

LoRa

Contents

.System Architecture

.Part(1): LoRa Node Setup

- Hardware setup**

- Software setup**

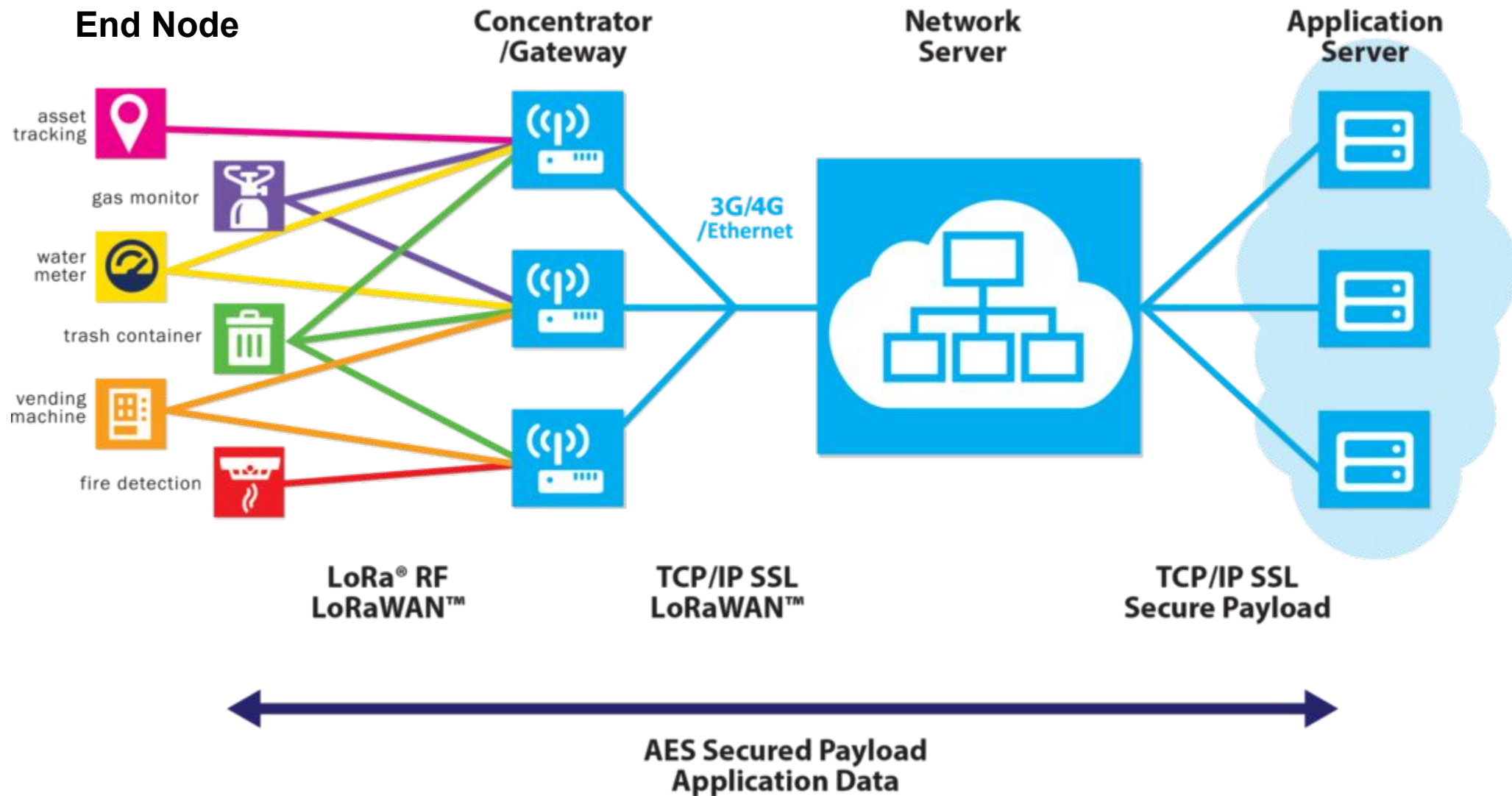
.Part(2): LoRa Gateway Setup

- Hardware setup**

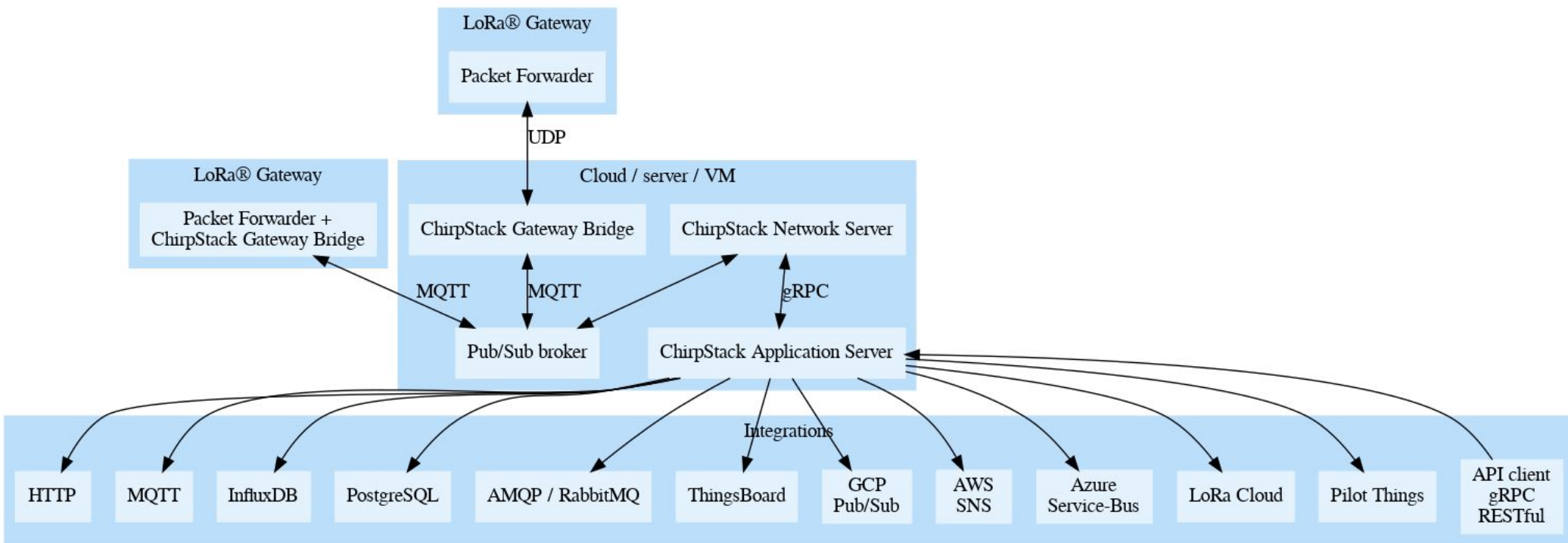
- Software setup**

.Test

System Architecture



System Architecture



System Architecture

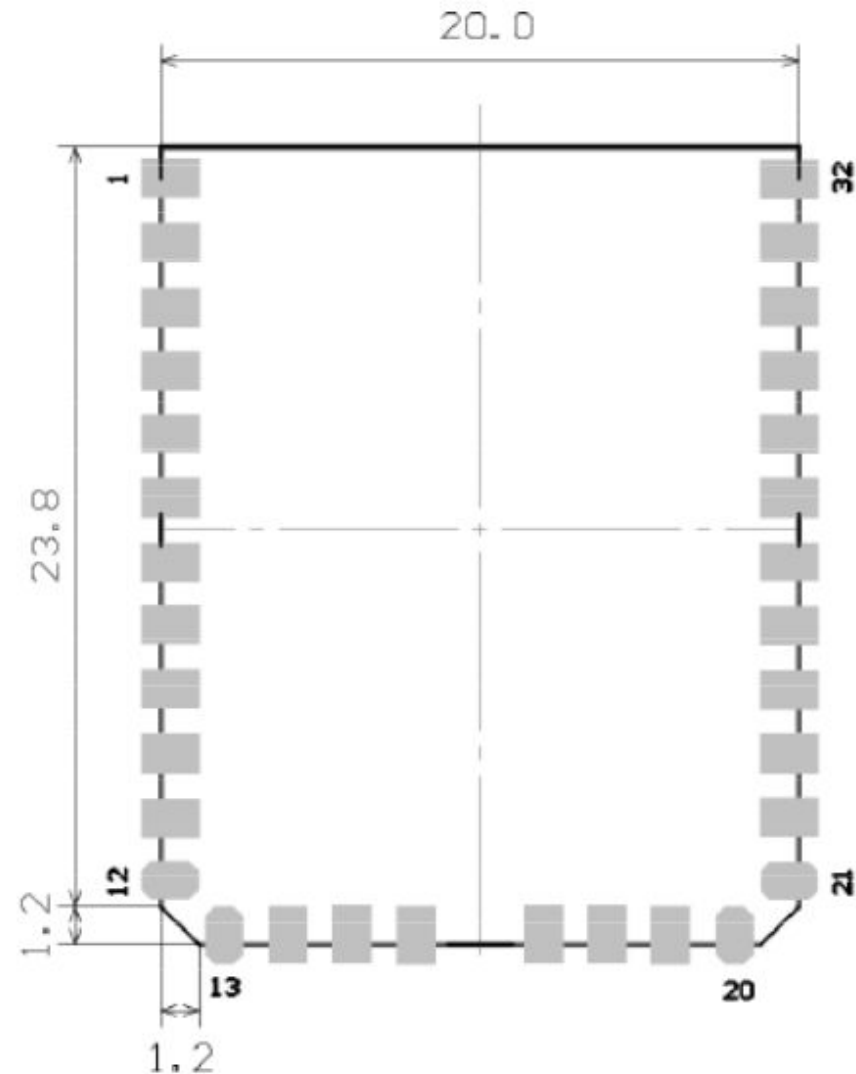
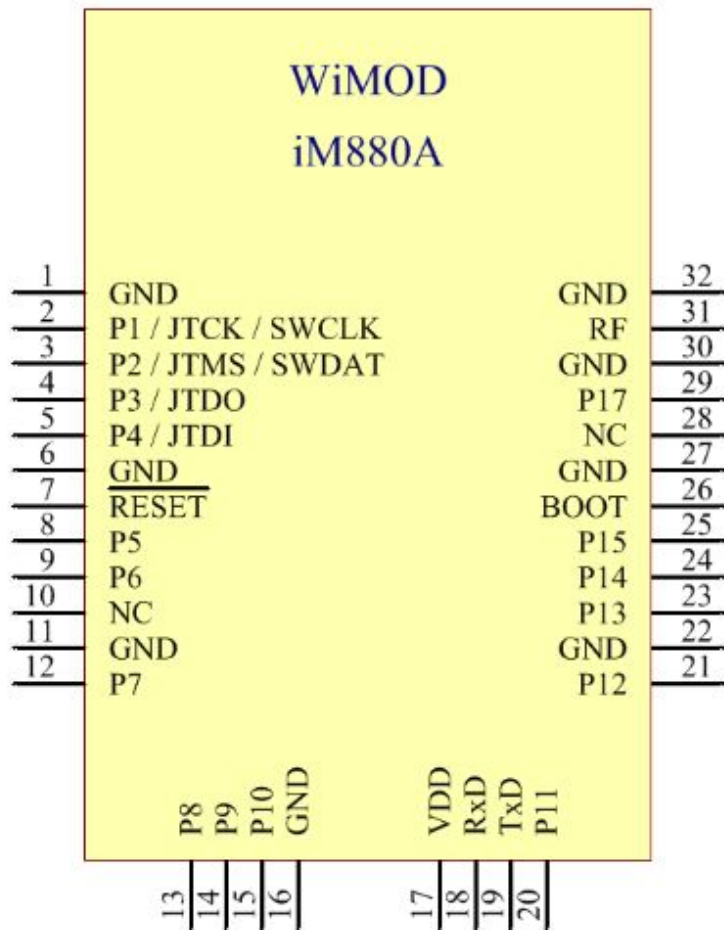
- .Gateway Bridge: handles the communication with the LoRaWAN gateways**
- .Network Server: a LoRaWAN Network Server implementation**
- .Application Server: a LoRaWAN Application Server implementation**
- .Gateway OS: Linux-based OS to run the (full) ChirpStack stack on a Raspberry Pi based LoRa gateway**

LoRa Node – Hardware Setup / iM880A / Layout

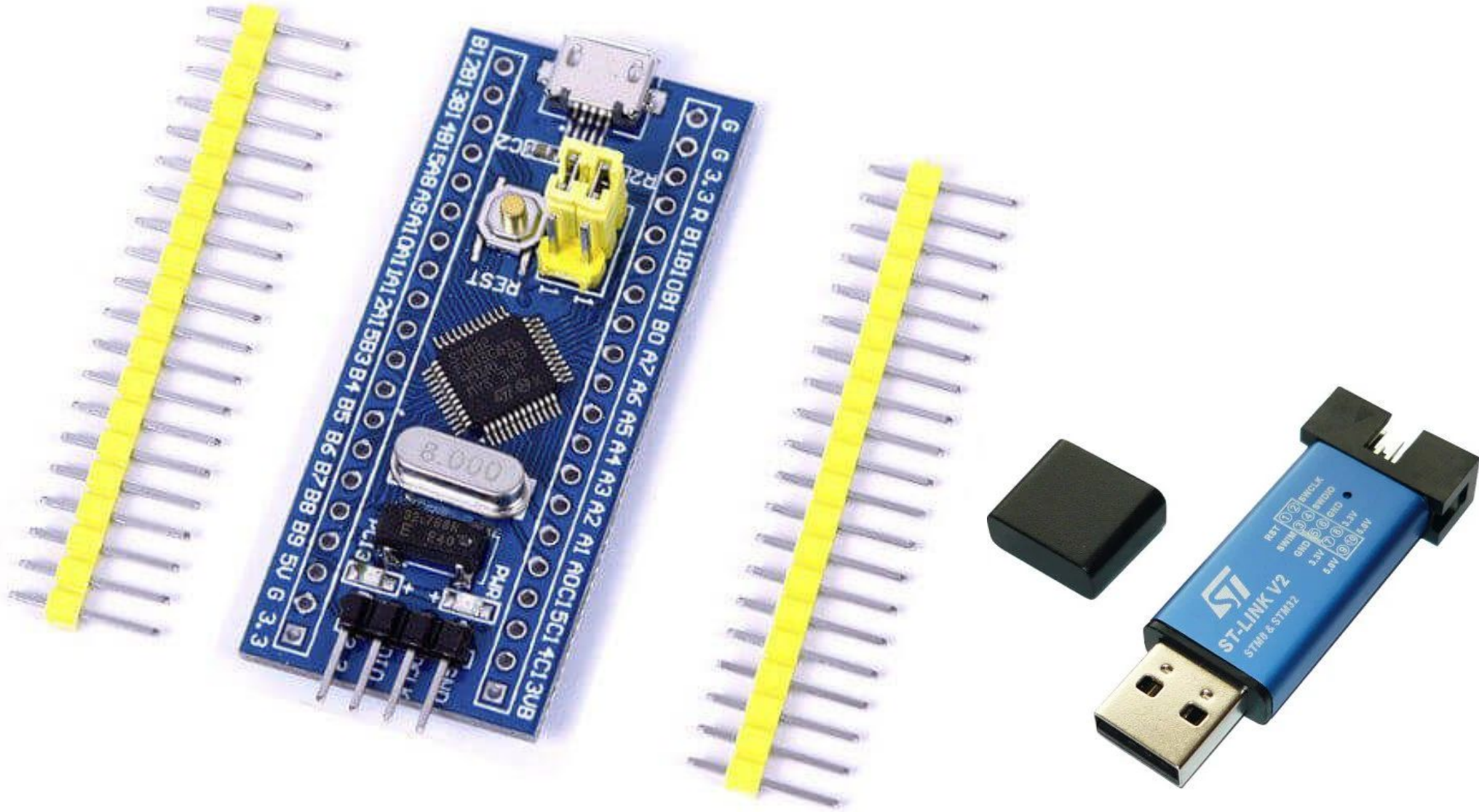


Datasheet

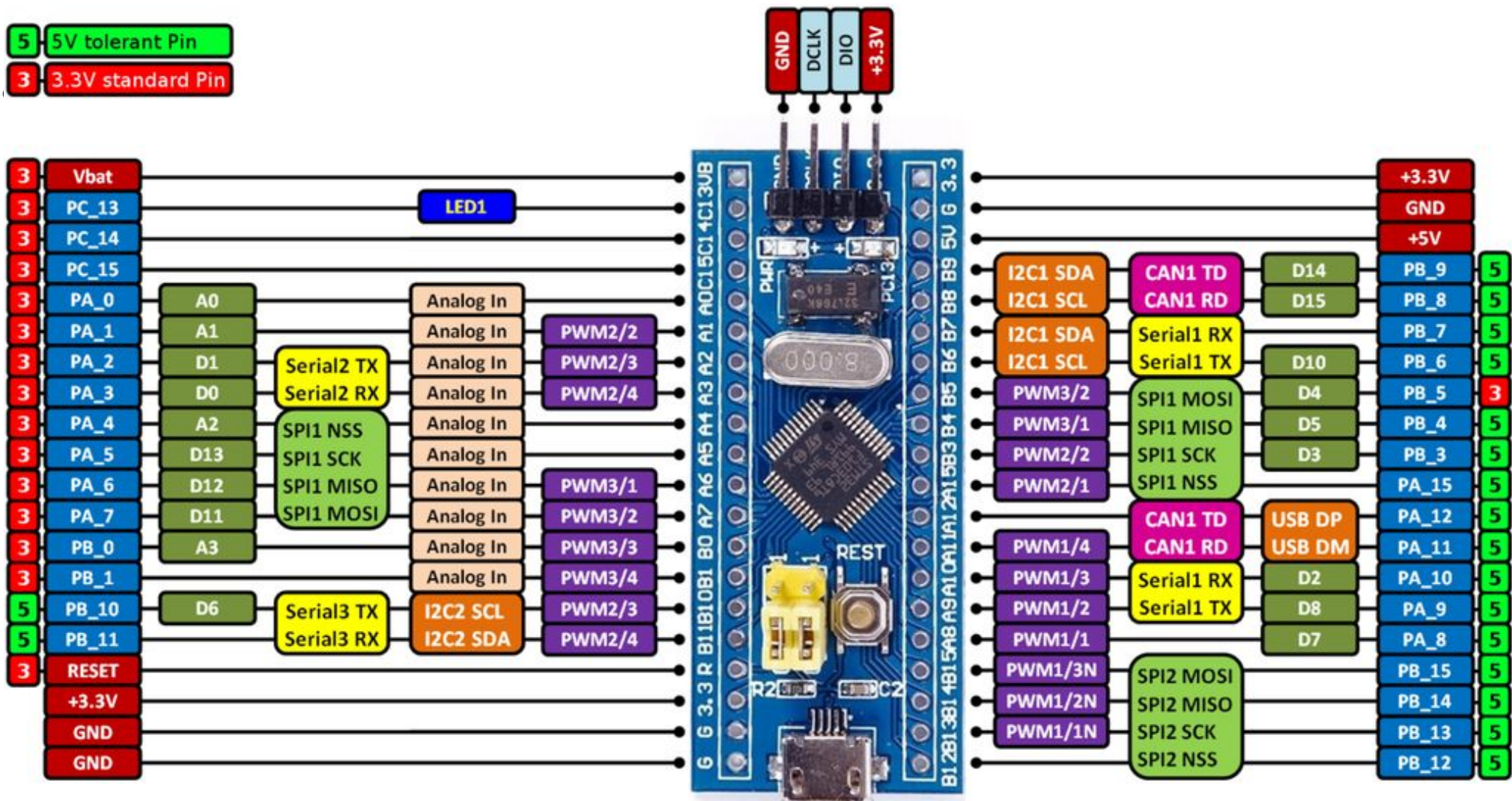
LoRa Node – Hardware Setup / iM880A / Pin-Out



LoRa Node – Hardware Setup / STMF103C8 / Layout



LoRa Node – Hardware Setup / STMF103C8 / Pin-Out



LoRa Node – Hardware Setup / iM880A ↔ STM32F103C8 connection

.Pins mapping

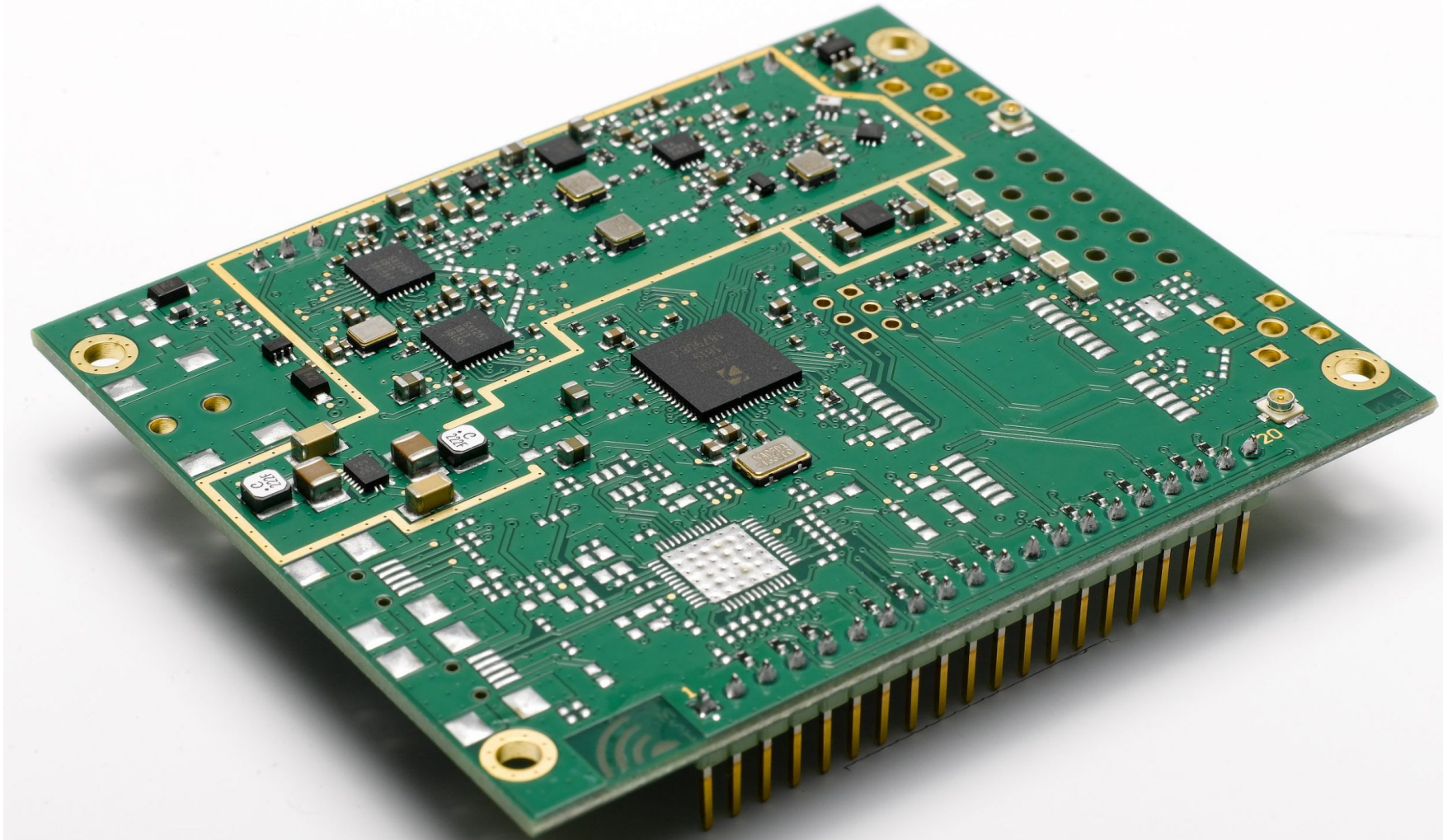
IM880A Pin	Description	STM32F103C8 Pin	Description
1, 6, 11, 16, 22, 27, 30 or 32	GND	GND	GND
17	VDD	3.3	3.3V
18	RxD	A2	Serial2 Tx
19	TxD	A3	Serial2 Rx

LoRa Node – Software Setup / iM880A / EndNode Studio

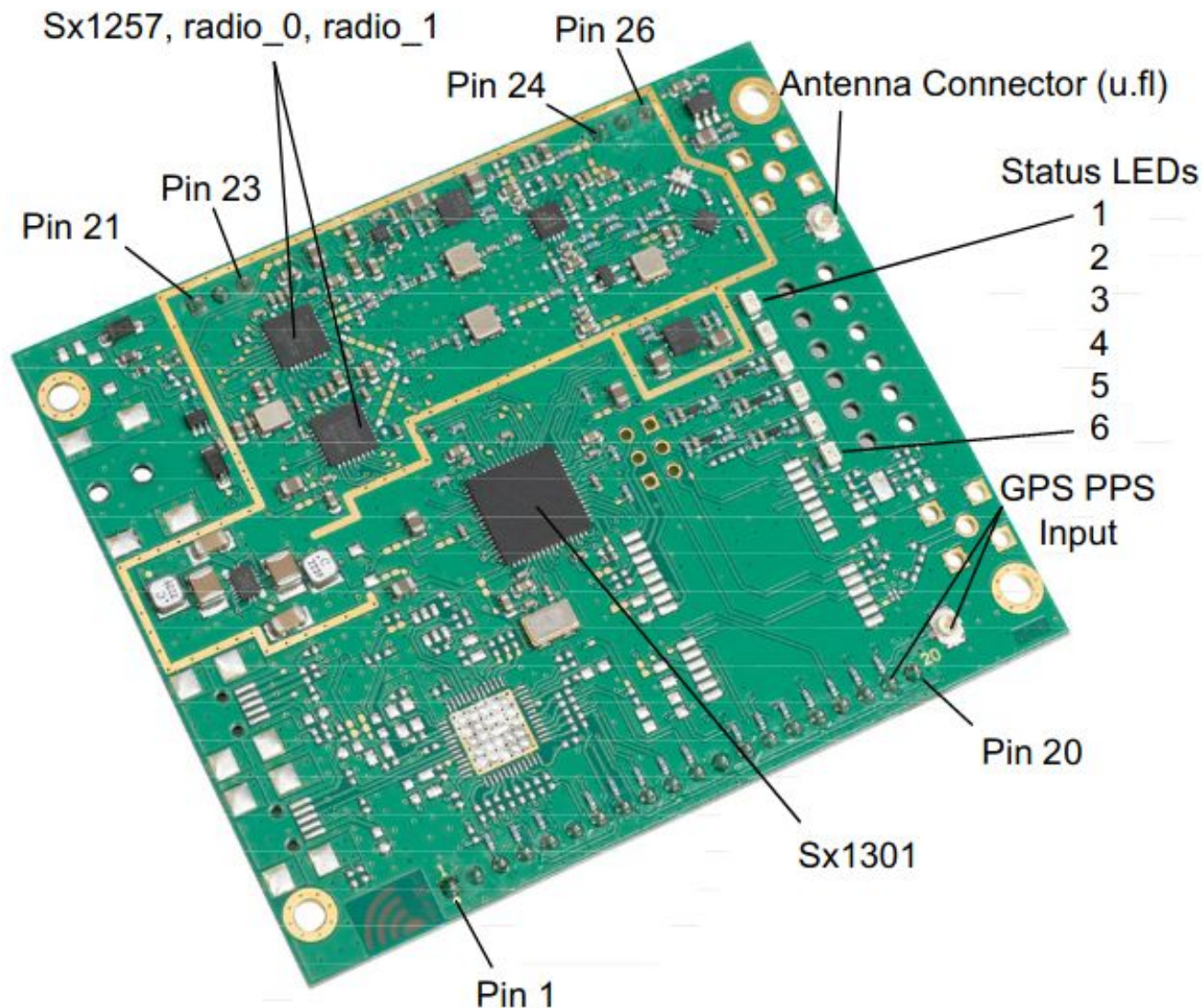
.Download EndNode Studio: ([Link](#))

**.Connect iM880A Module to PC using TTL Serial
Module**

LoRa Gateway – Hardware Setup / iC880a / Layout



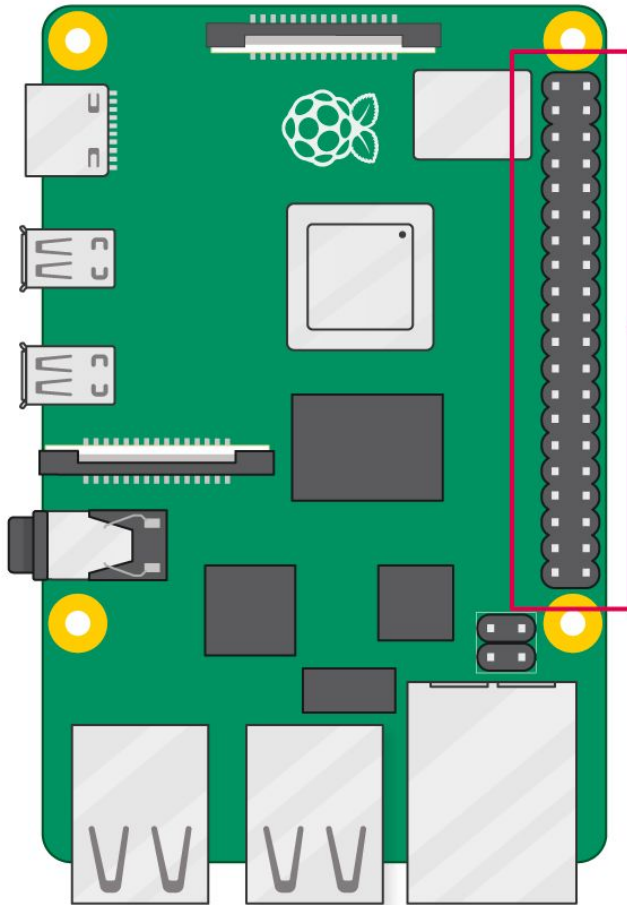
LoRa Gateway – Hardware Setup / iC880a / Pin-Out



LoRa Gateway – Hardware Setup / RaspberryPi 3B / Layout



LoRa Gateway – Hardware Setup / RaspberryPi 3B / Pin-Out



3V3 power	1	2	5V power
GPIO 2 (SDA)	3	4	5V power
GPIO 3 (SCL)	5	6	Ground
GPIO 4 (GCLK0)	7	8	GPIO 14 (TXD)
Ground	9	10	GPIO 15 (RXD)
GPIO 17	11	12	GPIO 18 (PCM_CLK)
GPIO 27	13	14	Ground
GPIO 22	15	16	GPIO 23
3V3 power	17	18	GPIO 24
GPIO 10 (MOSI)	19	20	Ground
GPIO 9 (MISO)	21	22	GPIO 25
GPIO 11 (SCLK)	23	24	GPIO 8 (CE0)
Ground	25	26	GPIO 7 (CE1)
GPIO 0 (ID_SD)	27	28	GPIO 1 (ID_SC)
GPIO 5	29	30	Ground
GPIO 6	31	32	GPIO 12 (PWM0)
GPIO 13 (PWM1)	33	34	Ground
GPIO 19 (PCM_FS)	35	36	GPIO 16
GPIO 26	37	38	GPIO 20 (PCM_DIN)
Ground	39	40	GPIO 21 (PCM_DOUT)

LoRa Gateway – Hardware Setup / iC880A ↔ RaspberryPi 3 connection

iC880A Pin	Description	Raspberry Pi 3
21	5V	2
22	GND	6
13	Reset (Active High)	22
14	SPI CLK	23

iC880A Pin	Description	Raspberry Pi 3
15	MISO	21
16	MOSI	19
17	NSS	24
12	GND	9

LoRa Gateway – Software Setup / Chirpstack / Install

.Chirpstack installation:

**.Follow chirpstack tutorial to install
`gateway-os-full`**

.<https://www.chirpstack.io/gateway-os/install/raspberrypi/>

LoRa Gateway – Software Setup / Chirpstack / Configuration

.Gateway configuration:

- .- Connect RaspberryPi with ethernet
- .- SSH to raspberrypi

```
islam@islam-dell:~$ ssh admin@10.42.0.219  
admin@10.42.0.219's password:
```



```
Documentation and copyright information:  
> www.chirpstack.io
```

```
Commands:
```

```
> sudo gateway-config - configure the gateway  
> sudo monit summary - display service monitor
```

```
raspberrypi3:~$ █
```

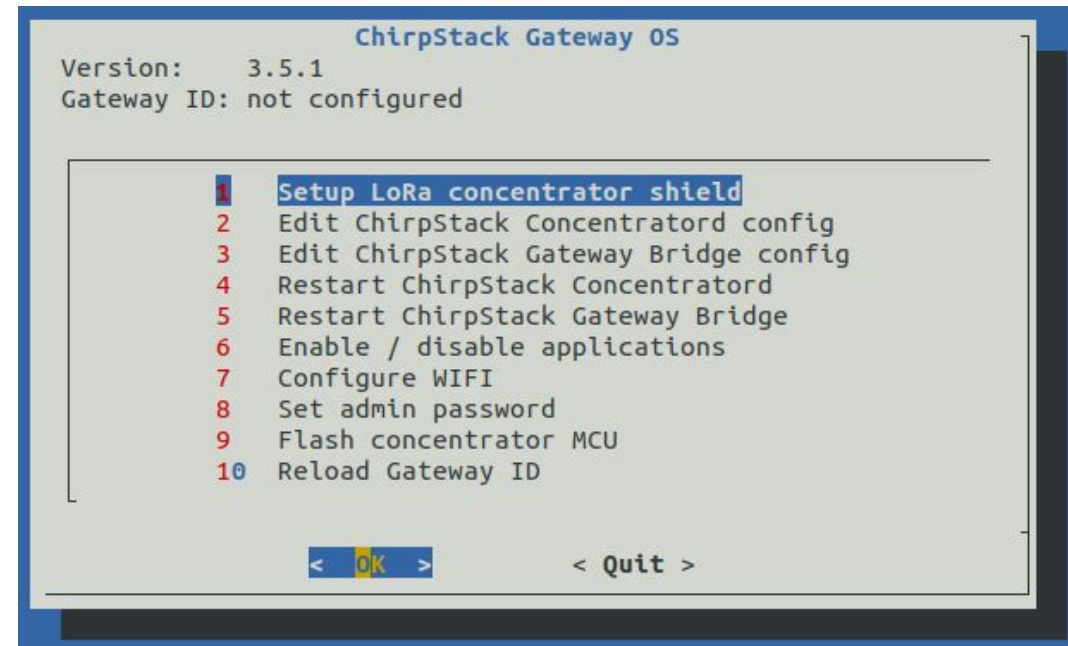
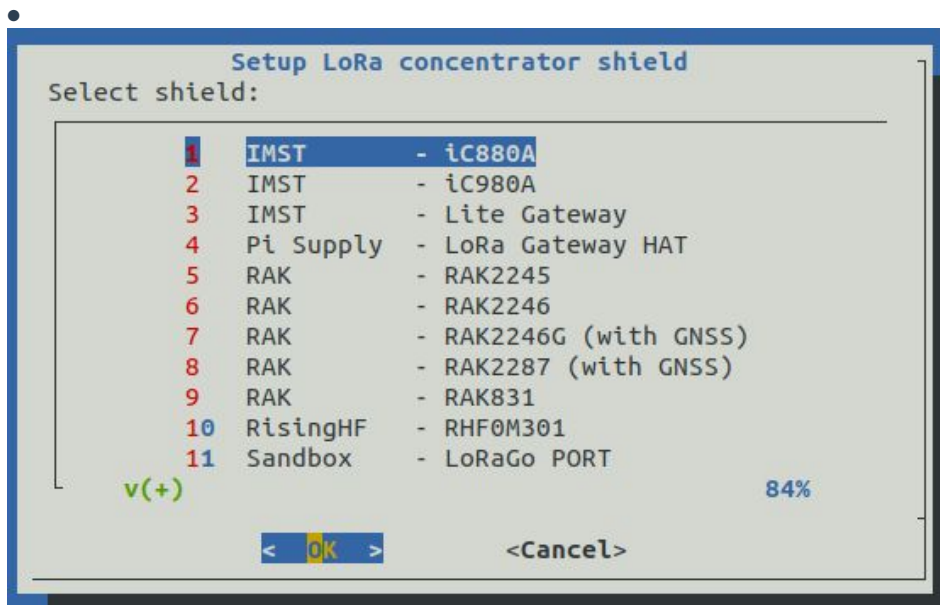
LoRa Gateway – Software Setup / Chirpstack / Configuration

.Enter command

. “sudo gateway-config”

.Select (1)

.Select iC880A



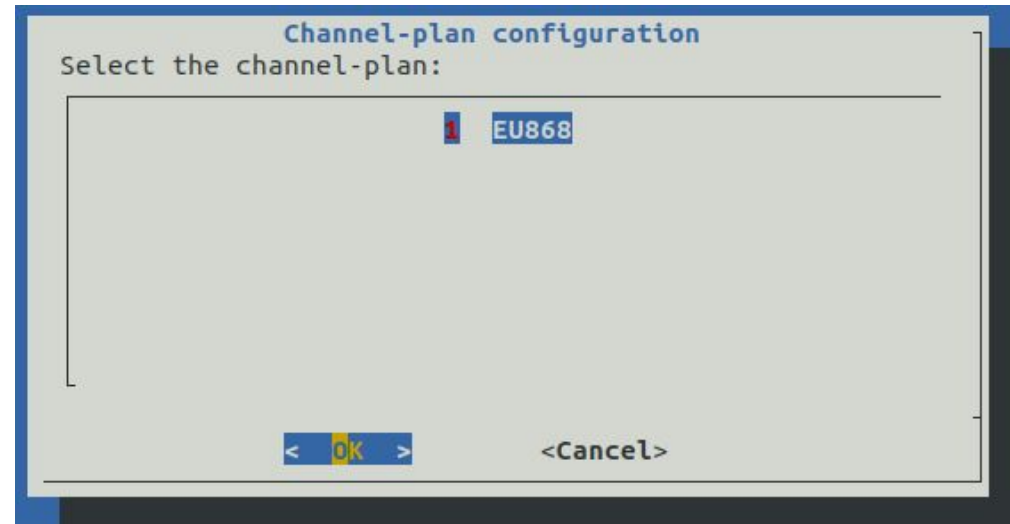
.Select iC880A

.or your concentrator model

LoRa Gateway – Software Setup / Chirpstack / Configuration

.Select (1)

.



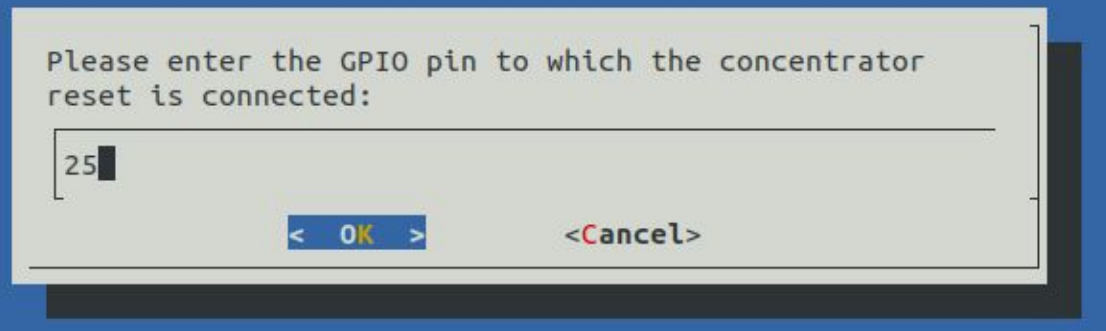
.Enter “25”,

.as GPIO25 = Pin 22

.If concentrator connected correctly to raspberrypi,

.it should restarts and

.the led blinks once



LoRa Gateway – Software Setup / Chirpstack / Configuration

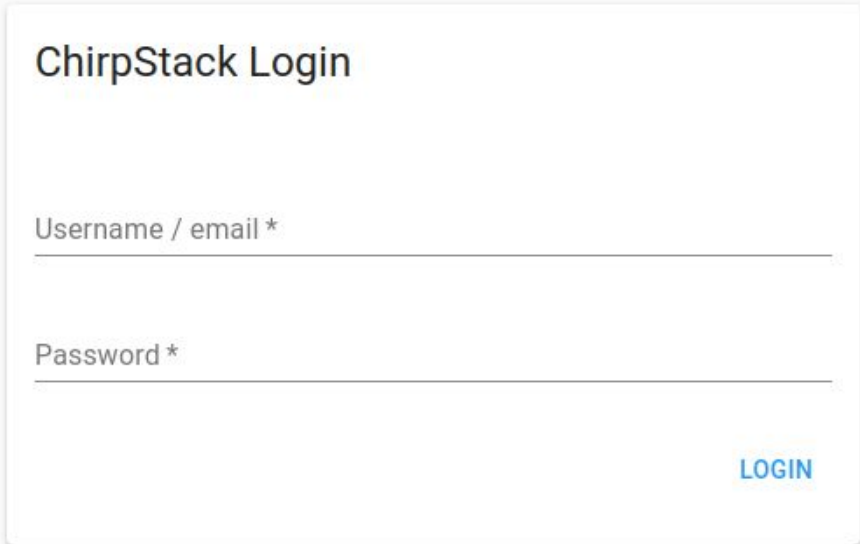
.Enter to Application server on

<http://192.168.1.100:8080/>

.Replace “192.168.1.100” with RaspberryPi IP

.Enter username and password, “admin” and “admin”

•



ChirpStack Login

Username / email *

Password *

LOGIN

LoRa Gateway – Software Setup / Chirpstack / Configuration

.From sidebar, select (Network Servers),

.then click “ADD”

.Enter following details:

–Network server name:

– ** Type any thing **

–Network server server:

– “localhost:8000”

–Interval (per day):

–100

–TX frequency (Hz):

Network-servers / Add

GENERAL

GATEWAY DISCOVERY

TLS CERTIFICATES

Network-server name *

Network-server

A name to identify the network-server.

Network-server server *

localhost:8000

The 'hostname:port' of the network-server, e.g. 'localhost:8000'.

[ADD NETWORK-SERVER](#)

GENERAL

GATEWAY DISCOVERY

TLS CERTIFICATES

Gateway discovery

☒ Enable gateway discovery

Enable the gateway discovery feature for this network-server.

Interval (per day) *

100

The number of gateway discovery 'pings' per day that ChirpStack Application Server will broadcast through each gateway.

TX frequency (Hz) *

60

The frequency (Hz) used for transmitting the gateway discovery 'pings'. Please consult the LoRaWAN Regional Parameters specification for the channels valid for each region.

TX data-rate *

57

The data-rate used for transmitting the gateway discovery 'pings'. Please consult the LoRaWAN Regional Parameters specification for the data-rates valid for each region.

LoRa Gateway – Software Setup / Chirpstack / Configuration

.From sidebar, select (Gateway Profiles)

.then click “Create”

.Enter following details:

–Name: * *Type any thing* *

–Stats Interval: 30

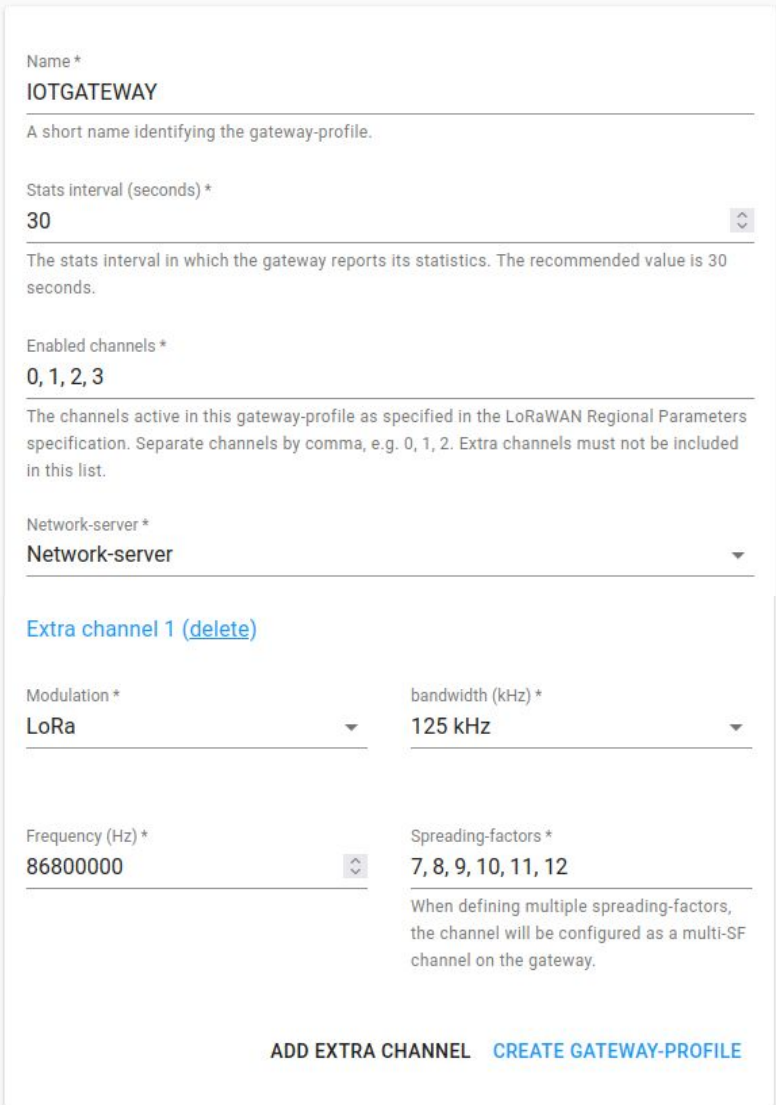
–Enabled channels: 0, 1, 2, 3

–Network Server: * *Select recently created*

.Click “Add Extra-Channel”

.Enter the following details:

–Modulation: LoRa



The screenshot shows the 'Create Gateway Profile' form in Chirpstack. The form is titled 'IOTGATEWAY' and includes the following fields and options:

- Name ***: IOTGATEWAY (A short name identifying the gateway-profile.)
- Stats interval (seconds) ***: 30 (The stats interval in which the gateway reports its statistics. The recommended value is 30 seconds.)
- Enabled channels ***: 0, 1, 2, 3 (The channels active in this gateway-profile as specified in the LoRaWAN Regional Parameters specification. Separate channels by comma, e.g. 0, 1, 2. Extra channels must not be included in this list.)
- Network-server ***: Network-server (A dropdown menu showing the selected network server.)
- Extra channel 1 (delete)**: A section for adding an extra channel.
- Modulation ***: LoRa (A dropdown menu showing the selected modulation.)
- bandwidth (kHz) ***: 125 kHz (A dropdown menu showing the selected bandwidth.)
- Frequency (Hz) ***: 86800000 (A dropdown menu showing the selected frequency.)
- Spreading-factors ***: 7, 8, 9, 10, 11, 12 (A dropdown menu showing the selected spreading factors. A note below states: 'When defining multiple spreading-factors, the channel will be configured as a multi-SF channel on the gateway.')

At the bottom of the form, there are two buttons: 'ADD EXTRA CHANNEL' and 'CREATE GATEWAY-PROFILE'.

LoRa Gateway – Software Setup / Chirpstack / Configuration

.From sidebar, select (Service Profiles),

.then click “Create”

.Enter following details:

–Service-Profile name:

– ** Type any thing **

–Network Server:

– ** Select recently created server **

.Click “Create Service-Profile”

Service-profiles / Create

Service-profile name *

Default Service Profile

A name to identify the service-profile.

Network-server *

Network-server

The network-server on which this service-profile will be provisioned. After creating the service-profile, this value can't be changed.

LoRa Gateway – Software Setup / Chirpstack / Configuration

.From sidebar, select (Device Profiles),

.then click “Create”

.Enter following details:

–Device-profile Name: * *Type any thing* *

–Network Server: * *Select recently created server* *

–LoRaWAN MAC Version: 1.0.2

–LoRaWAN Regional Parameters

–ADR algorithm: Default ADR alg

–MAX EIRP: 0

–Uplink interval: 30

–Check “Device Supports Class-B”

☒ Device supports Class-B

Class-B confirmed downlink timeout *

30

Class-B timeout (in seconds) for confirmed downlink transmissions.

Class-B ping-slot periodicity *

every 2 seconds

Class-B ping-slot periodicity.

Class-B ping-slot data-rate *

5

Class-B ping-slot frequency (Hz) *

1

GENERAL

JOIN (OTAA / ABP)

CI

Device-profile name *

Default Device Profile

A name to identify the device-profile.

Network-server *

Network-server

The network-server on which this device-profile will be provisioned. After creating the device-profile, this value can't be changed.

LoRaWAN MAC version *

1.0.2

The LoRaWAN MAC version supported by the device.

LoRaWAN Regional Parameters revision *

B

Revision of the Regional Parameters specification supported by the device.

ADR algorithm *

Default ADR algorithm

The ADR algorithm that will be used for controlling the device data-rate.

Max EIRP *

0

Maximum EIRP supported by the device.

Uplink interval (seconds) *

30

LoRa Gateway – Software Setup / Chirpstack / Configuration

• From sidebar, select (Gateways),

• then click “Create”

• Enter following details:

– Gateway Name:

– * *Type any thing* *

– Gateway Description:

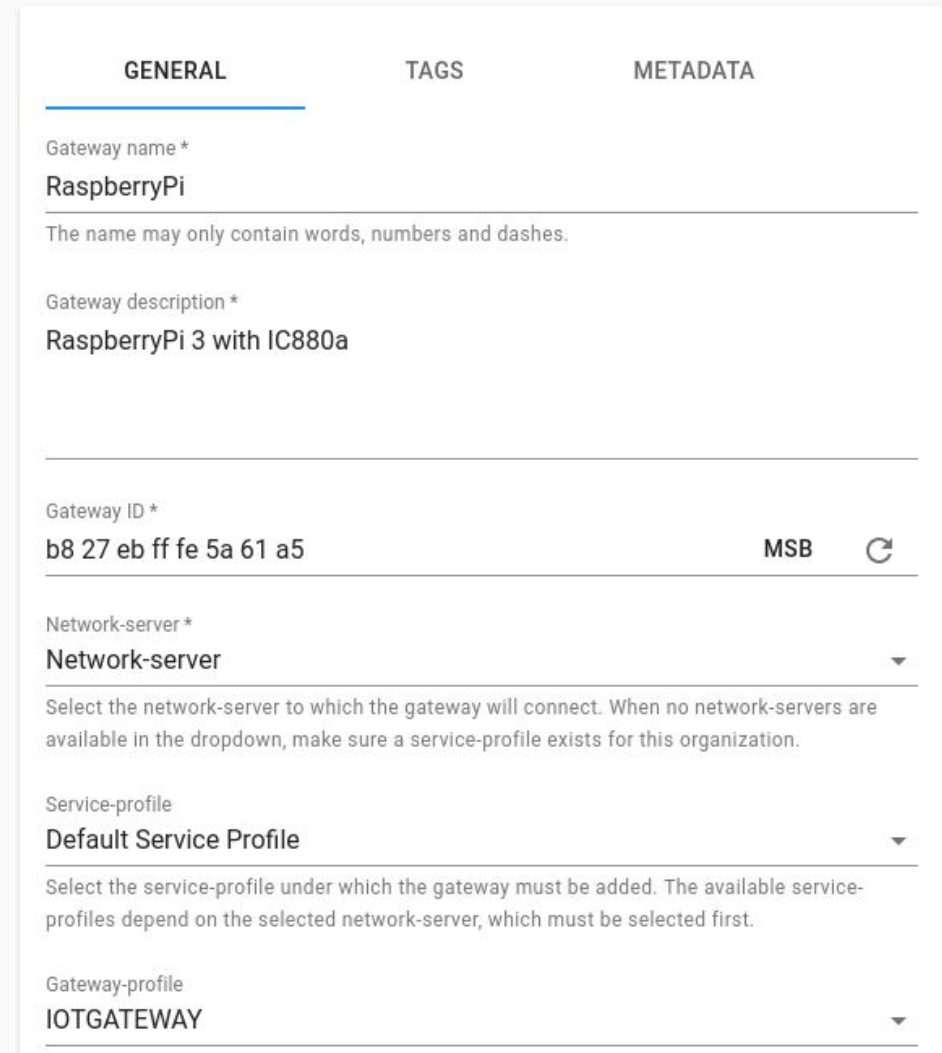
– * *Type any thing* *

– Gateway ID:

– Enter gateway ID as shown in “gateway-

– with “MSB” mode

– Network Server:



The screenshot shows the 'GENERAL' tab of a Chirpstack Gateway creation form. The form has three tabs: GENERAL, TAGS, and METADATA. The GENERAL tab is active. The form contains the following fields:

- Gateway name ***: A text input field containing 'RaspberryPi'. Below it is a note: 'The name may only contain words, numbers and dashes.'
- Gateway description ***: A text input field containing 'RaspberryPi 3 with IC880a'.
- Gateway ID ***: A text input field containing 'b8 27 eb ff fe 5a 61 a5'. To the right of the field are the labels 'MSB' and a refresh icon.
- Network-server ***: A dropdown menu with 'Network-server' selected. Below it is a note: 'Select the network-server to which the gateway will connect. When no network-servers are available in the dropdown, make sure a service-profile exists for this organization.'
- Service-profile**: A dropdown menu with 'Default Service Profile' selected. Below it is a note: 'Select the service-profile under which the gateway must be added. The available service-profiles depend on the selected network-server, which must be selected first.'
- Gateway-profile**: A dropdown menu with 'IOTGATEWAY' selected.

LoRa Gateway – Software Setup / Chirpstack / Configuration

.From sidebar, select (Applications),

.then click “Create”

.Enter following details:

–Gateway Name:

–* *Type any thing* *

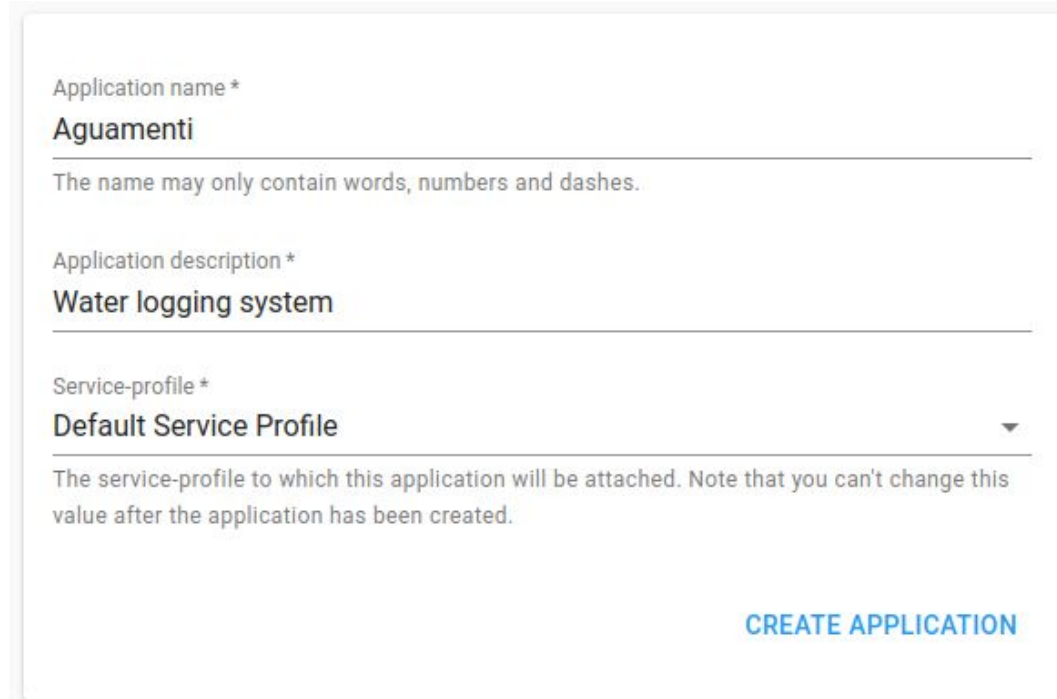
–Application Description:

–* *Type any thing* *

–Service profile:

–* *Select recently created profile* *

.Click “Create Application”



The screenshot shows a web form for creating a new application in ChirpStack. It contains three input fields: 'Application name *' with the value 'Aguamenti', 'Application description *' with the value 'Water logging system', and 'Service-profile *' with a dropdown menu showing 'Default Service Profile'. A blue button labeled 'CREATE APPLICATION' is at the bottom right. A note below the service profile dropdown states: 'The service-profile to which this application will be attached. Note that you can't change this value after the application has been created.'

Application name *

Aguamenti

The name may only contain words, numbers and dashes.

Application description *

Water logging system

Service-profile *

Default Service Profile

The service-profile to which this application will be attached. Note that you can't change this value after the application has been created.

CREATE APPLICATION

LoRa Gateway – Software Setup / Chirpstack / Configuration

- From sidebar, select (Applications),
- then select recently created application, and click “Create”
- Enter following details:
 - Device Name:
 - * *Type any thing* *
 - Device Description:
 - * *Type any thing* *
 - Device EUI:
 - Write device EUI from step #? (MSB)
 - Device profile:
 - * *Select recently created profile* *

The screenshot shows the 'Create Device' form in Chirpstack, with the 'GENERAL' tab selected. The form contains the following fields and options:

- Device name ***: Node-1. A note below states: 'The name may only contain words, numbers and dashes.'
- Device description ***: Testing Node
- Device EUI ***: 70 B3 D5 8F F1 01 28 6C. To the right is a label 'MSB' and a refresh icon.
- Device-profile ***: Default Device Profile (with a dropdown arrow).
- ☒ **Disable frame-counter validation**. A note below states: 'Note that disabling the frame-counter validation will compromise security as it enables people to perform replay-attacks.'

LoRa Gateway – Software Setup / Chirpstack / Configuration

.Next, you will be redirected automatically to “activation” tab

.for the recently created device.

.Enter following details:

–Device address:

–Write device address as shown in step #‘

–Network session key (LoRaWAN 1.0):

–* *Generate random key as MSB* *

–Application session key (LoRaWAN 1.0):

–* *Generate random key as MSB* *

–Uplink frame-counter:

–0?

–Downlink frame-counter (network):

Device address *

01 6E 16 E2 MSB

While any device address can be entered, please note that a LoRaWAN compliant device address consists of an AddrPrefix (derived from the NetID) + NwkAddr.

Network session key (LoRaWAN 1.0) *

BF C3 59 7D D0 48 96 4 MSB

Application session key (LoRaWAN 1.0) *

90 3D 05 28 0E 7F BB E MSB

Uplink frame-counter *

0

Downlink frame-counter (network) *

0

LoRa Test

.Using EndNode Studio

.Change payload

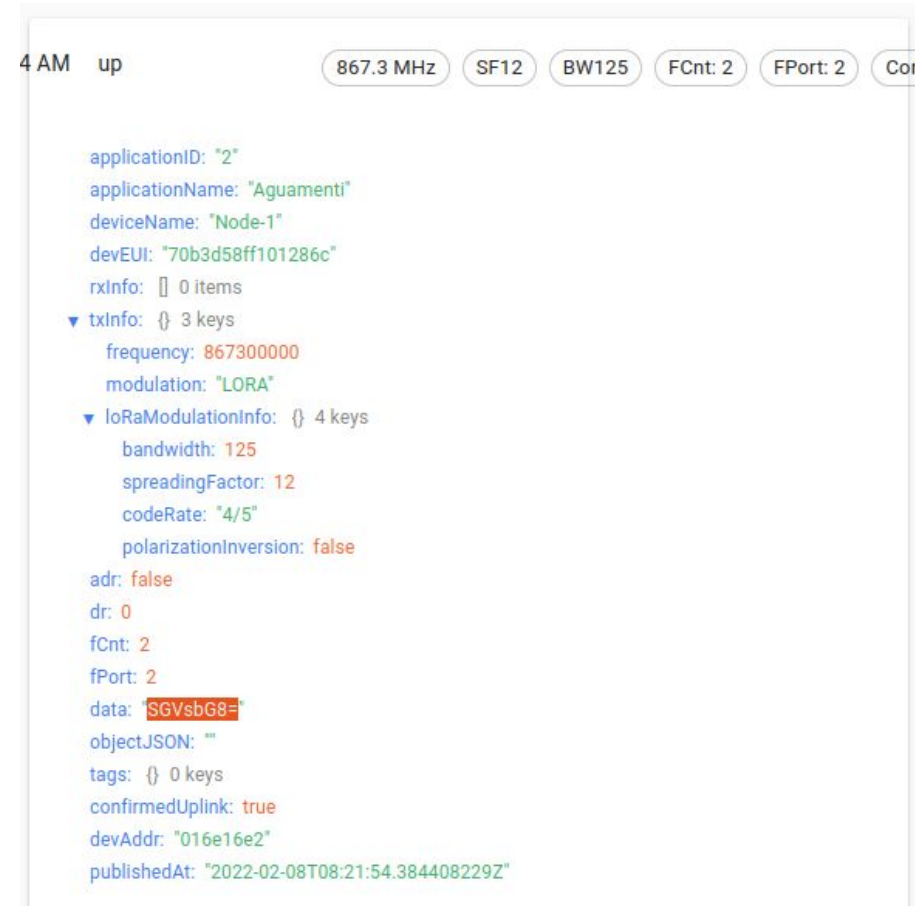
.Send U-Data

The screenshot shows the 'LoRaWAN Configuration' page in the EndNode Studio application. The interface is divided into several sections:

- Device Network Status** (expanded):
 - Device EUI: 70-B3-D5-8F-F1-01-28-6C
 - Network Status: Active (ABP)
 - Tx Power Level (EIRP): 16 dBm
 - Max. Payload Size: 51
 - Uplink Data Rate: LoRa / SF12 / 125 kHz
 - Buttons: Get Network Status, Deactivate Device
- Device Activation by Personalization (ABP)** (expanded):
 - Device Address: 0x016E16E2
 - Network Session Key: BF-C3-59-7D-D0-4B-96-43-81-64-E6-D8-E1-DF-63-F9
 - Application Session Key: 90-3D-05-28-0E-7F-BB-E9-8A-CC-B8-5D-A7-76-F2-AD
 - Buttons: Activate Device, Reactivate Device
- Device Activation Over The Air (OTAA)** (collapsed)
- Uplink Data Service** (expanded):
 - Port: 0x02
 - Payload: 48-65-6C-6C-6F- - - - -
 - Transmit Period: 1 s
 - Buttons: Send U-Data, Send C-Data
 - Options: ☐ Send periodically, ☒ U-Data, ☐ C-Data

LoRa Test

- Enter to Application → Devices → and select recently created device
- Select the “Device Data” tab
- Send data from EndNode Studio
- Decode the received data by Base64 Decoder to find the sent data



LoRa Test / Message decoding

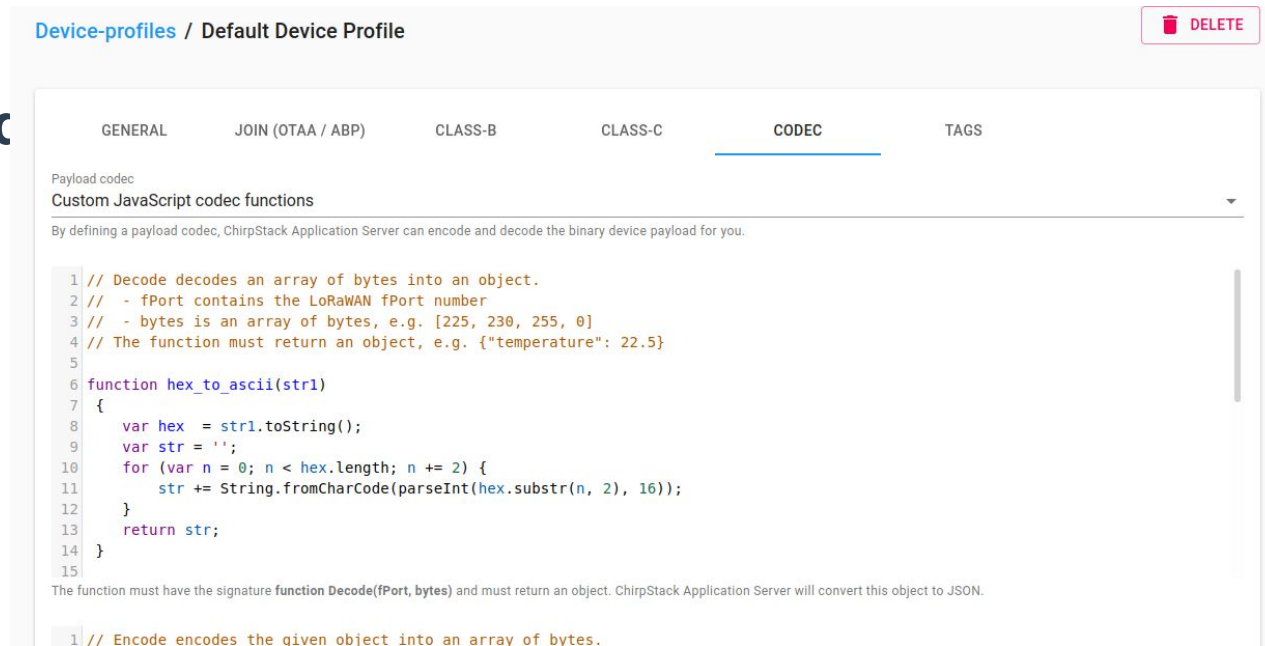
.From sidebar, select (Device Profiles),

.then select recently created profile.

.Select the
“CODEC”

.tab

.Select “Custom



Thank you

References

.LoRa Alliance:

https://lora-alliance.org/lora_products/ic880a-lora-concentrator/

.Instructables:

<https://www.instructables.com/Raspberry-Pi-LoRaWAN-Gateway/>

.RaspberryPi:

<https://www.raspberrypi.com>

.Wireless Solutions: