it can't resolve internal domain name, used for LoRaWAN server, i.e. chirpstack.vas.internal.

As a workaround, this domain name can be fixed by editing hosts file on the gateway.

LoRaWAN Stack for VAS sensors

By default, SSH is enabled on the gateway. Therefore, use any SSH client to connect to the gateway and login using default username (root) and password, which was set during the initial configuration of the gateway. E.g.:

```
ssh root@<IP_OF_THE_GATEWAY>
```

Open hosts file using vi editor:

```
vi /etc/hosts
```

Press INSERT button on the keyboard.

Append entry for the domain name of the LoRaWAN server (erplace the IP with the correct one):

```
#ChirpStack, mosquitto server

<IP_OF_THE_GATEWAY> chirpstack chirpstack.vas.internal mosquito
```

Save and quit vi editor by pressing typing following combination:

```
:wq
```

Confidential

References:

[1]   RAK Wireless, "8 or 16 channel Outdoor LoRaWAN Gateway." Accessed: Apr. 26, 2024. [Online]. Available: https://store.rakwireless.com/products/rak7289-8-16-channel-outdoor-lorawan-gateway?variant=42334687789254

[2]   ChirpStack, "ChirpStack, open-source LoRaWAN® Network Server." Accessed: Apr. 26, 2024. [Online]. Available: https://www.chirpstack.io/

[3]   The ThingsBoard Authors, "ThingsBoard. Open-source IoT Platform." Accessed: Apr. 26, 2024. [Online]. Available: https://thingsboard.io/

[4]   The ThingsBoard Authors, "Installing ThingsBoard using Docker (Linux or Mac OS)." Accessed: Apr. 26, 2024. [Online]. Available: https://thingsboard.io/docs/user-guide/install/docker/

[5]   Traefik Labs, "Traefik, The Cloud Native Application Proxy." Accessed: Apr. 26, 2024. [Online]. Available: https://traefik.io/traefik/