

TTN in Practice

Credits:

Luka Mustafa, intro to TTN at
ICTP smr3188 workshop

Marco Zennaro, PhD
ICTP



The Things Network

THE THINGS NETWORK

A **global** community, building **open source** software and hardware to operate a **crowd-sourced IoT network**.

TheThingsNetwork is known as TTN



3^*10

LORAWAN

3 * 10

10 km range

10 USD/node

10 years battery life

LoRaWAN

LORA

RANGE

Yes No

Up to 15km

LOW POWER CONSUMPTION

Yes No

Devices can last months / years
on a battery

THOUSANDS OF DEVICES

Yes No

Can be connected per gateway

UNLICENSED SPECTRUM

Yes No

868MHz (EU) 915MHz (US)

BANDWIDTH

Yes No

Max 50kb/s

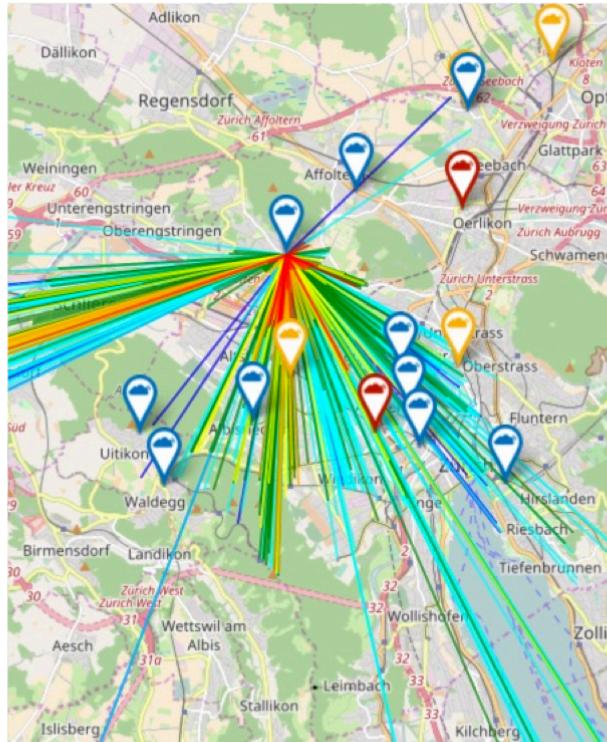


LoRaWAN

LONG RANGE

2km - 5km in urban setting

40km+ in rural setting



TTN's mission

Our mission is to build a
DECENTRALIZED,

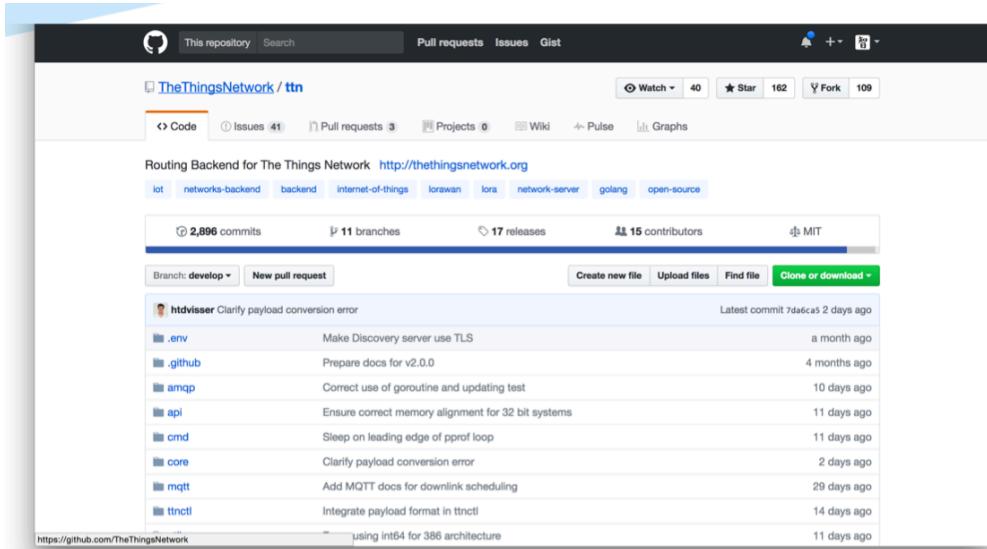
OPEN and **CROWDSOURCED**

INTERNET OF THINGS data network

OWNED and **OPERATED** by its **USERS**



TTN is Open Source



OPEN SOURCE BACKEND

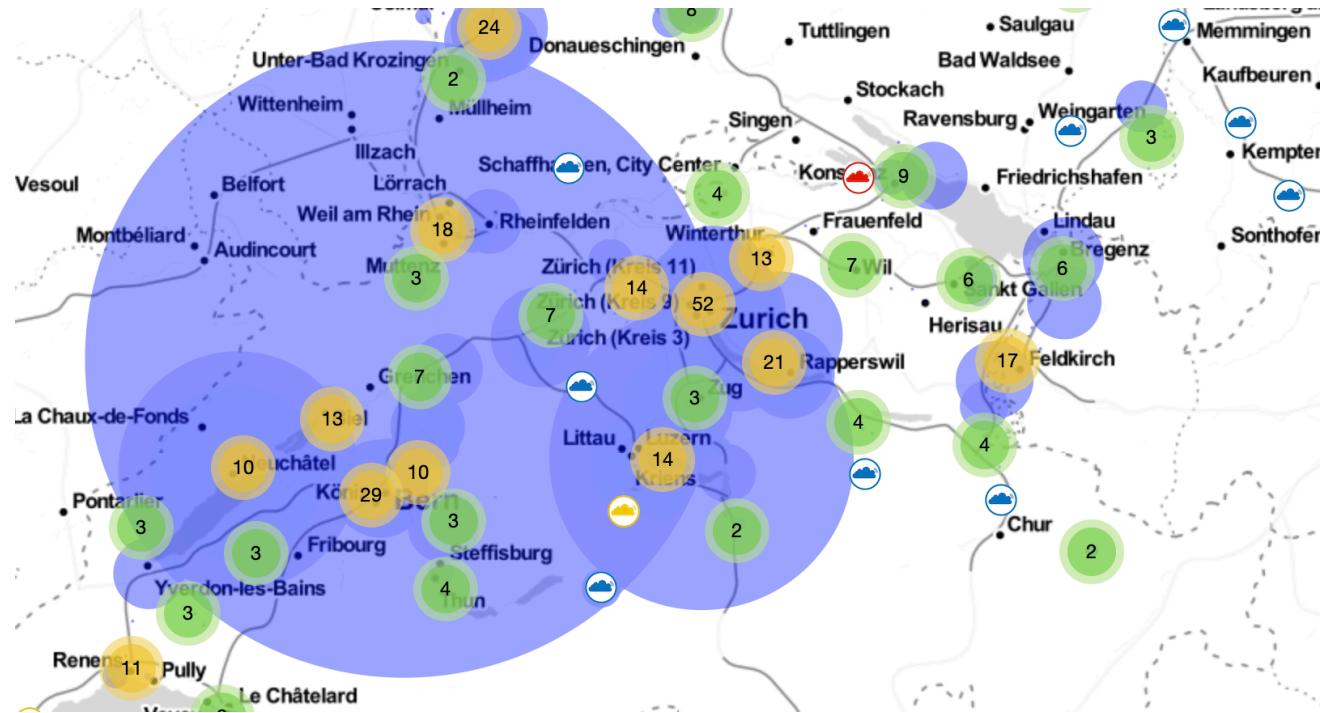


TTN Communities



Over 300 communities in 100 countries

TTN Communities



<https://ttnmapper.org>

TTN: devices, gateways, servers

HOW DOES THIS WORK?



DEVICES

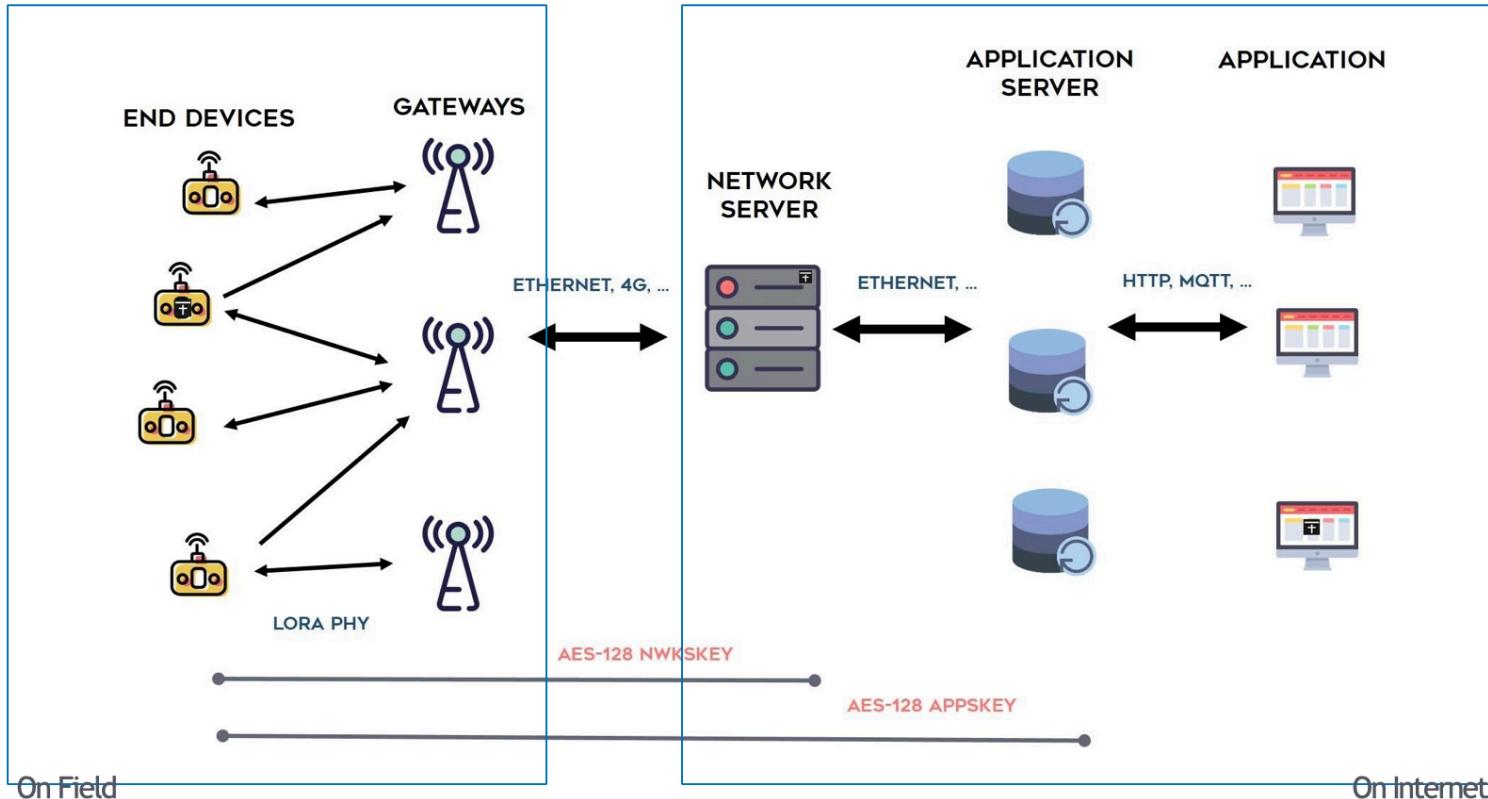
GATEWAYS

NETWORK
SERVER

APPLICATION
SERVER



LoRaWAN architecture



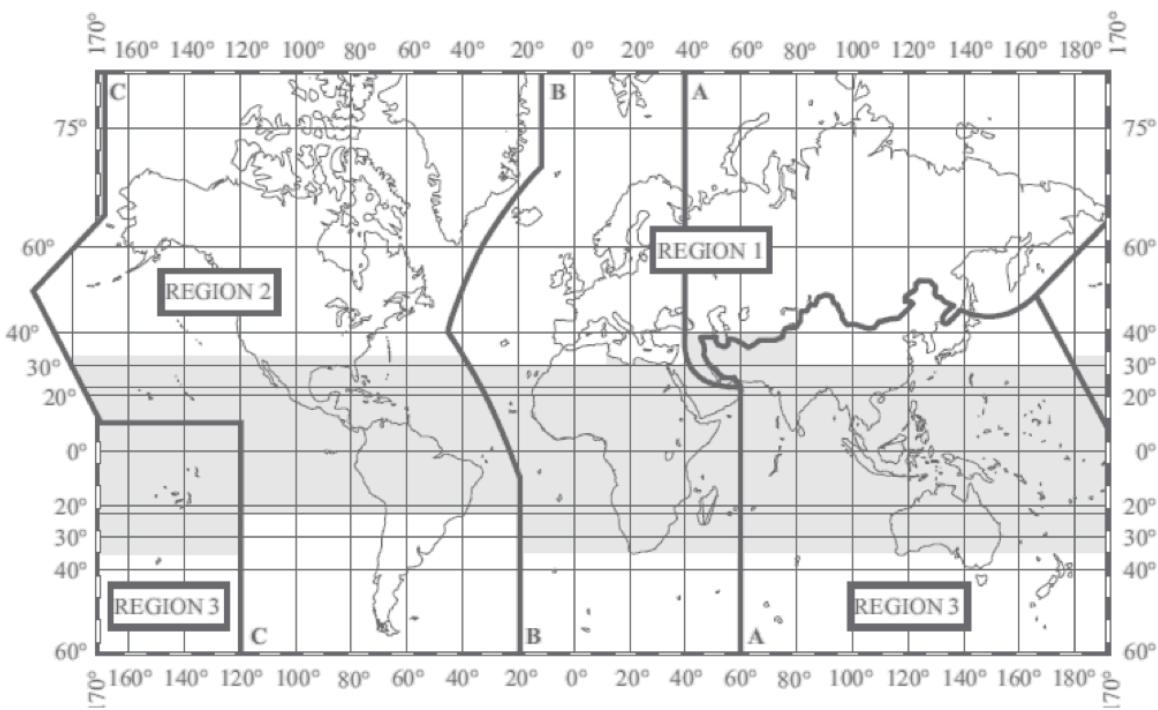
Gateways

Gateways

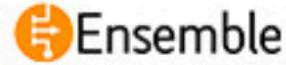
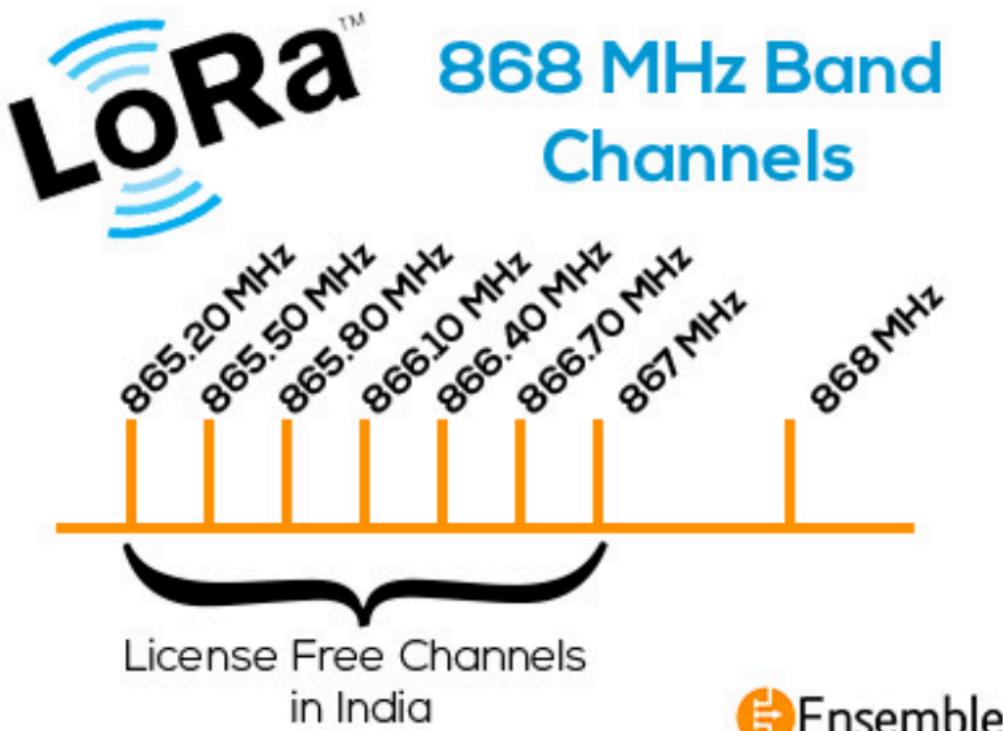
- Gateways are **packet forwarders**
- They “forward” LoRaWAN packets to TCP/IP using WiFi/Ethernet/Cellular
- They operate on different frequency bands, depending on the region (pay attention!)
- Once you buy/build a gateway, there is not much to do!
- You simply need to register your gateway in TTN

LoRa frequency bands

Countries	Frequency band review	Max. output power
EU	868 MHz	14 dBm
USA	915 MHz	20 dBm
Korea	900 MHz	14 dBm
Japan	920 MHz	
Malaysia	862 to 875 MHz	20 dBm
Philippines	868 MHz	
Vietnam	920 to 925 MHz	
India	865 to 867 MHz	
Singapore	922 MHz	
Thailand	920 to 925 MHz	
Indonesia		
ANZ	915 to 928 MHz	
Taiwan	920 to 925 MHz	
China	470 to 510 MHz	17 dBm



LoRa channels in India



Single Channel Gateway



70 euro

RPi+board

No enclosure

Single Channel

7/8 Channels Gateway



500-1500 euro

Enclosure

8 Channels

7/8 Channels Gateway



200-300 euro

No enclosure

8 Channels

Is it working?

GATEWAY OVERVIEW

Gateway ID **eui-b827ebfffebbee2**

Description MarconiLab LoRaWAN Gateway

Owner  **marcozen** [Transfer ownership](#)

Status  **connected**

Frequency Plan Europe 868MHz

Router **ttn-router-eu**

Gateway Key  **.....**

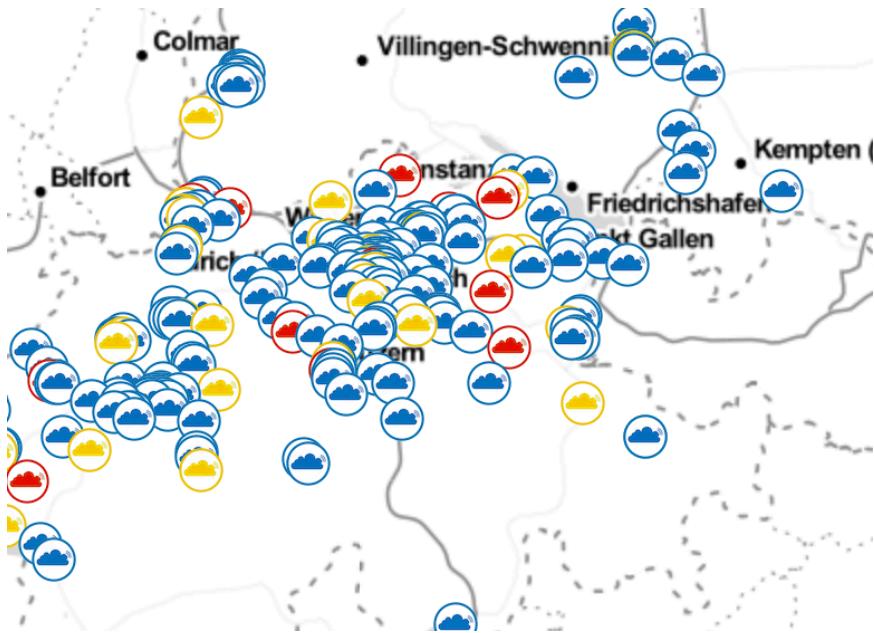
Last Seen 2 seconds ago

Received Messages 1315877

Transmitted Messages 6702

Connected!

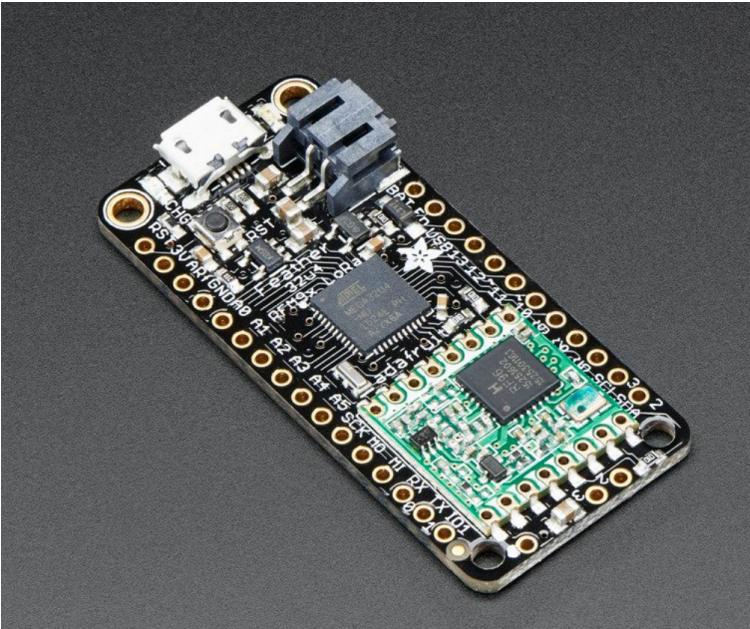
Do I need a gateway?



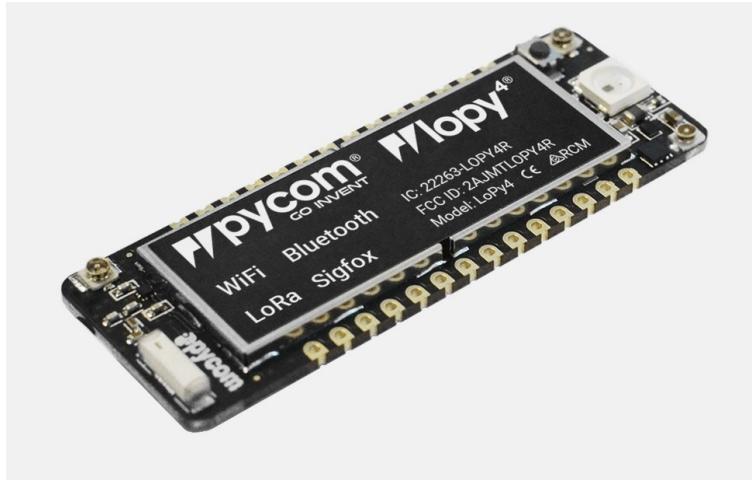
You don't need to install a Gateway to use TTN if there are gateways available in your area!

Nodes

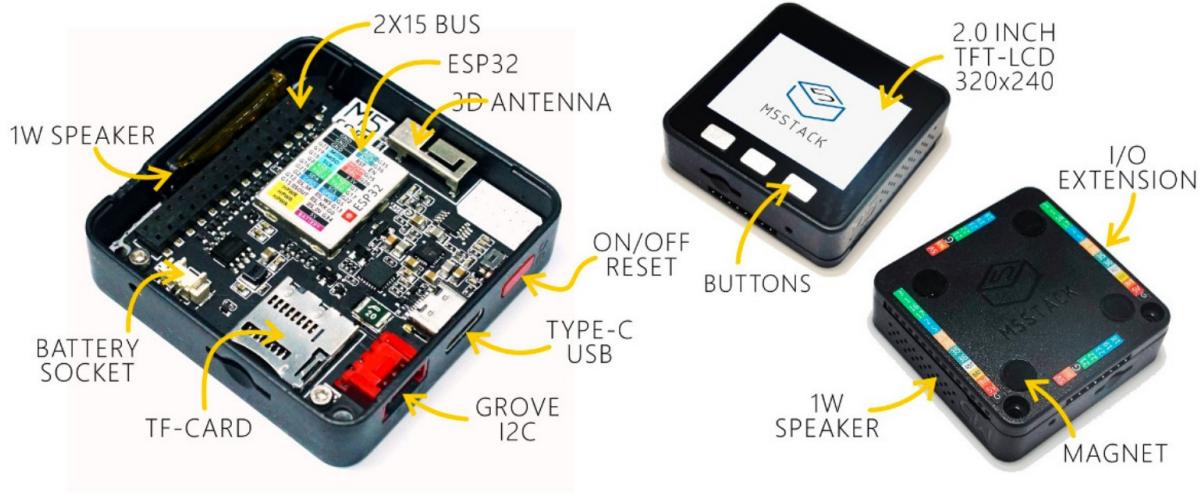
LoRaWAN nodes - Feather



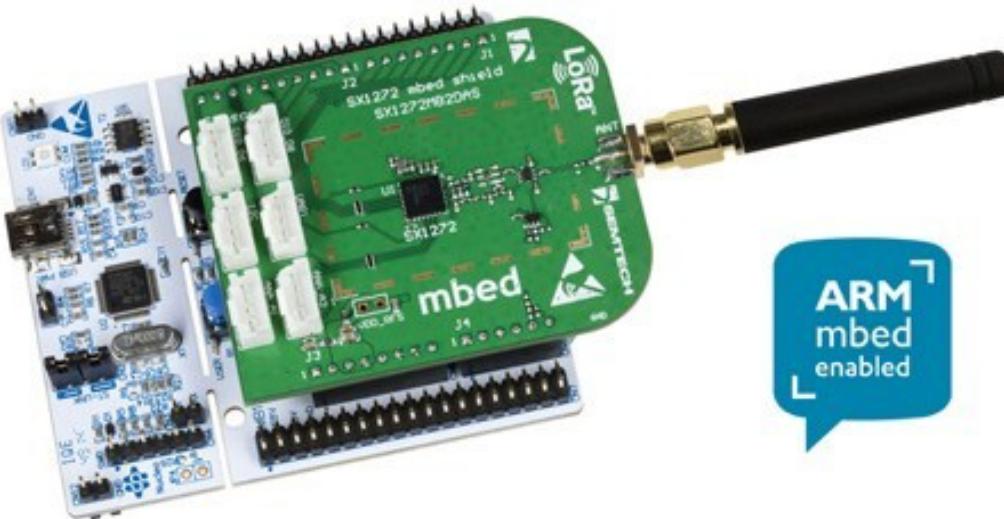
LoRaWAN nodes – Pycom Lopy



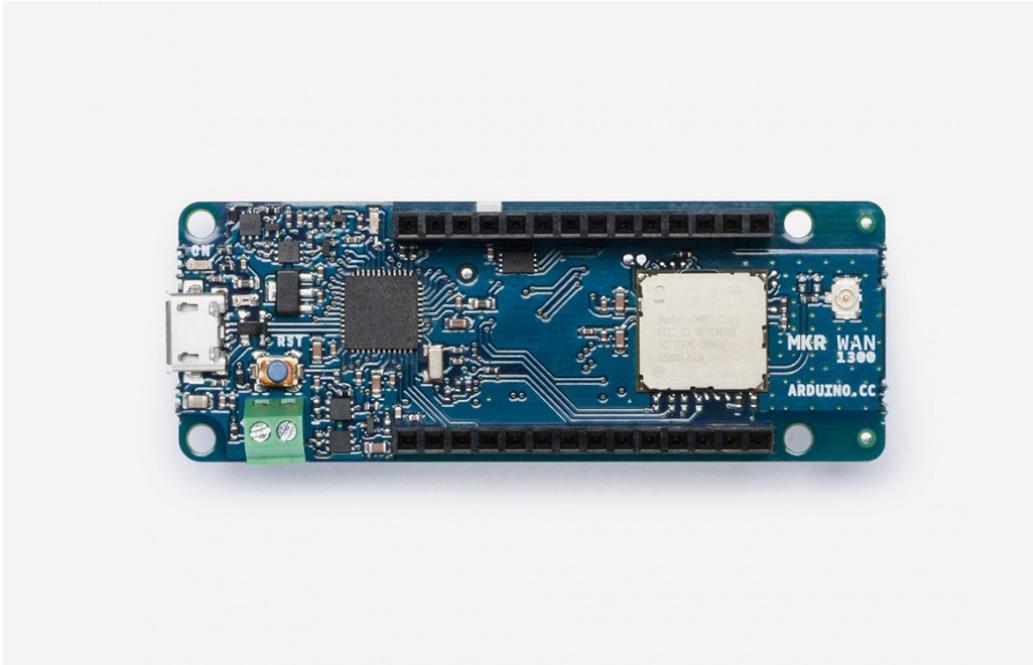
LoRaWAN nodes – m5stack



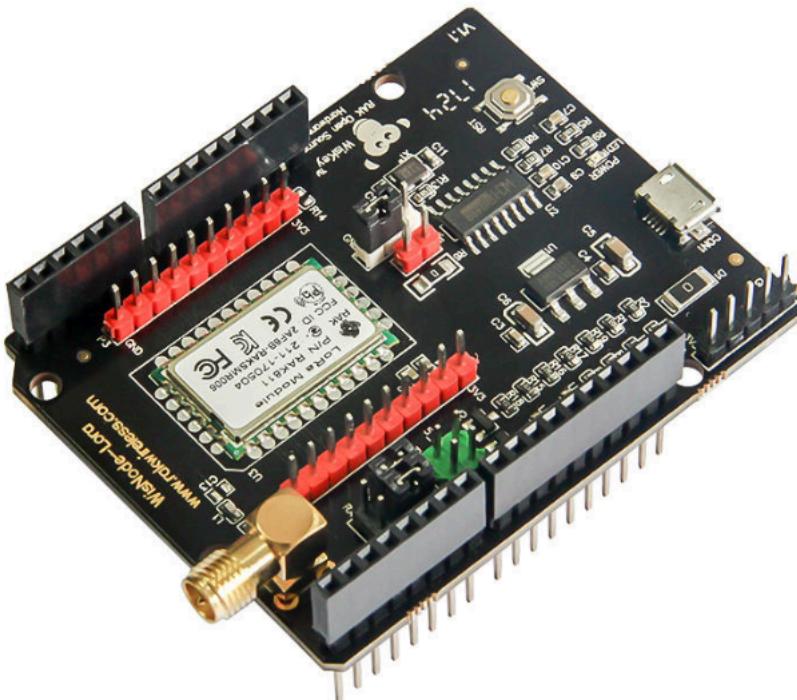
LoRaWAN nodes – ARM mbed



LoRaWAN nodes – Arduino 1300



LoRaWAN nodes – Arduino shield



LoRaWAN products



ZTEMP LORAWAN TEMPERATURE SENSOR Z01856

€ 52

LoRa temperature sensor in IP65 house with external DS18B20 sensor

1



Add to cart

Categories: industrial, LoRaWAN



LoRaWAN products



ZTAG – LORAWAN GPS TRACKER – Z01915

€ 87

zTag is a LoRaWAN GPS tracker for tracking mostly cattle and other livestock. The tracker is constantly charging itself via its solar panel.

For more info about the device, please visit zane.hu/en/iot.

Devices are available in the following frequency regions:

- EU863-870
- US902-928
- AU915-928
- IN865-867.

LoRaWAN products

A blue banner featuring the The Things Network logo on the left and the text "MARKETPLACE" and "IoT-ready products & solutions offered by The Things Industries partners." on the right. A button at the bottom says "Add your product".

**THE THINGS
NETWORK**

MARKETPLACE

IoT-ready products & solutions offered by The Things Industries partners.

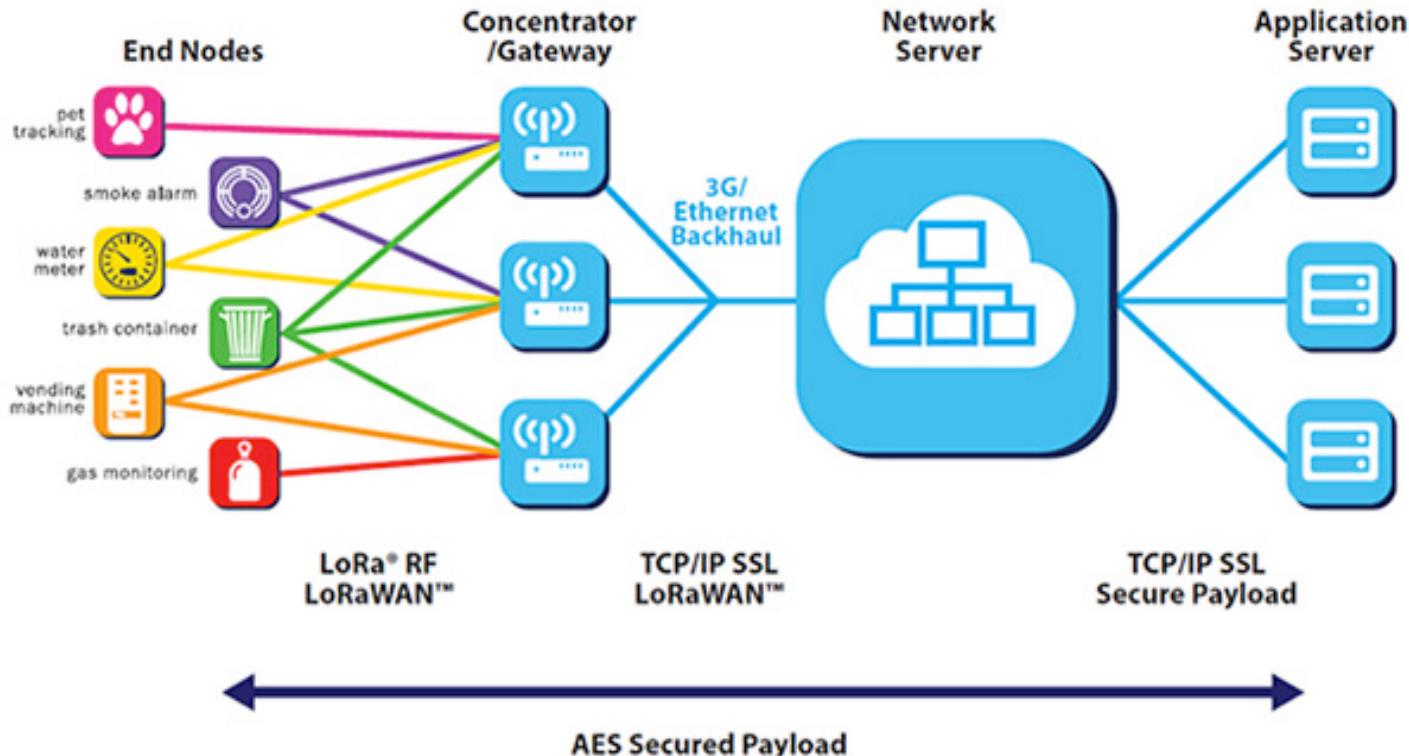
Add your product

<https://www.thethingsnetwork.org/marketplace/products/devices>

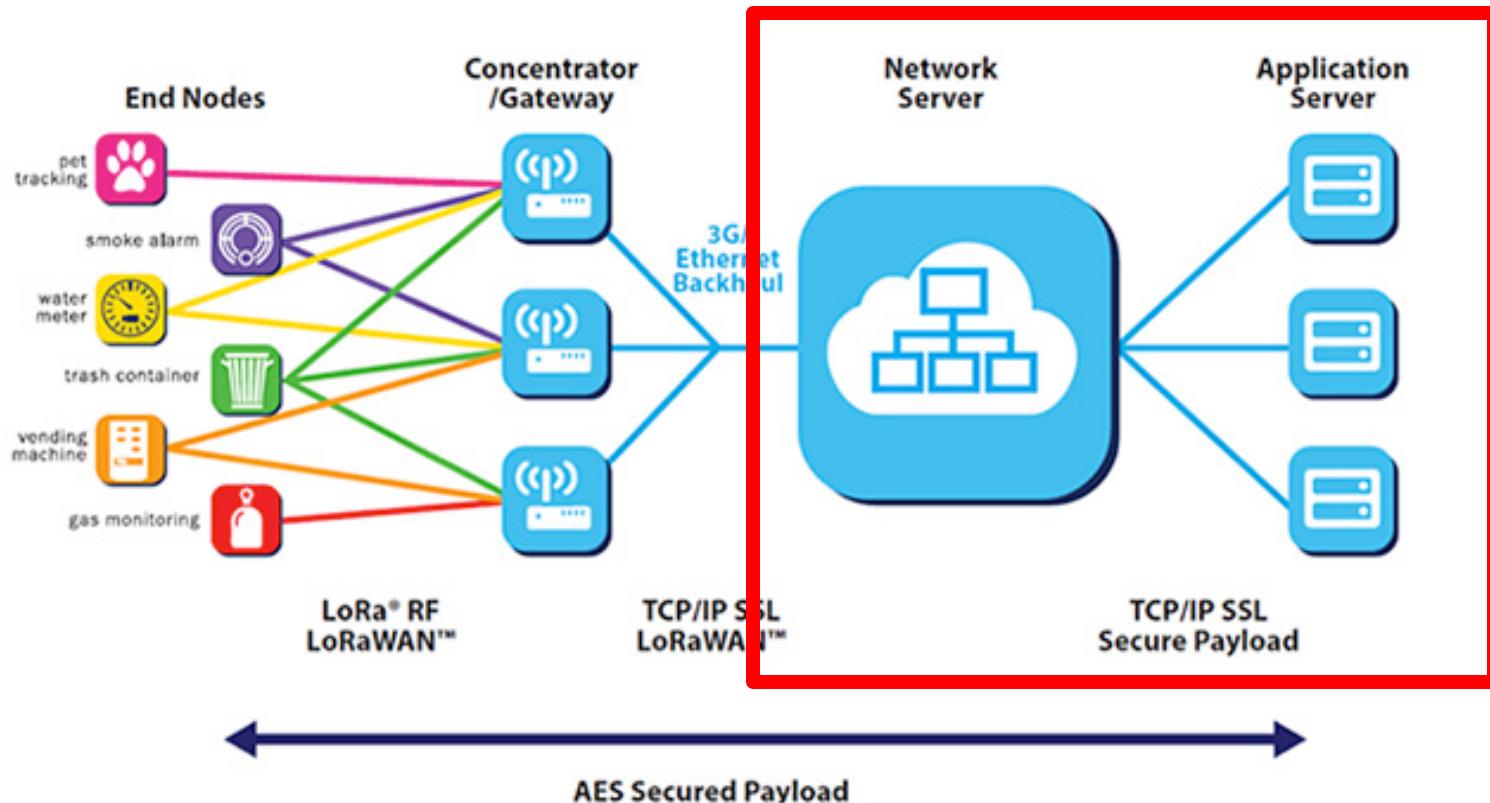


Packets

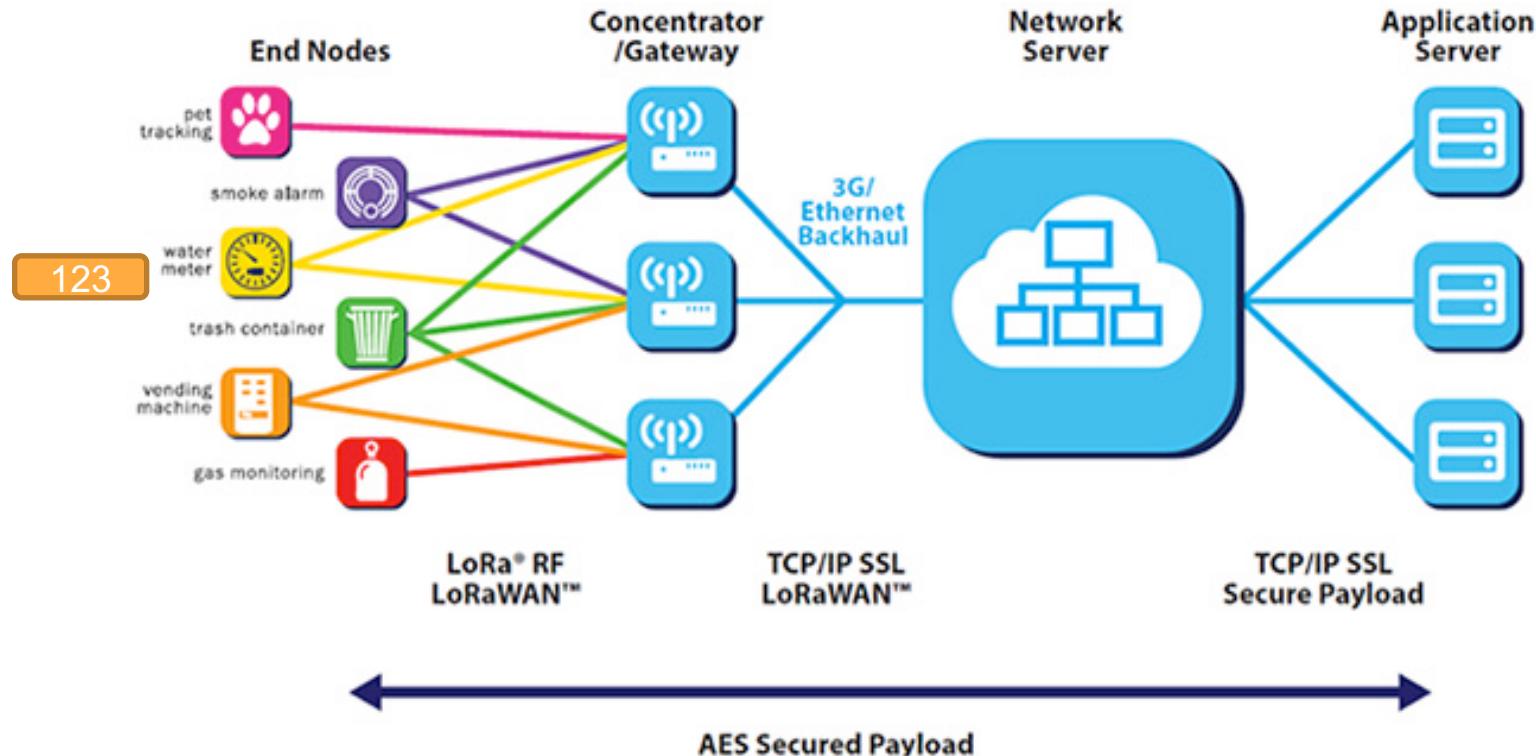
LoRaWAN architecture



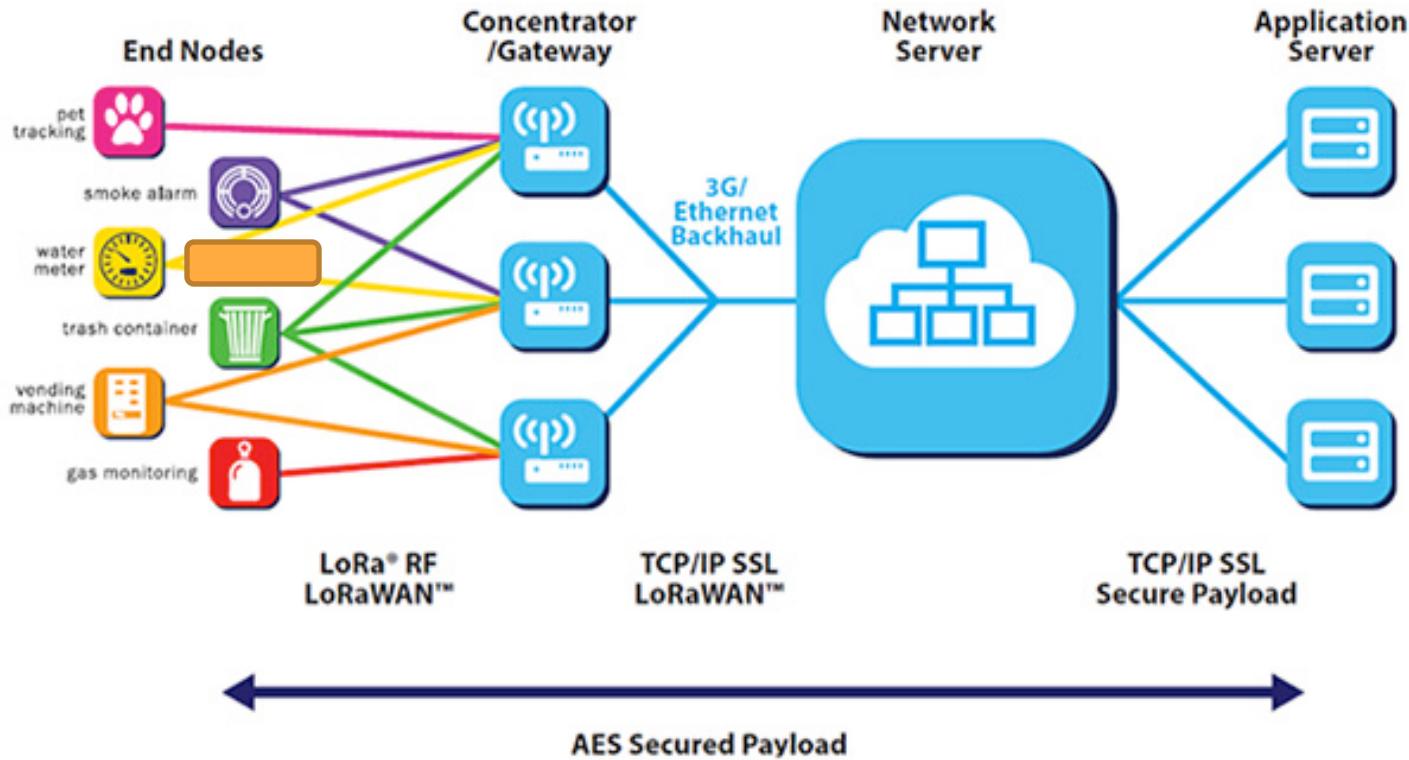
LoRaWAN architecture - TTN



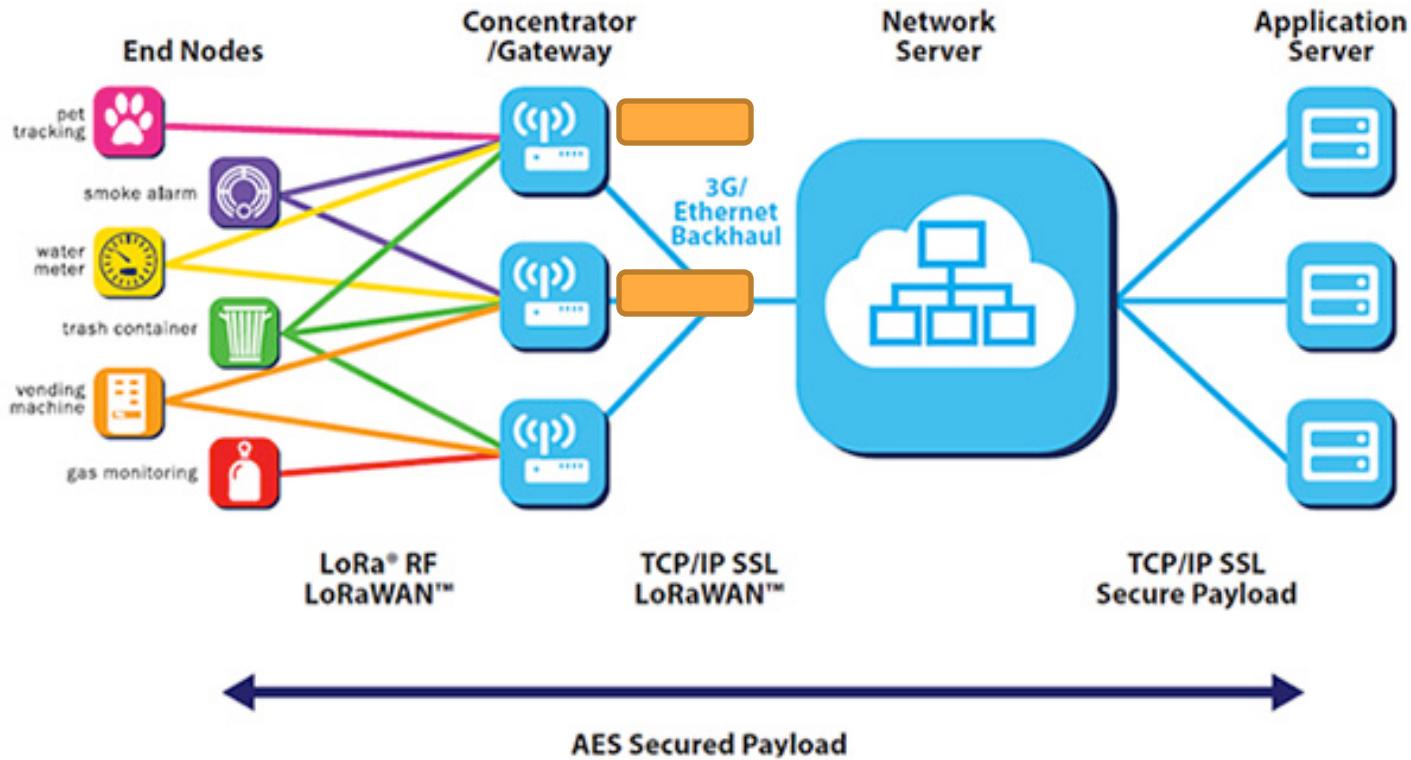
LoRaWAN architecture



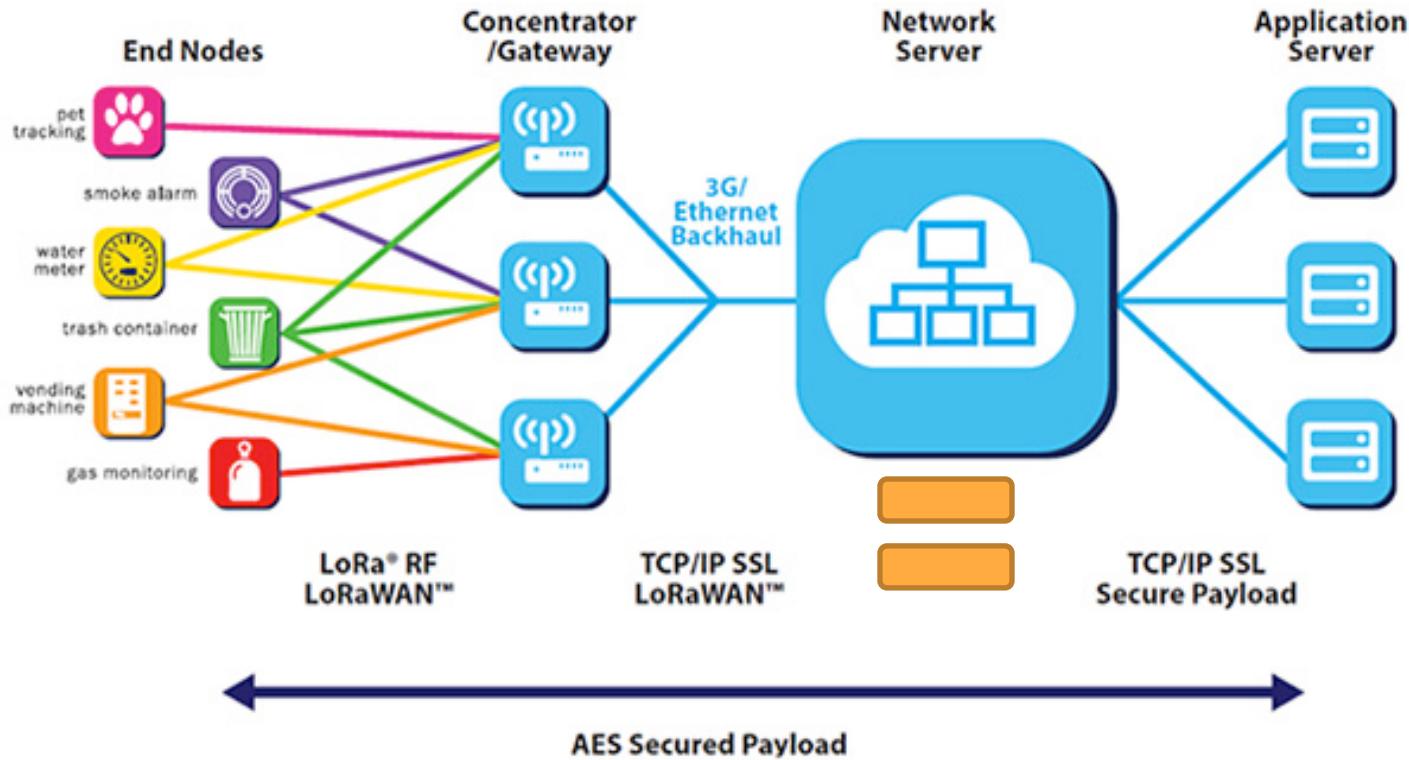
LoRaWAN architecture



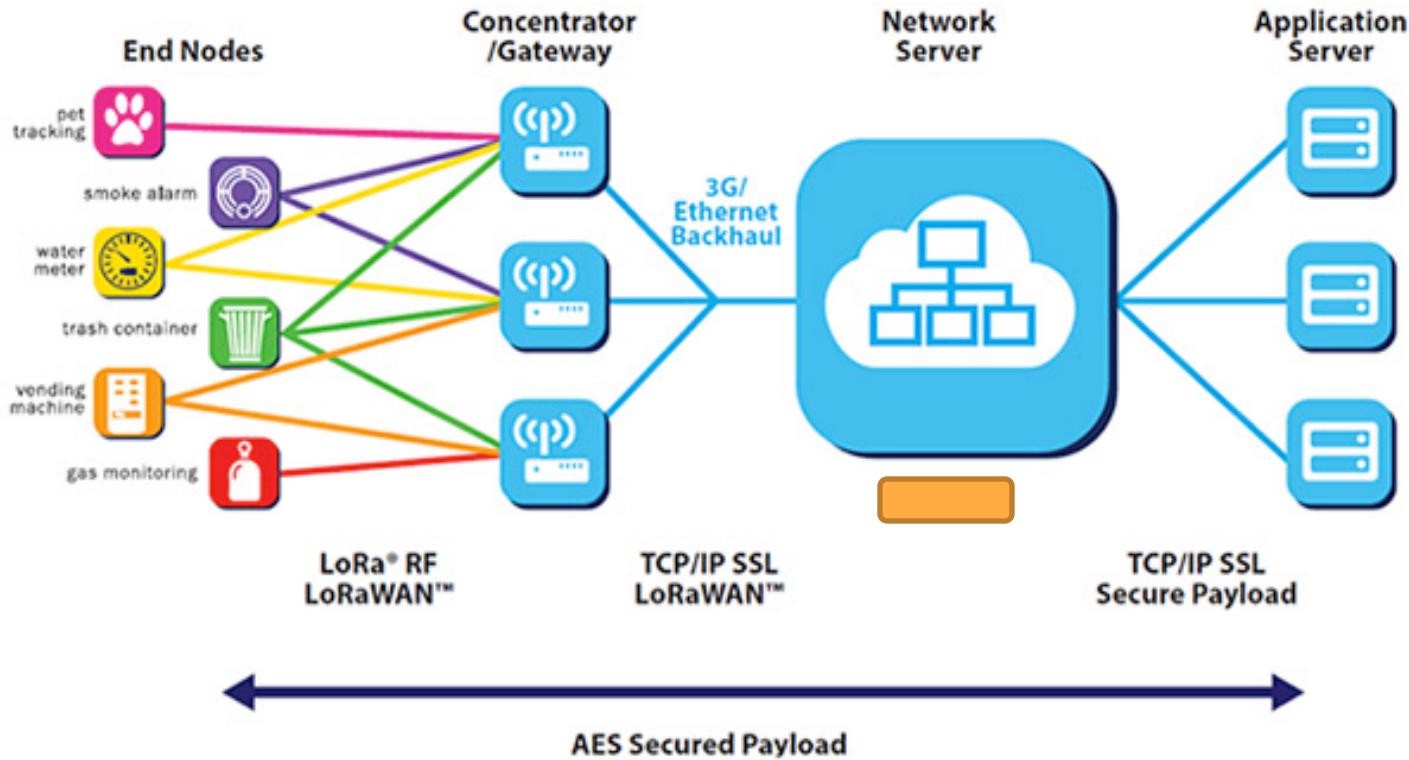
LoRaWAN architecture



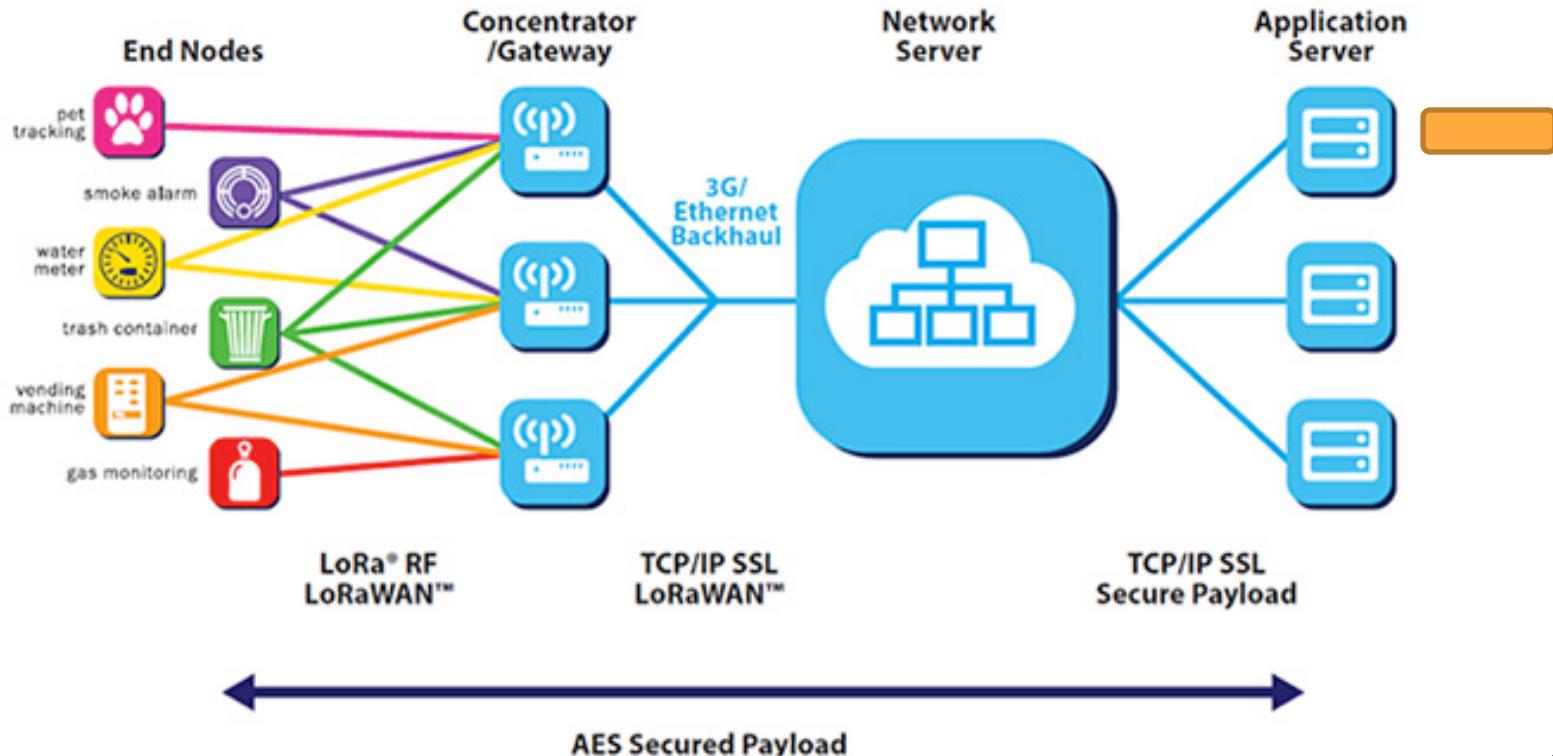
LoRaWAN architecture



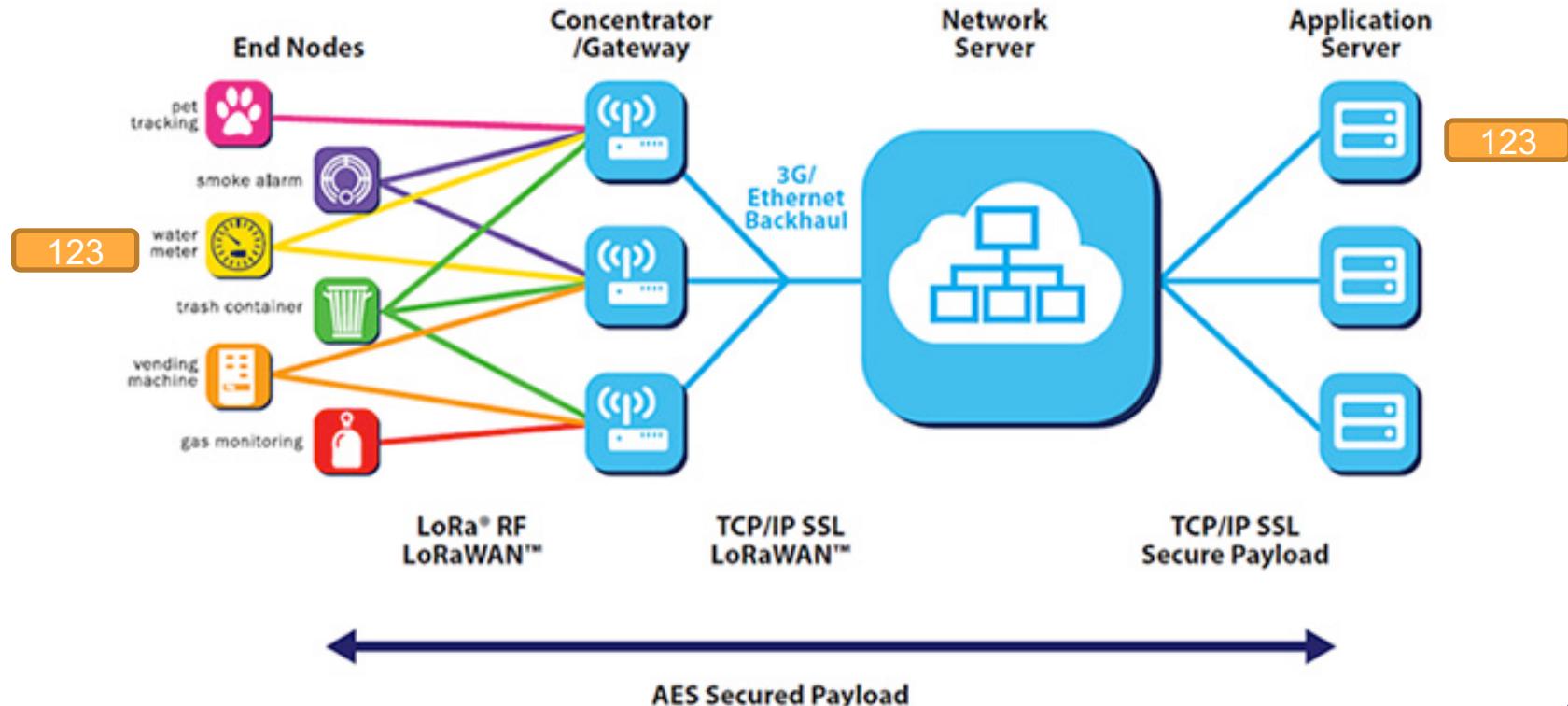
LoRaWAN architecture



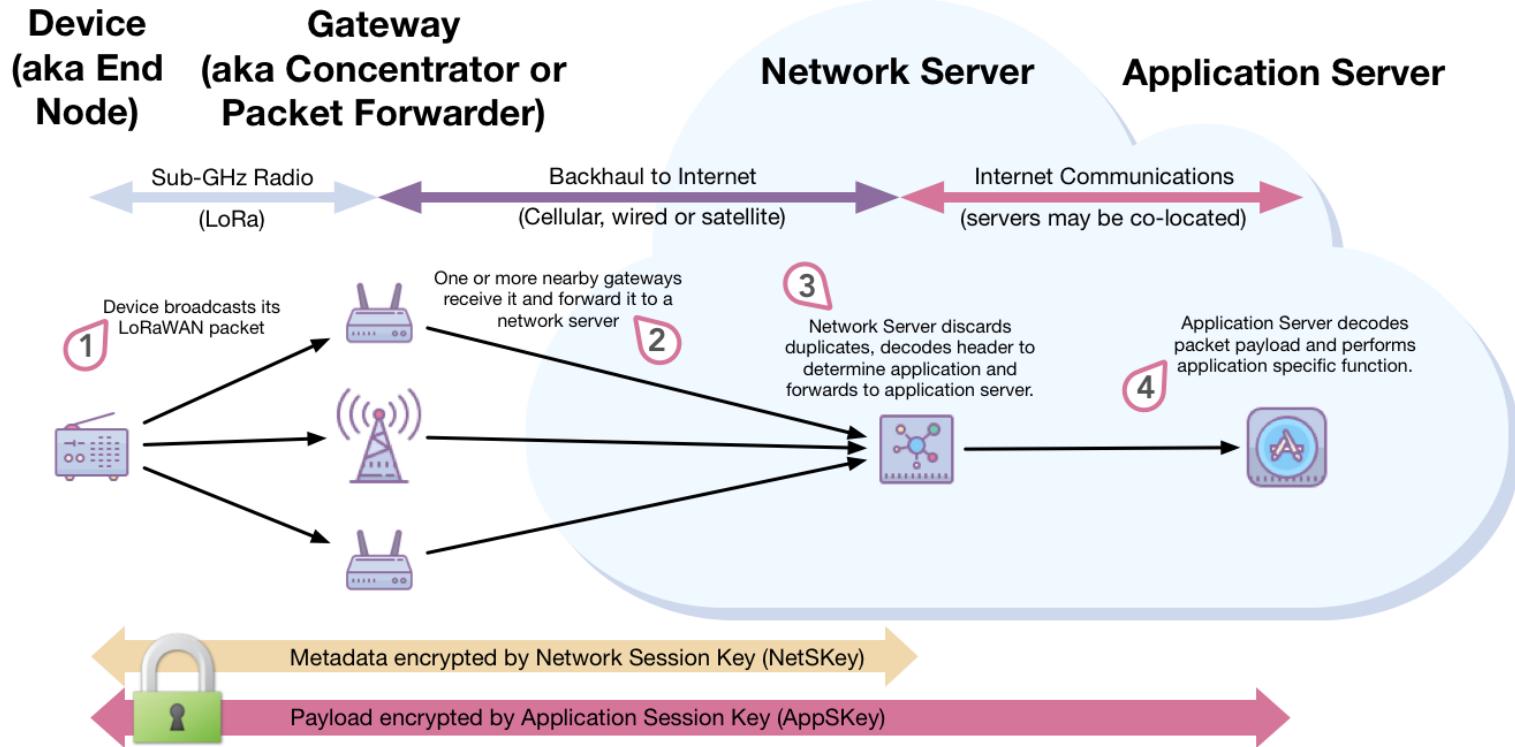
LoRaWAN architecture



LoRaWAN architecture

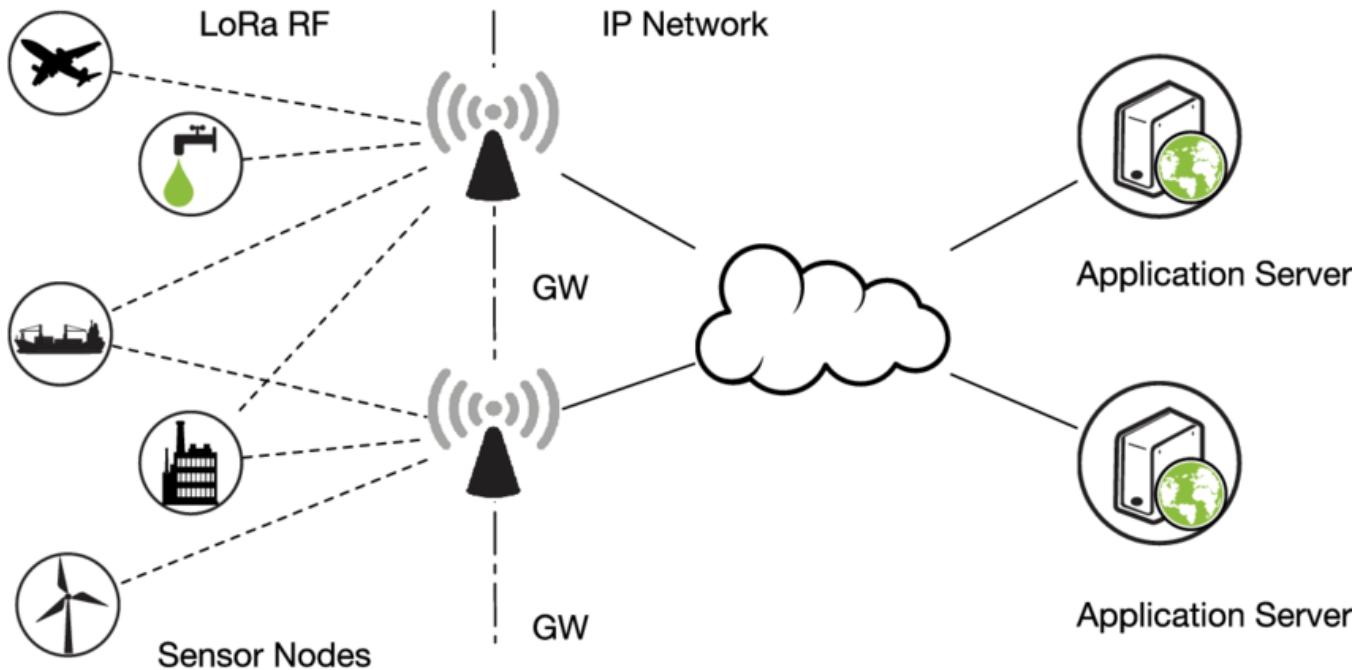


TTN: authentication

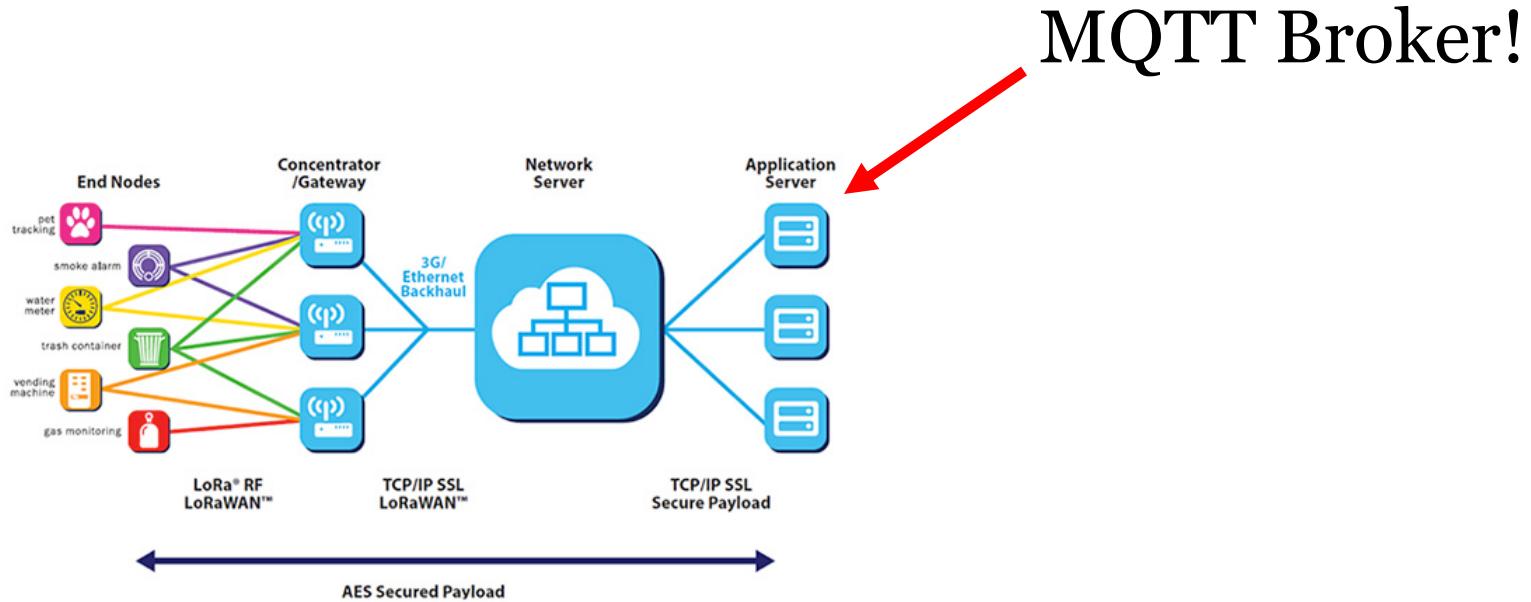


Credit: <https://www.newieventures.com.au/blogtext/2018/2/26/lorawan-otaa-or-abp>

LoRaWAN architecture



LoRaWAN architecture



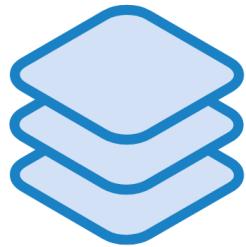
TTN in practice

TTN: App and Gateway

👋 Hi, Marco!

Welcome to The Things Network Console.

This is where the magic happens. Here you can work with your data. Register applications, devices and gateways, manage your integrations, collaborators and settings.



APPLICATIONS



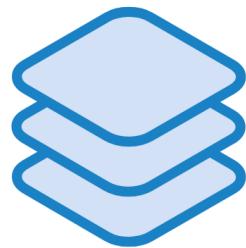
GATEWAYS

TTN: Gateway

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APPLICATIONS



GATEWAYS

TTN: Gateway



Gateway Setup

Setting up the software

- Plug the power supply of the RPi which will also power the concentrator board
- From a computer in the same LAN, `ssh` into the RPi using the default hostname:

```
local $ ssh pi@raspberrypi.local
```

- Default password of a plain-vanilla RASPBIAN install for user `pi` is `raspberry`.
- Use `raspi-config` utility to **enable SPI** ([5] Interfacing options -> P4 SPI) and also expand the filesystem ([7] Advanced options -> A1 Expand filesystem):

```
$ sudo raspi-config
```

- Reboot (it will ask on exit, but you can do it manually with `sudo reboot`)
- Configure locales and time zone:

```
$ sudo dpkg-reconfigure locales  
$ sudo dpkg-reconfigure tzdata
```

Example for the ic880a

Is it working?

GATEWAY OVERVIEW

Gateway ID **eui-b827ebfffebbee2**

Description MarconiLab LoRaWAN Gateway

Owner  **marcozen** [Transfer ownership](#)

Status  **connected**

Frequency Plan Europe 868MHz

Router **ttn-router-eu**

Gateway Key  **.....**

Last Seen 2 seconds ago

Received Messages 1315877

Transmitted Messages 6702

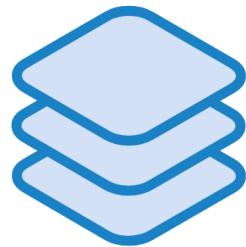
Connected!

TTN: App

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APPLICATIONS



GATEWAYS

TTN: App

Application ID

ADD APPLICATION

Application ID
The unique identifier of your application

Description
A human readable description of your new application

Application EUI
An application EUI will be issued for The Things Network block for convenience. You can add your own in the application settings

Handler registration
Select the handler you want to register your application to

Description

Handler

TTN: we have a new App!

APPLICATION OVERVIEW

Application ID **test_application_fablab**

Description

Created 11 seconds ago

Handler **ttn-handler-eu** (*current handler*)

APPLICATION EUIS

70 B3 D5 7E D0 01 70 74

TTN: Collaborators

DEVICES

 0 registered devices

[register device](#) [manage devices](#)

COLLABORATORS

 marcozennaro

[manage collaborators](#)

[collaborators](#) [delete](#) [devices](#) [settings](#)

TTN: add a Collaborator to the App

ADD COLLABORATOR

Could not add application
An app with the application id test_3 already exists.

Username

Erm| 

 Ermanno Ermanno Pietrosemoli

Rights

settings
Manage the application settings and access keys

collaborators
Edit the application collaborators

delete
Delete the application

devices
View and edit devices of the application

TTN: register a device

REGISTER DEVICE

Device ID
This is the unique identifier for the device in the app. The device ID will be generated.

Device EUI
The device EUI is the unique identifier for this device on the network. You can change the EUI later.

App Key
The App Key will be used to secure the communication between your device and the network.
 this field will be generated

App EUI
 70 B3 D5 7E D0 01 70 74

Name of Device
Device EUI

Where is the device EUI?

Step 1: Create a device in TTN with the OTAA keys from LGT-92.

Each LGT-92 is shipped with a sticker with the default device EUI as below:



TTN: devices

REGISTER DEVICE

Device ID
This is the unique identifier for the device in this app. The device ID will be immutable.

Device EUI
The device EUI is the unique identifier for this device on the network. You can change the EUI later.



App Key
The App Key will be used to secure the communication between your device and the network.

 this field will be generated

App EUI

TTN: devices

DEVICE OVERVIEW

Application ID test_application_fablab

Device ID test_device

Activation Method OTAA

Device EUI <> 70 B3 D5 49 95 AB DB CE

Application EUI <> 70 B3 D5 7E D0 01 70 74

App Key <> ⚑ ...

Status • never seen

Frames up 0 [reset frame counters](#)

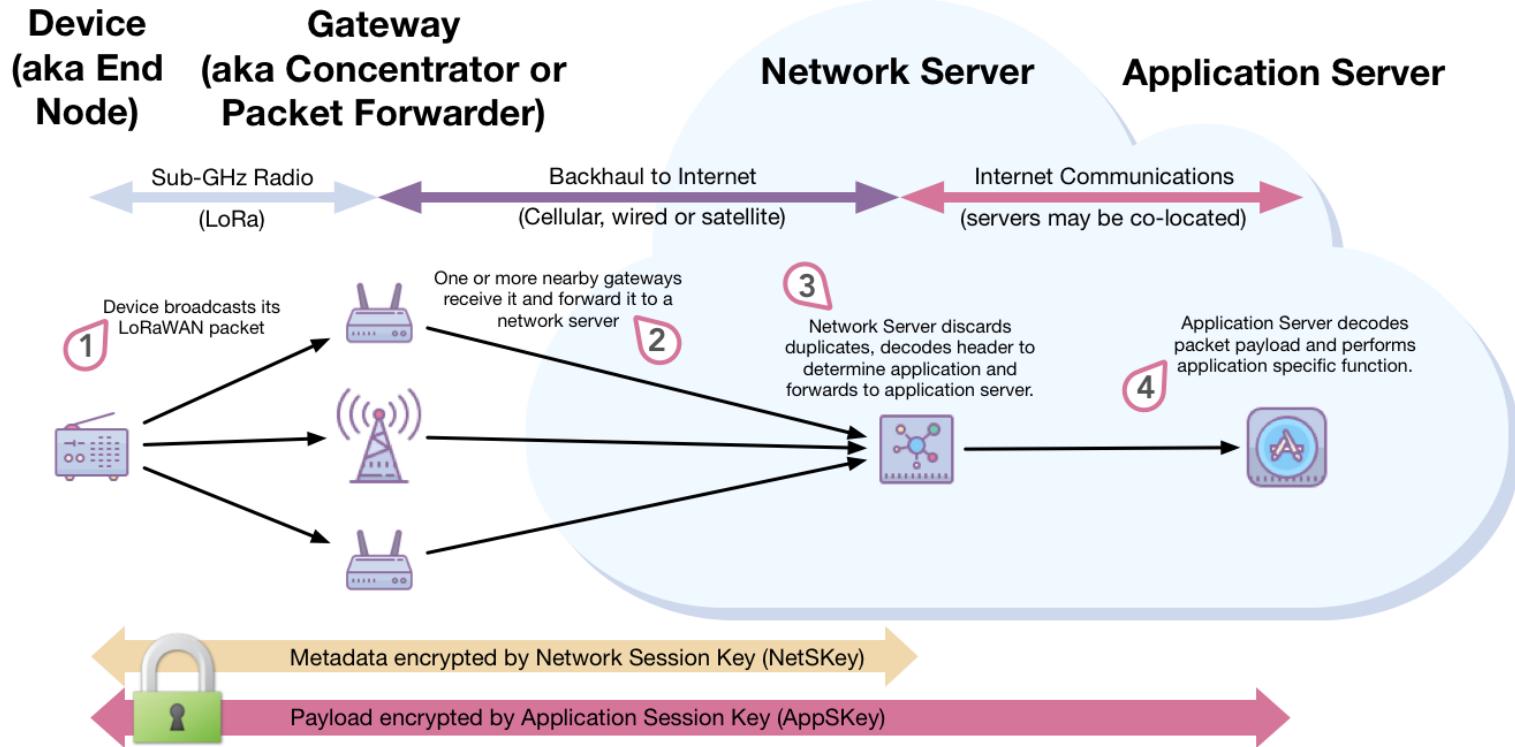
Frames down 0



Authentication

Never seen!

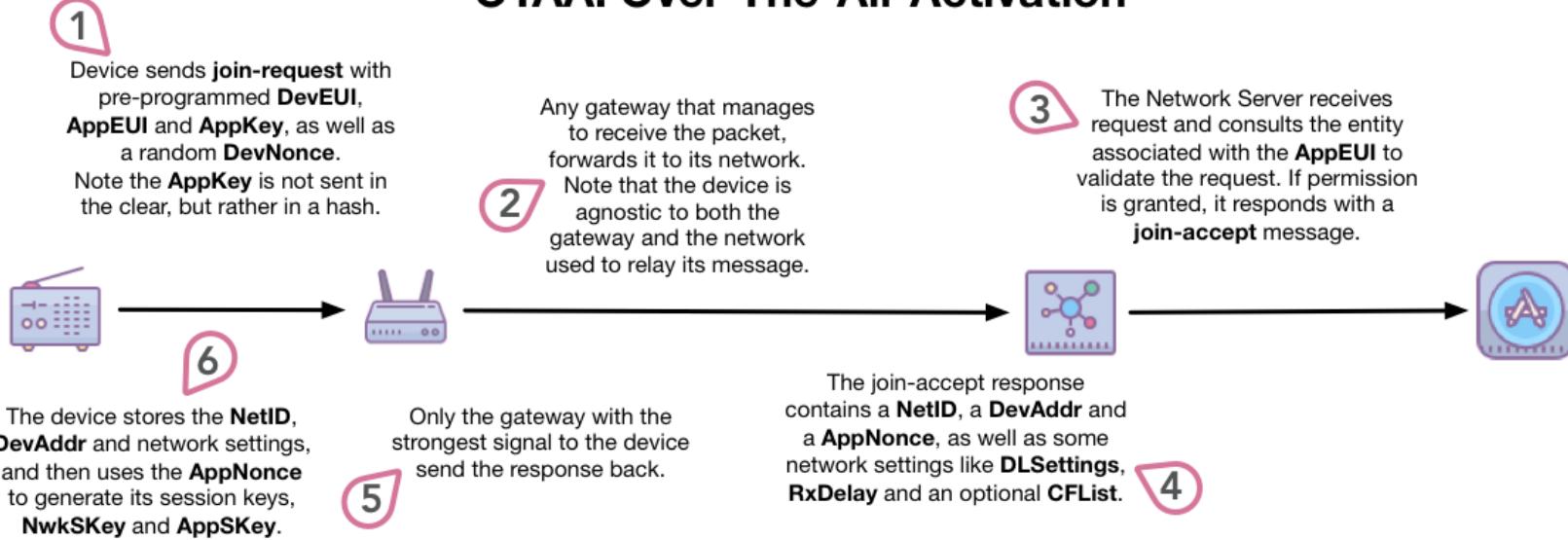
TTN: authentication



Credit: <https://www.newieventures.com.au/blogtext/2018/2/26/lorawan-otaa-or-abp>

TTN: OTAA authentication

OTAA: Over-The-Air Activation



TTN: ABP authentication

ABP: Activation By Personalisation

1

Device is pre-programmed with a **DevAddr**, an **AppSKey** and a **NwkSKey**. No join procedure is necessary.



The Network Server is also pre-configured with the device's **DevAddr**, **AppSKey** and **NwkSKey** so it recognises its transmissions.

2



TTN: devices

Settings

A screenshot of the TTN Device Overview page. At the top right, there is a navigation bar with three tabs: "Overview" (highlighted in blue), "Data", and "Settings". A large red arrow points downwards towards the "Settings" tab. The main section is titled "DEVICE OVERVIEW". It displays the following device details:

- Application ID:** test_application_fablab
- Device ID:** test_device
- Activation Method:** OTAA
- Device EUI:** 70 B3 D5 49 95 AB DB CE
- Application EUI:** 70 B3 D5 7E D0 01 70 74
- App Key:** (redacted)
- Status:** never seen

TTN: devices

SETTINGS

Description
A human-readable description of the device

Device EUI
The serial number of your radio module, similar to a MAC address
 70 B3 D5 49 95 AB DB CE 8 bytes

Application EUI
 70 B3 D5 7E D0 01 70 74

Activation Method
 OTAA ABP



ABP

TTN: devices

Activation Method

OTAA

ABP

Device Address

The device address will be assigned by the network server

Network Session Key



Network Session Key will be generated

App Session Key



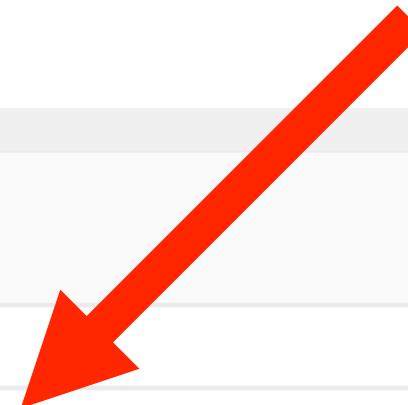
App Session Key will be generated

TTN: devices

DeviceAdd, NetKey, AppKey

EXAMPLE CODE

```
1 const char *devAddr = "26011607";
2 const char *nwkSKey = "09827AA1D4BBDB382859F47A49F6C20B";
3 const char *appSKey = "6B54FDB99BF4A1E90A768C3B5FAD3F50";
```



TTN: payload

Payload format

The screenshot shows the TTN application overview page. At the top, there is a navigation bar with tabs: Overview (highlighted in blue), Devices, Payload Formats (highlighted with a red arrow), Integrations, Data, and Settings. Below the navigation bar, the section title "APPLICATION OVERVIEW" is displayed in blue. To the right of the title is a link to "documentation". The main content area contains the following information:

- Application ID:** test_application_fablab (highlighted with an orange box)
- Description:** (empty)
- Created:** 30 minutes ago
- Handler:** ttu-handler-eu (*current handler*)

TTN: payload

PAYOUT FORMATS

Payload Format
The payload format sent by your devices

Custom

decoder converter validator encoder

```
1 function Decoder(bytes, port) {  
2   // Decode an uplink message from a buffer  
3   // (array) of bytes to an object of fields.  
4   var decoded = {};  
5  
6   // if (port === 1) decoded.Led = bytes[0];  
7  
8   return decoded;  
9 }
```

TTN: payload testing

Payload

0 bytes

1

Test



TTN: integrations

Integrations

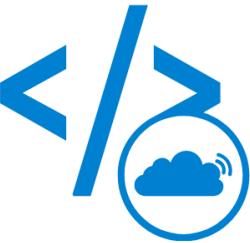


The screenshot shows a user interface for managing integrations in a TTN application. At the top, there is a navigation bar with tabs: Overview, Devices, Payload Formats, **Integrations**, Data, and Settings. The "Integrations" tab is currently active. Below the navigation bar, the word "INTEGRATIONS" is displayed in blue capital letters. To the right of this, there is a button with a plus sign and the text "add integration". The main content area contains the message: "There are no integrations for application test_application_fablab." followed by a link: "Get started by creating one!".

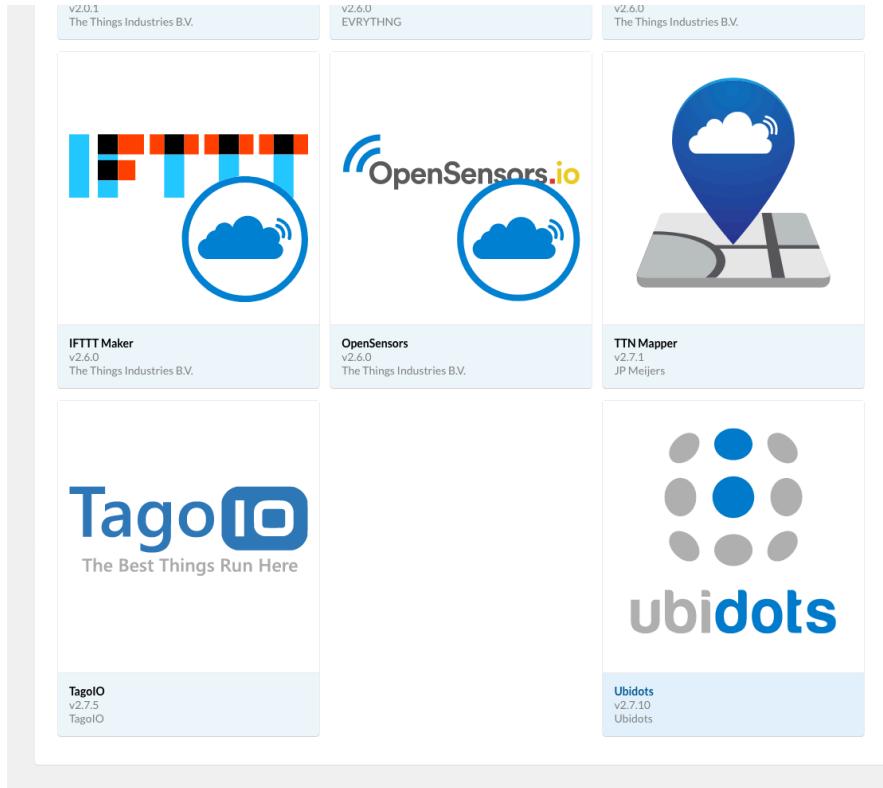
TTN: integrations

Overview Devices Payload Formats Integrations Data Settings

ADD INTEGRATION

 AllThingsTalk Maker v2.6.0 AllThingsTalk	 Cayenne v2.6.0 myDevices	 COLLOS collaborative location service Collos v2.7.4 Semtech Corporation
 Data Storage v2.0.1 The Things Industries B.V.	 EVRYTHNG v2.6.0 EVRYTHNG	 HTTP Integration v2.6.0 The Things Industries B.V.

TTN: integrations



TTN: integrations

Applications >  test_application_fablab > Integrations

ADD INTEGRATION

 **Ubidots** (v2.7.10)
Ubidots

Learn to handle your The Things Network's account data with Ubidots to launch your IoT Control or Monitoring App.
[documentation](#)

Process ID
The unique identifier of the new integration process

Access Key
The app access key

Summary

We introduced TheThingsNetwork.

We learned how to setup a TTN Gateway.

We looked at authentication alternatives.

We learned how to register new devices.

Feedback?

Email mzennaro@ictp.it