

# TTN in Practice

Credits:

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ICTP smr3188 workshop

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ICTP



# The Things Network

## THE THINGS NETWORK

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

TheThingsNetwork is known as TTN



$3^*10$

# LORAWAN

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**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

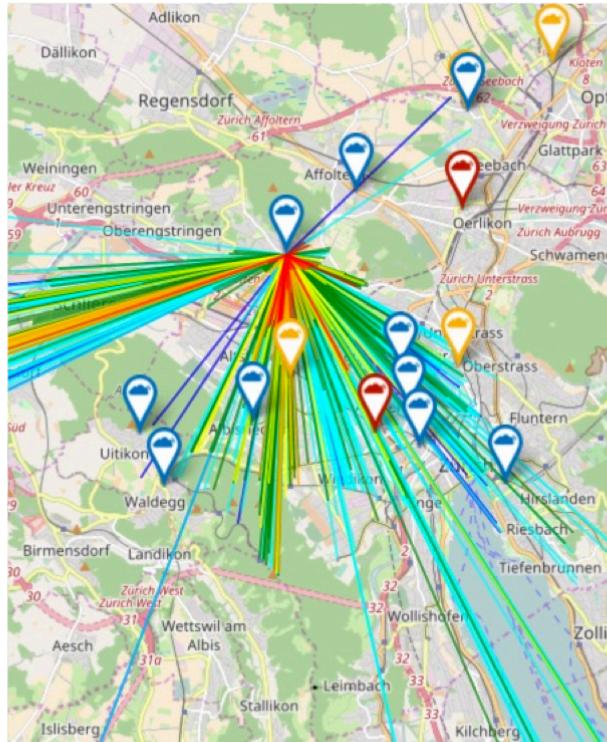


# LoRaWAN

## LONG RANGE

2km - 5km in urban setting

40km+ in rural setting



# TTN's mission

Our mission is to build a  
**DECENTRALIZED,**

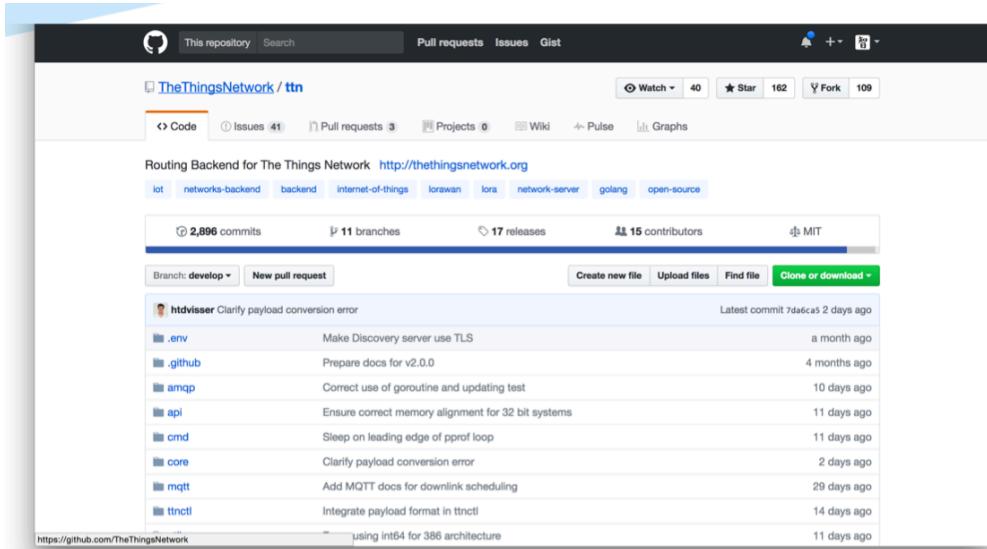
**OPEN** and **CROWDSOURCED**

**INTERNET OF THINGS** data network

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



# TTN is Open Source



## OPEN SOURCE BACKEND

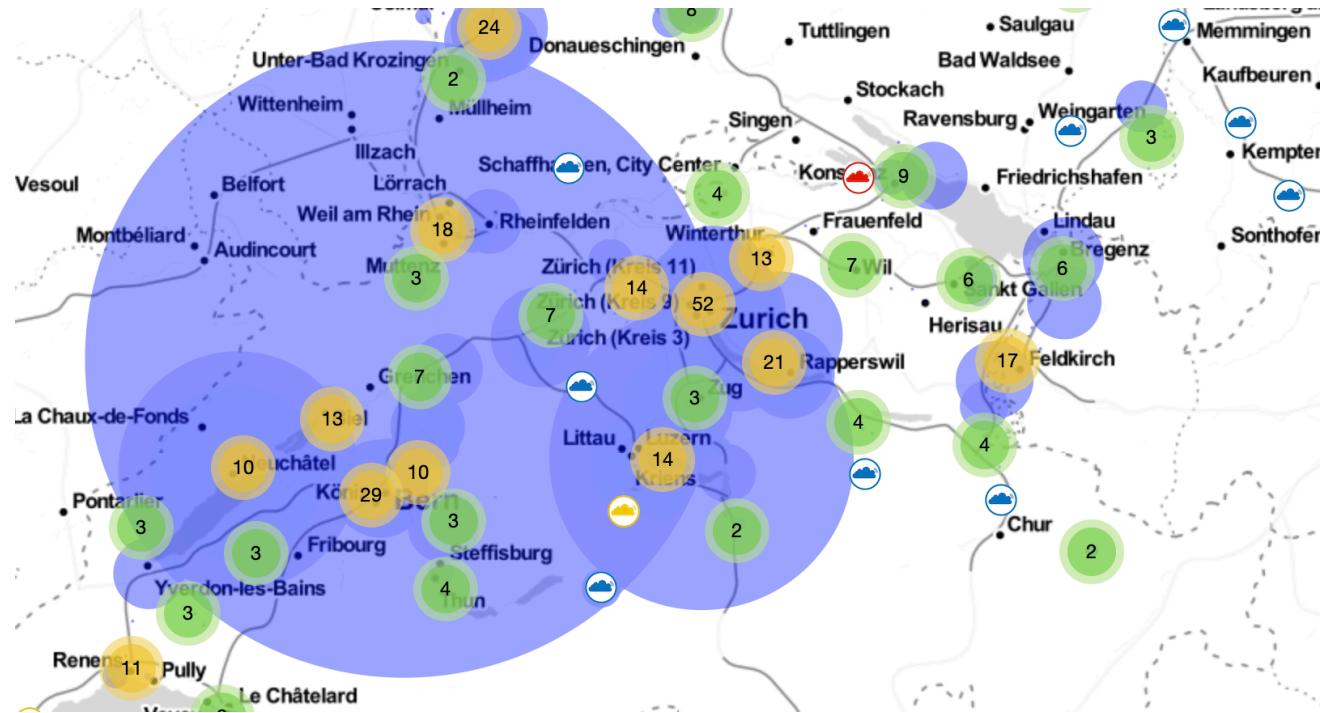


# TTN Communities



# Over 300 communities in 100 countries

# TTN Communities



<https://ttnmapper.org>

# TTN: devices, gateways, servers

HOW DOES THIS WORK?



DEVICES

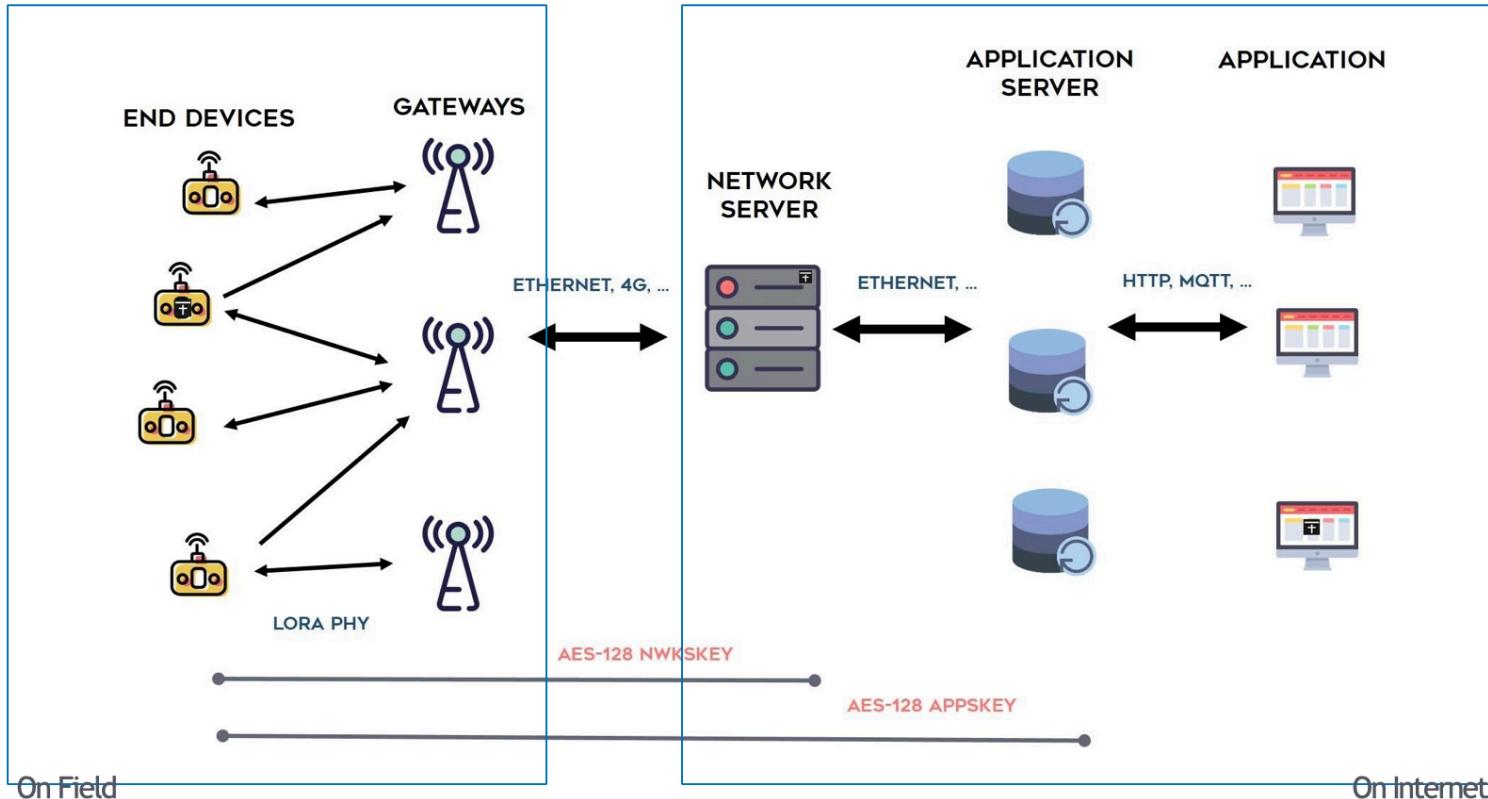
GATEWAYS

NETWORK  
SERVER

APPLICATION  
SERVER



# LoRaWAN architecture



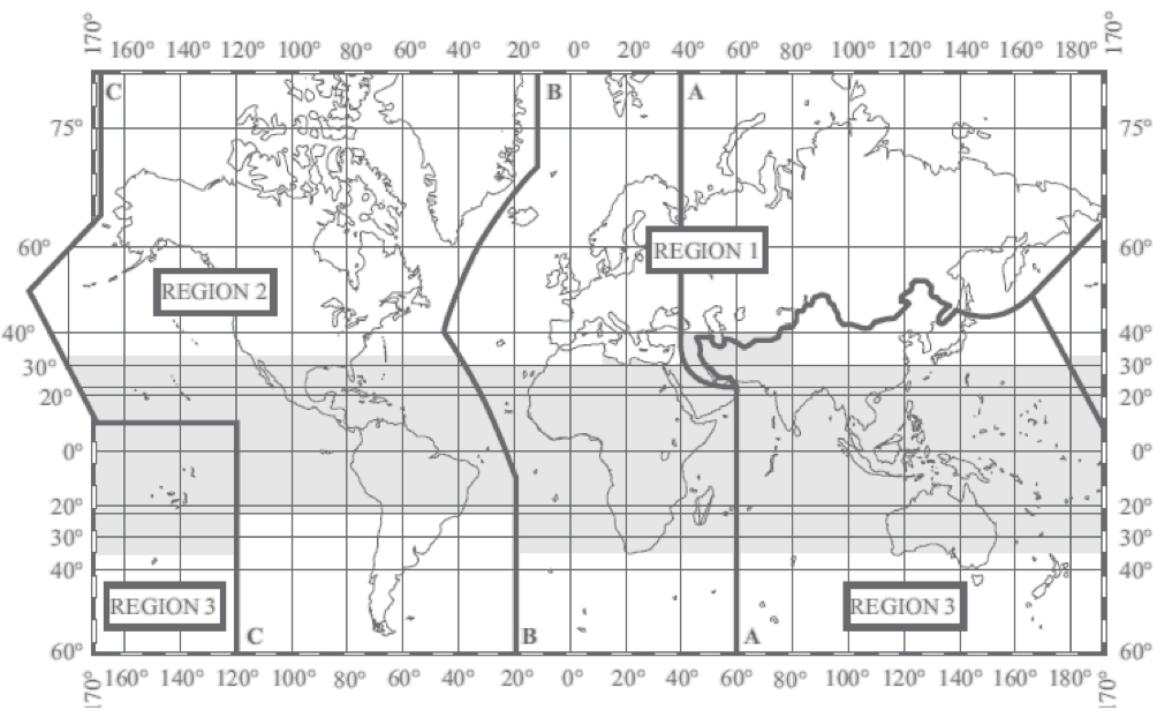
# Gateways

# Gateways

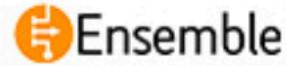
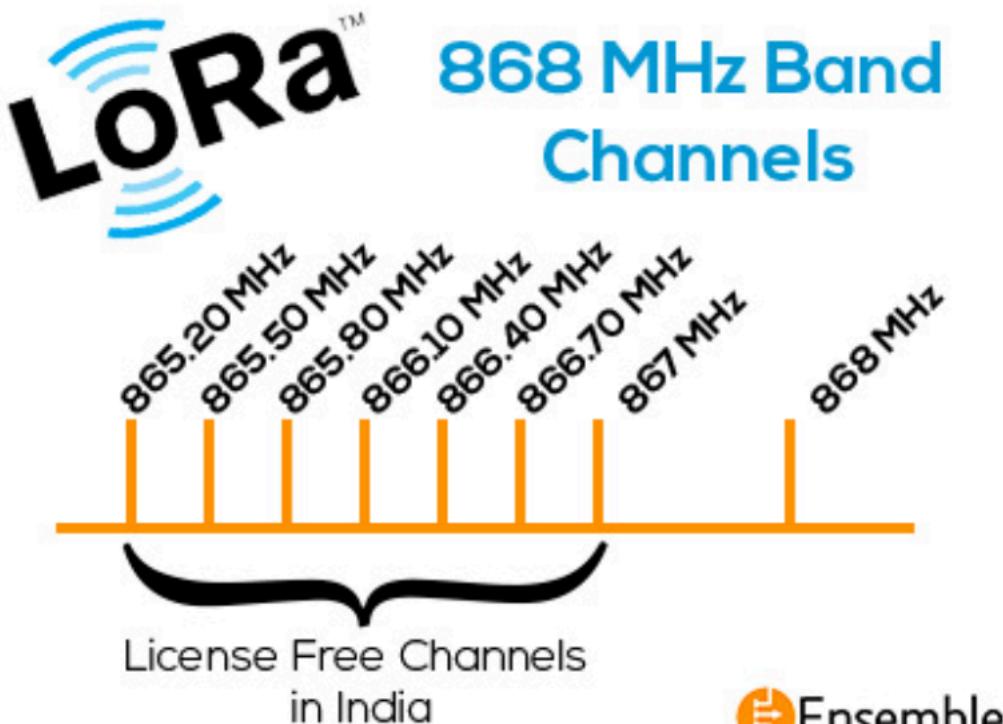
- Gateways are **packet forwarders**
- They “forward” LoRaWAN packets to TCP/IP using WiFi/Ethernet/Cellular
- They operate on different frequency bands, depending on the region (pay attention!)
- Once you buy/build a gateway, there is not much to do!
- You simply need to register your gateway in TTN

# 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  **.....**

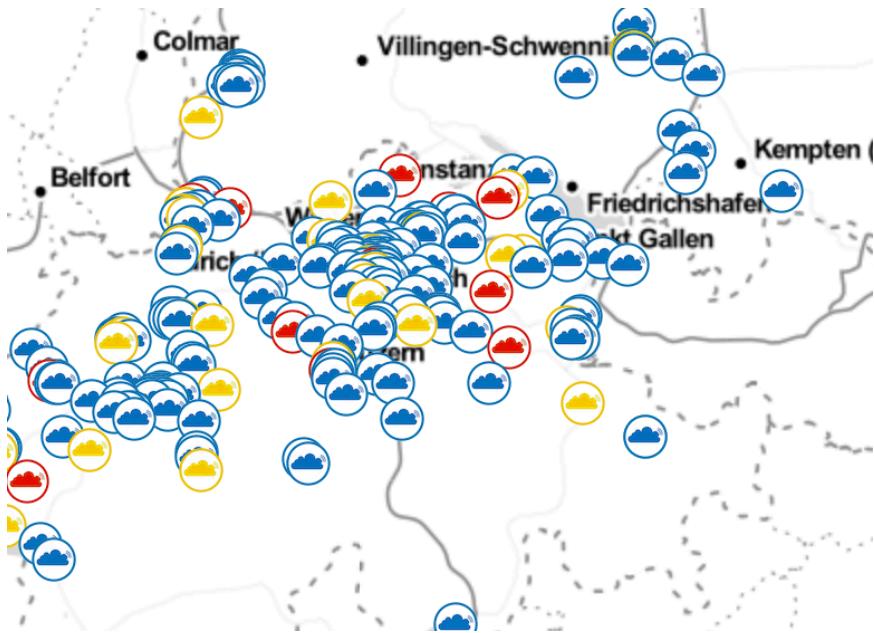
Last Seen 2 seconds ago

Received Messages 1315877

Transmitted Messages 6702

Connected!

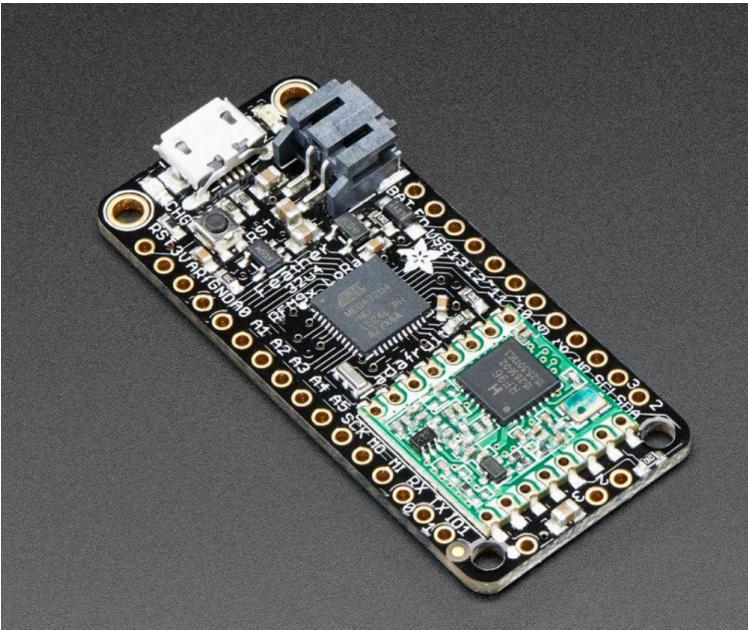
# Do I need a gateway?



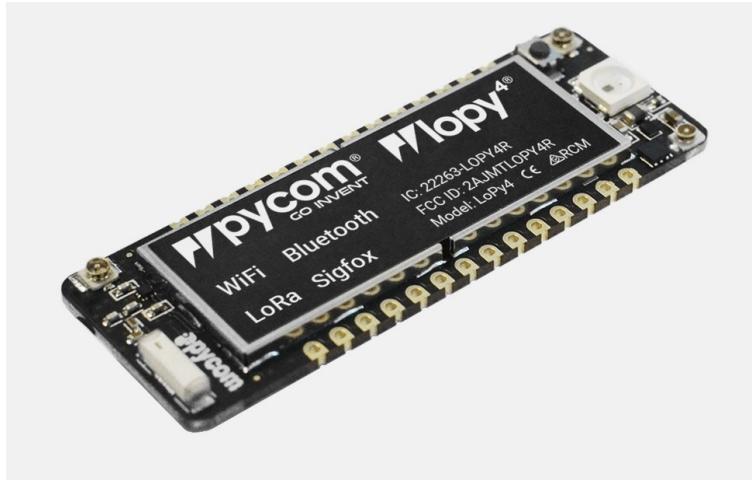
You don't need to install a Gateway to use TTN if there are gateways available in your area!

# Nodes

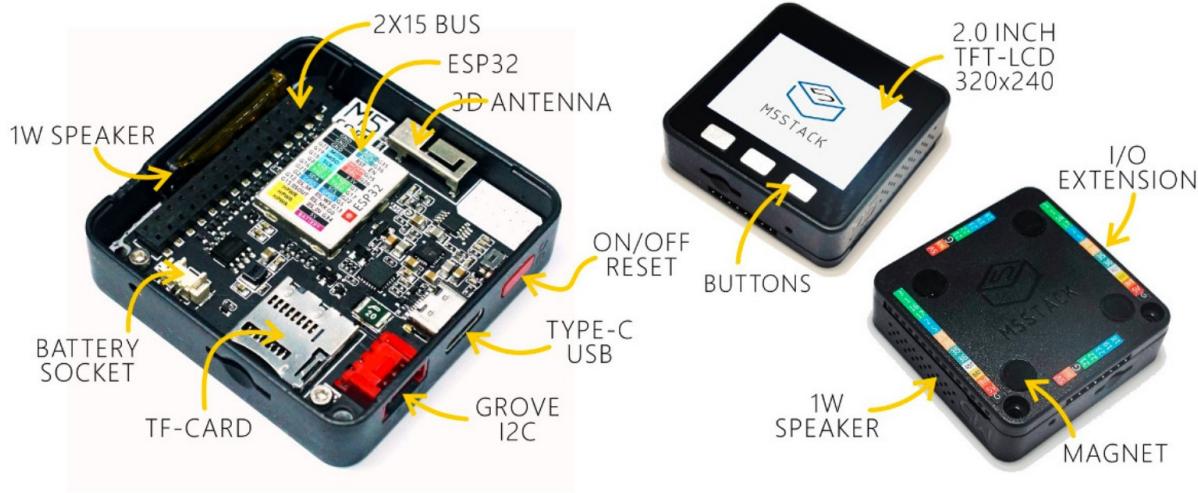
# LoRaWAN nodes - Feather



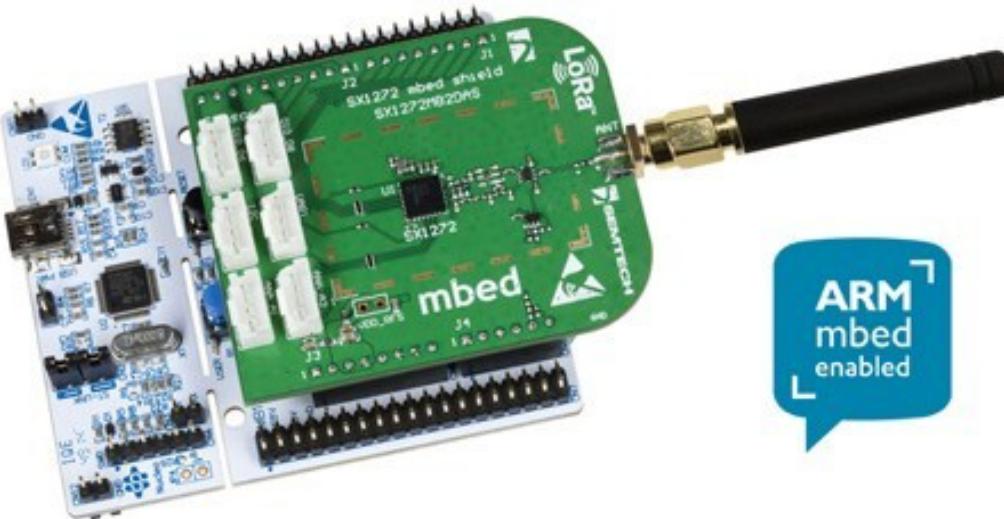
# LoRaWAN nodes – Pycom Lopy



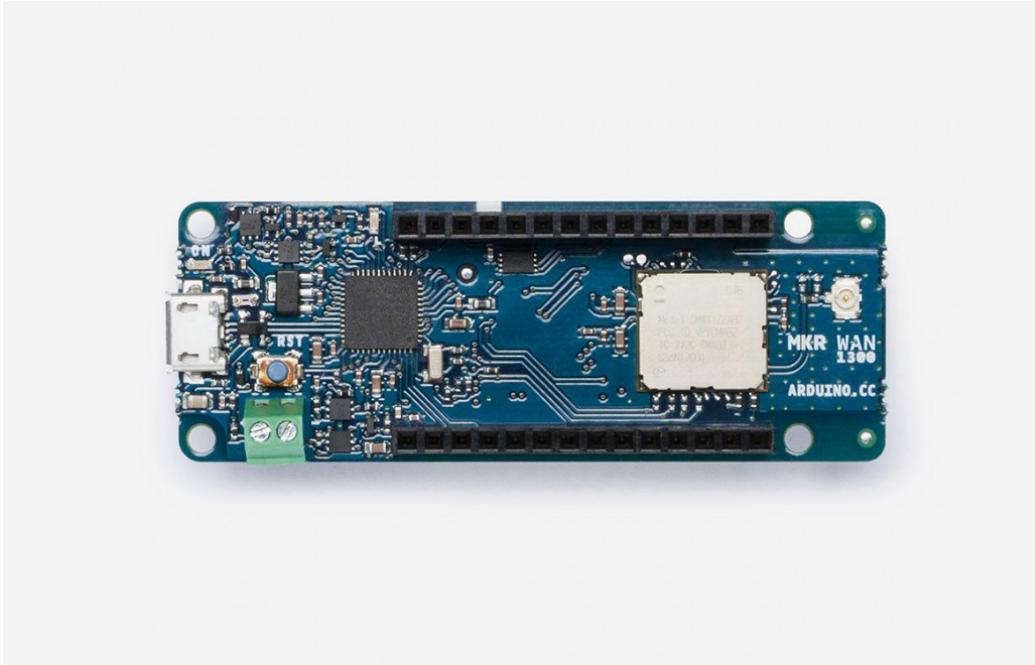
# LoRaWAN nodes – m5stack



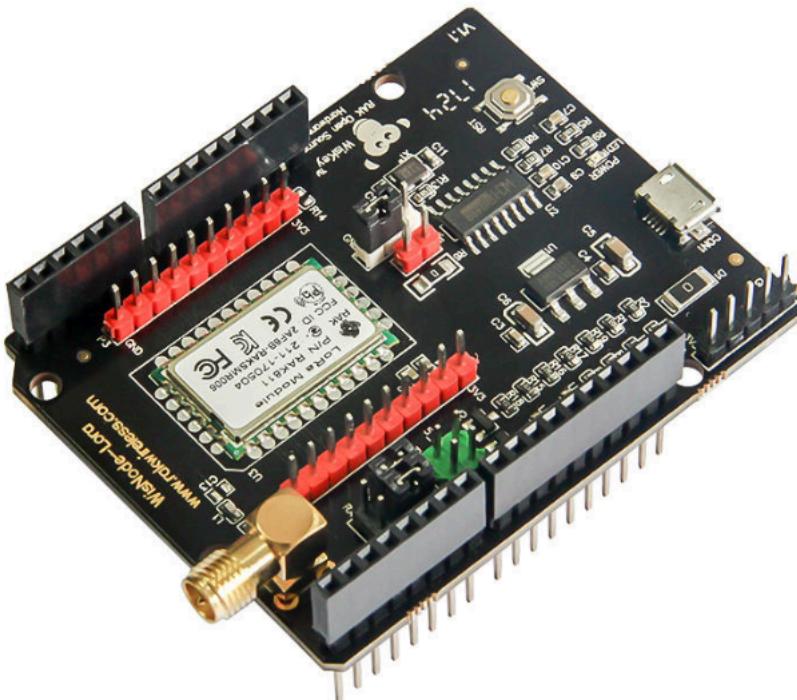
# LoRaWAN nodes – ARM mbed



# 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](http://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.

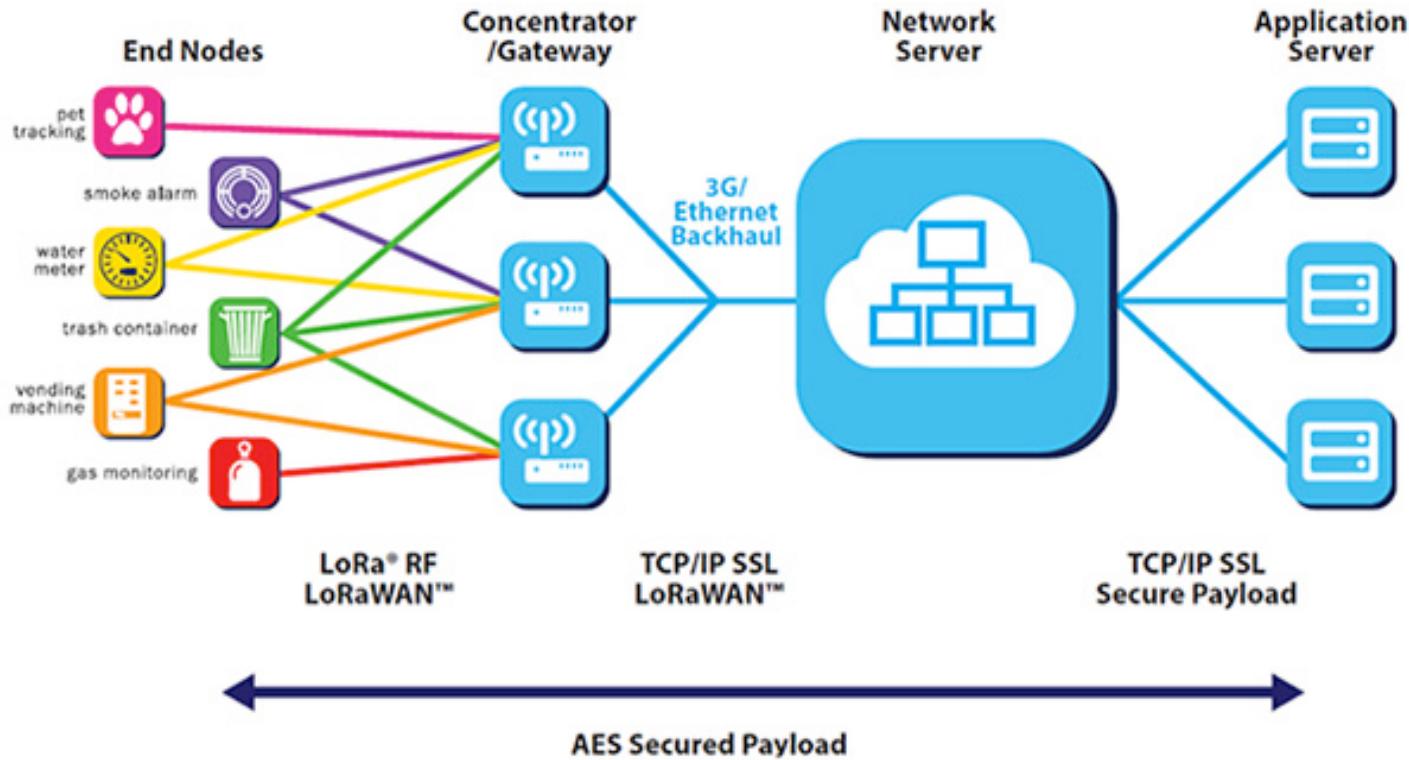
Add your product

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

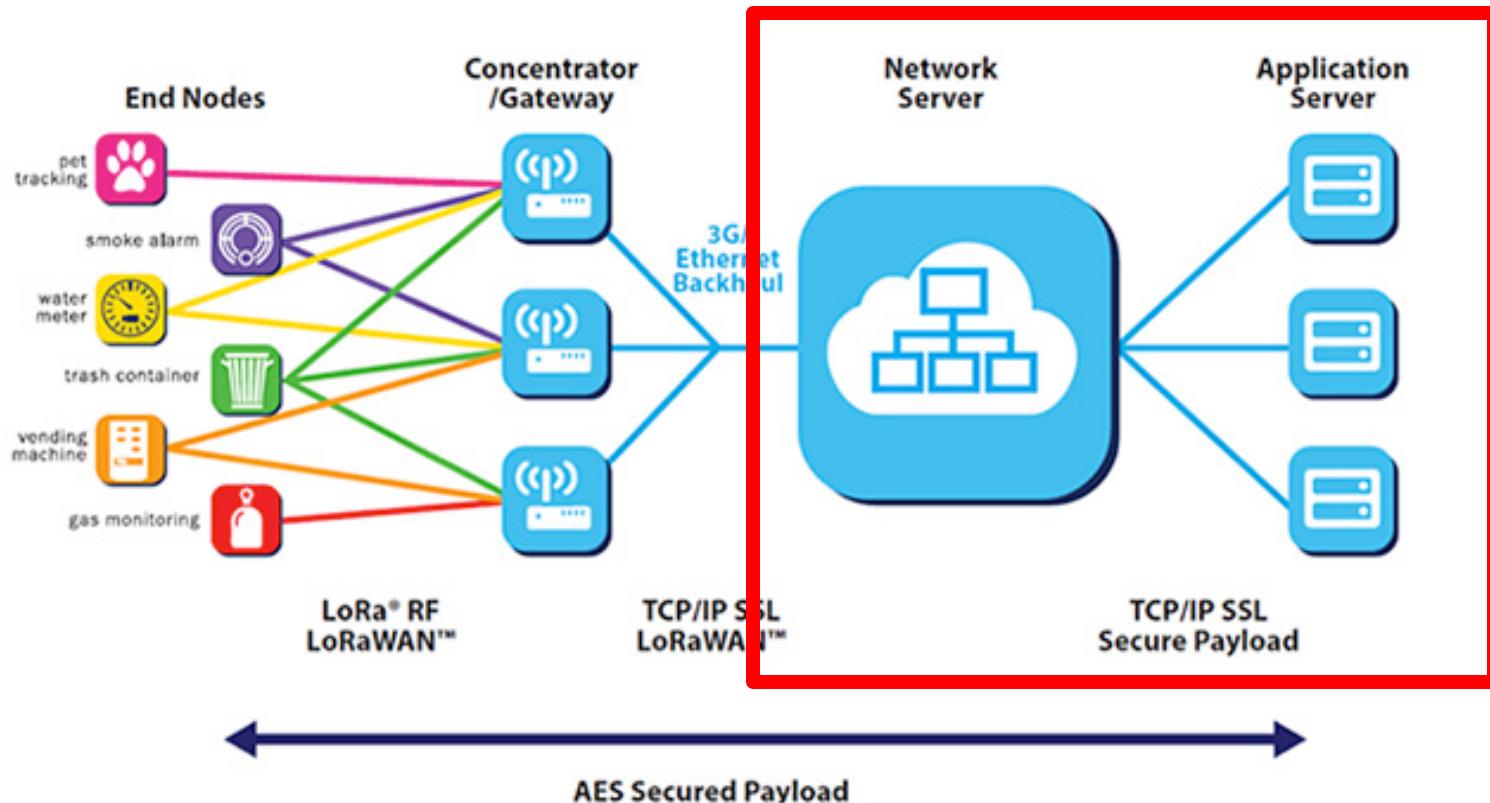


# Packets

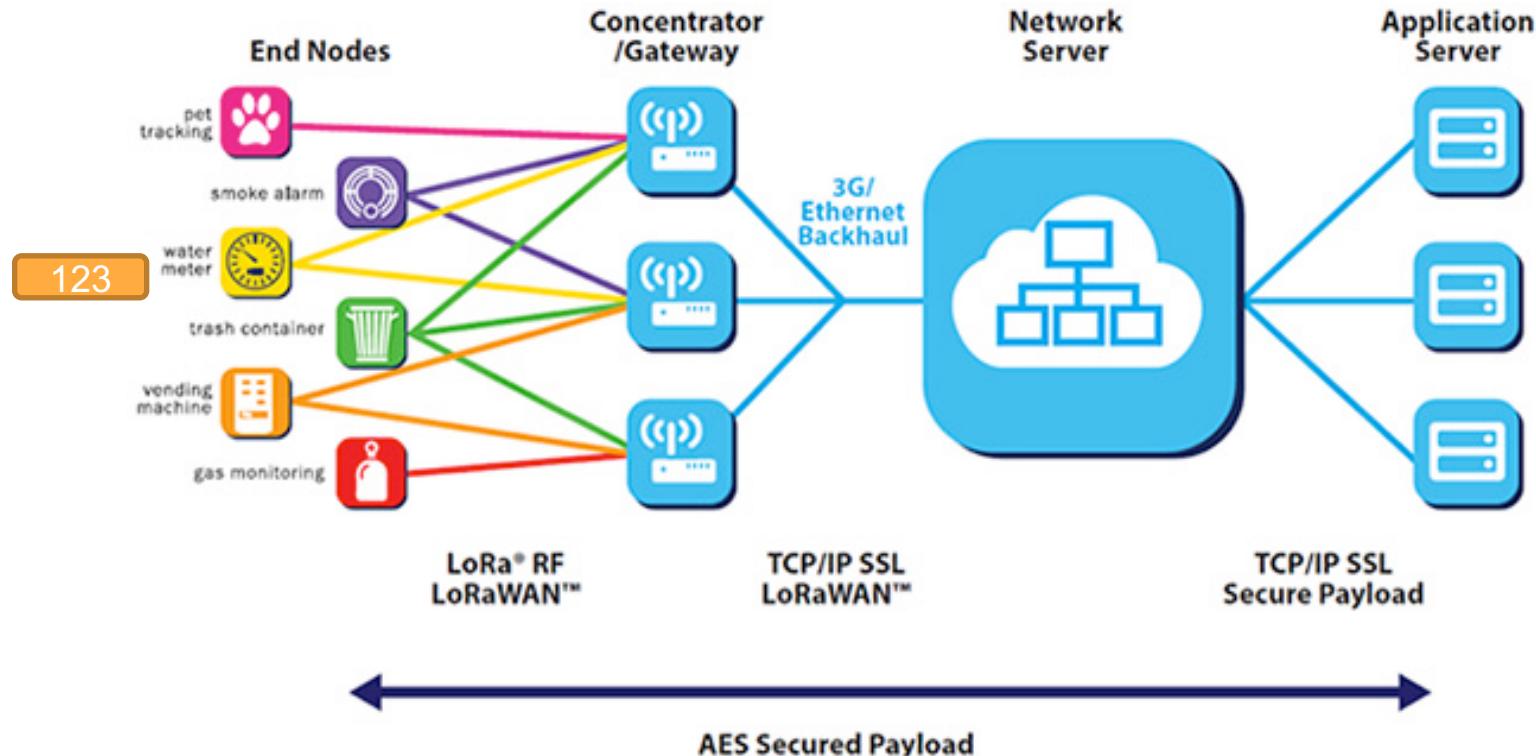
# LoRaWAN architecture



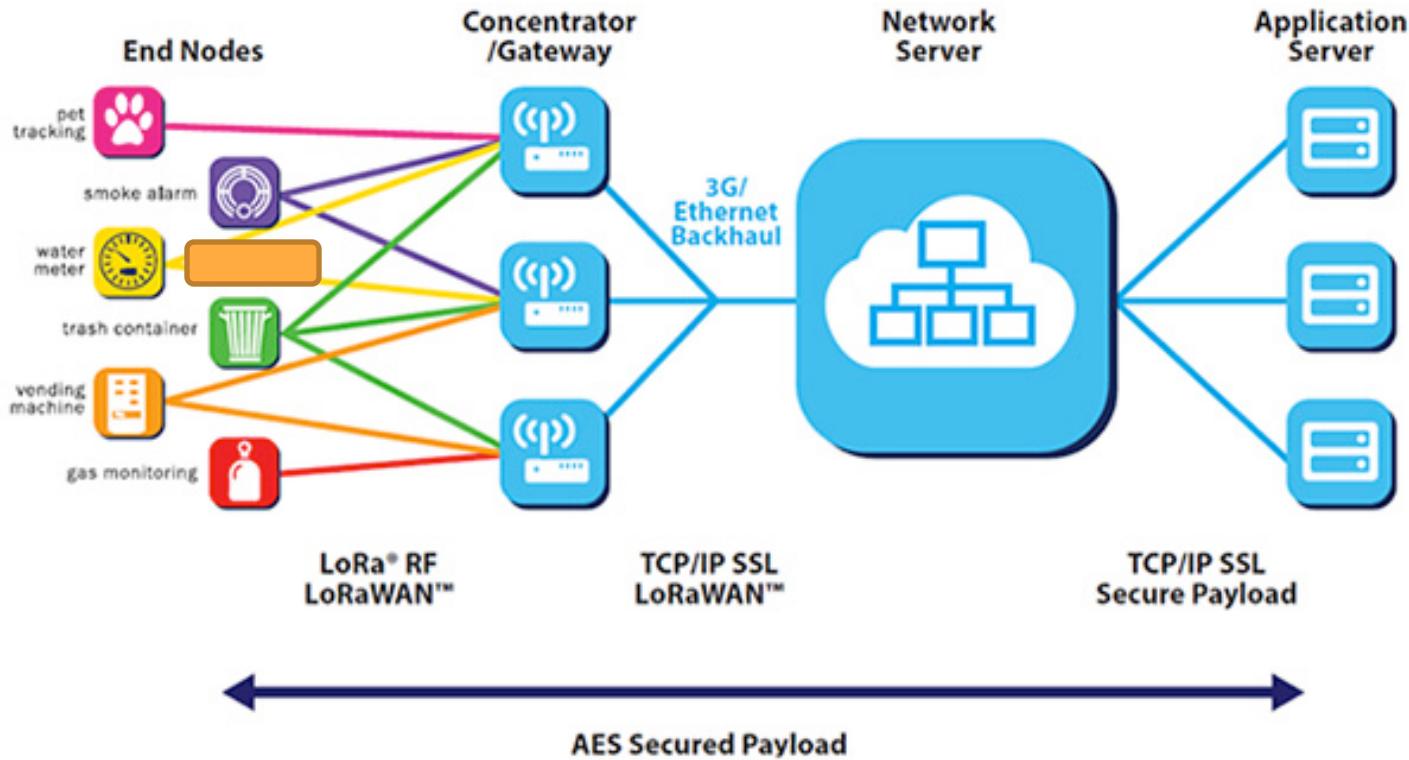
# LoRaWAN architecture - TTN



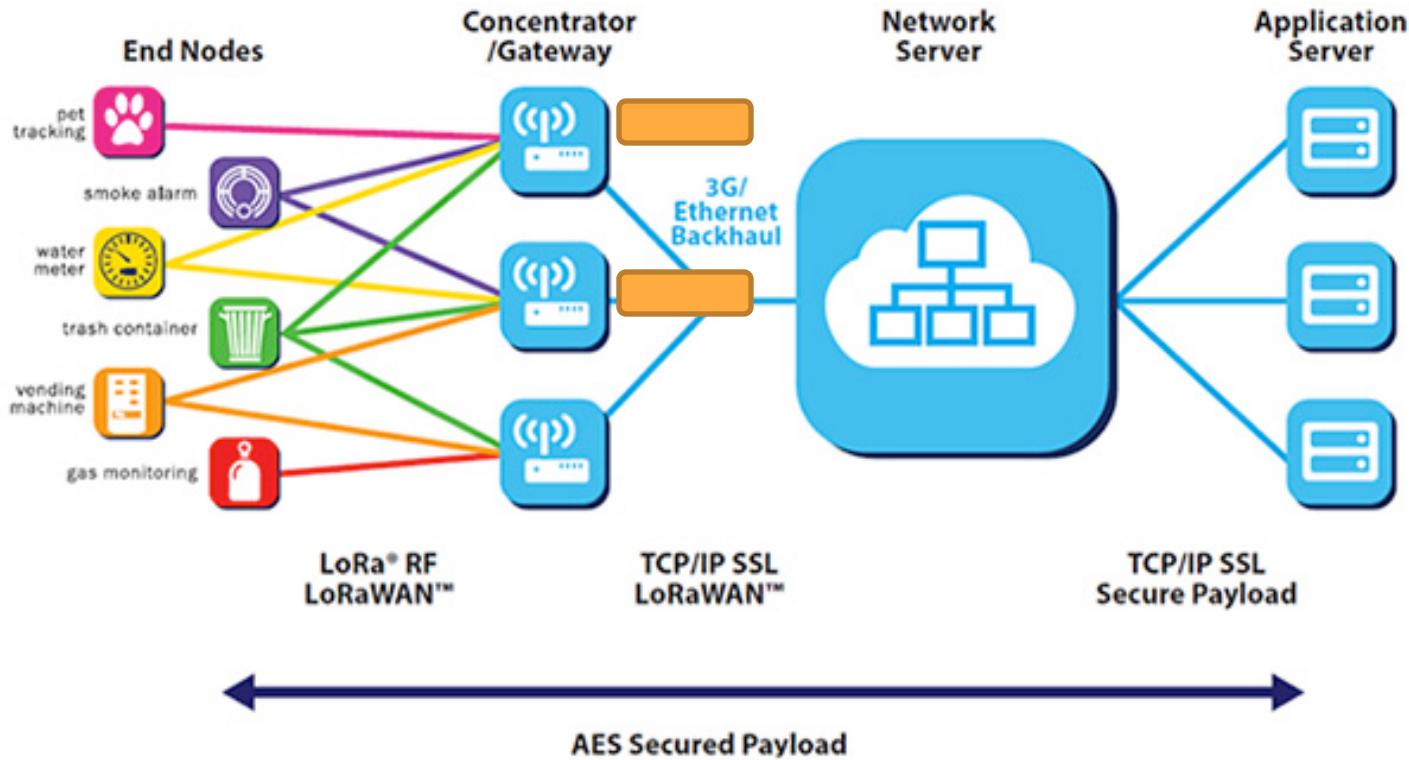
# LoRaWAN architecture



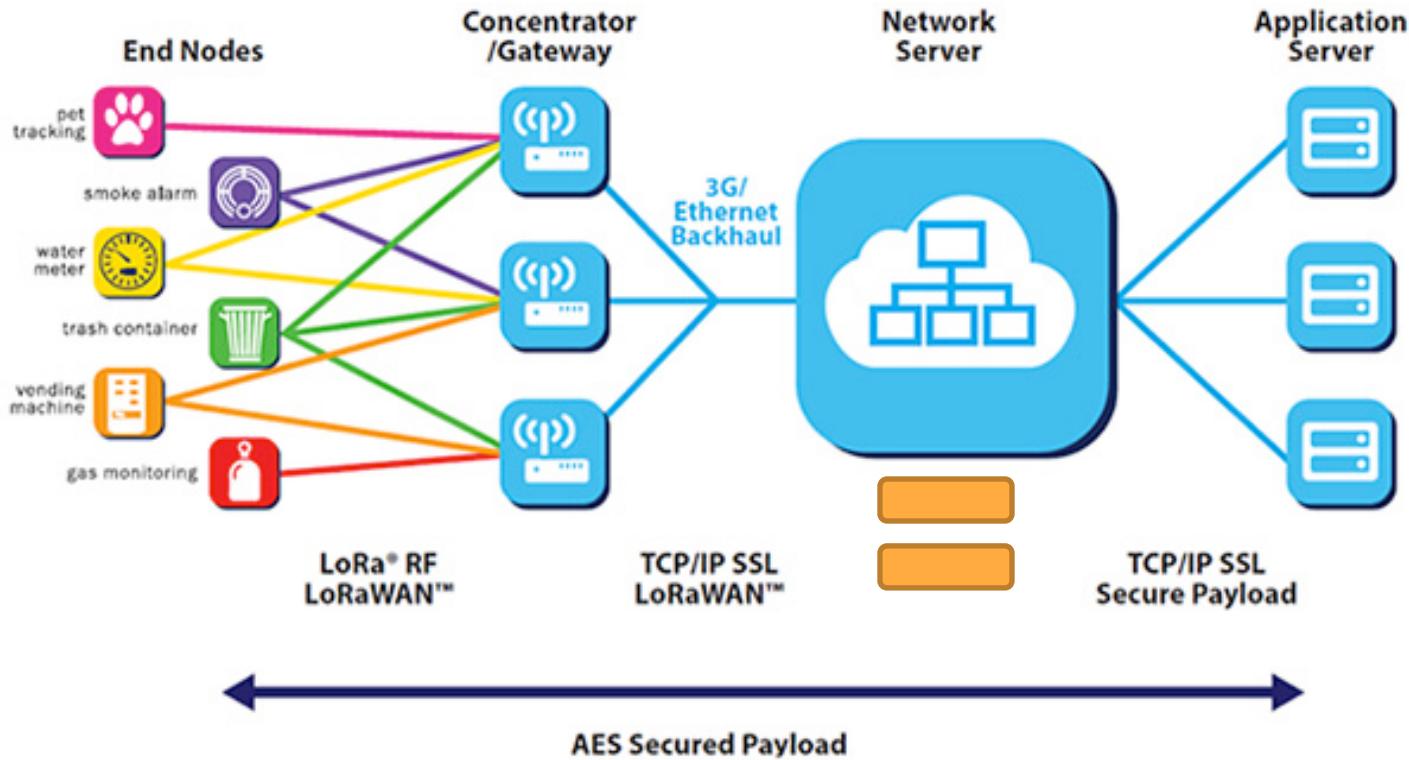
# LoRaWAN architecture



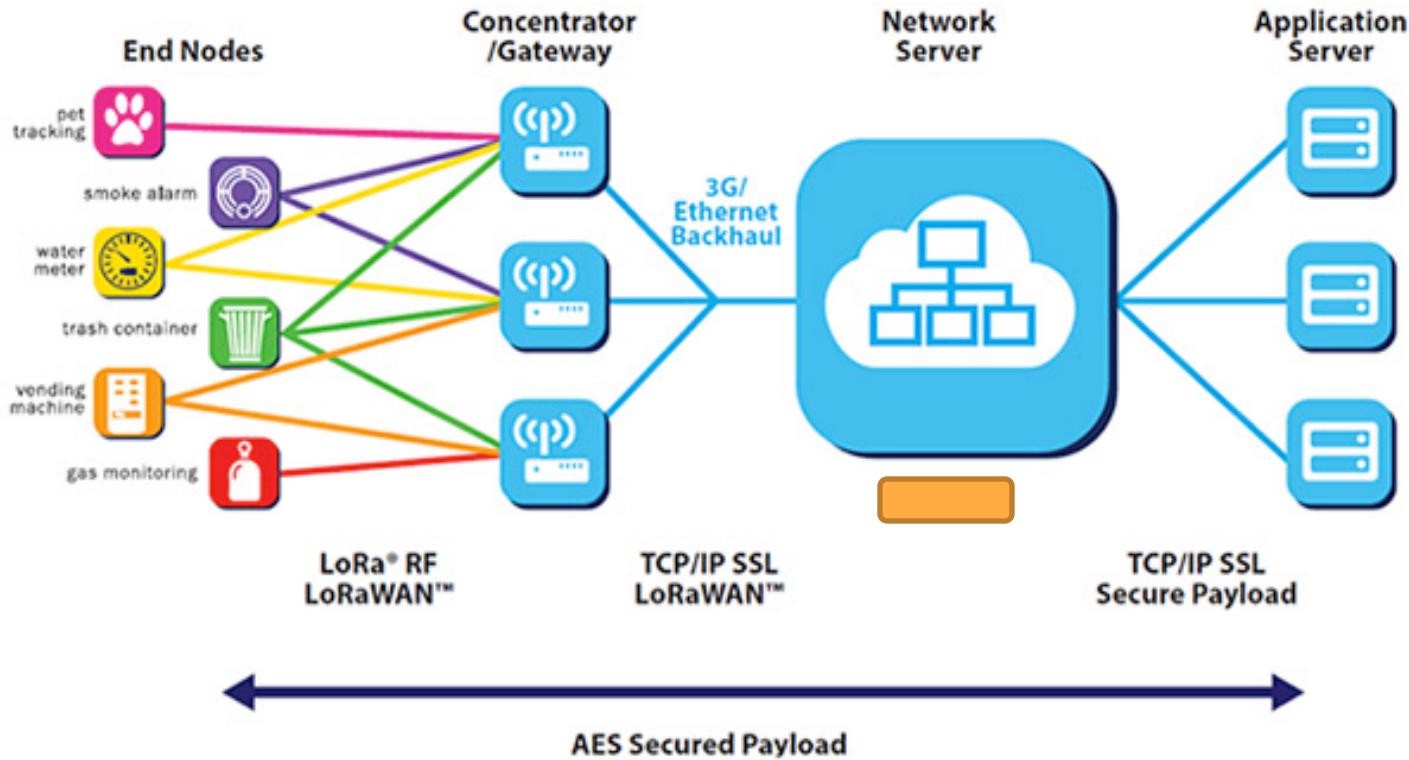
# LoRaWAN architecture



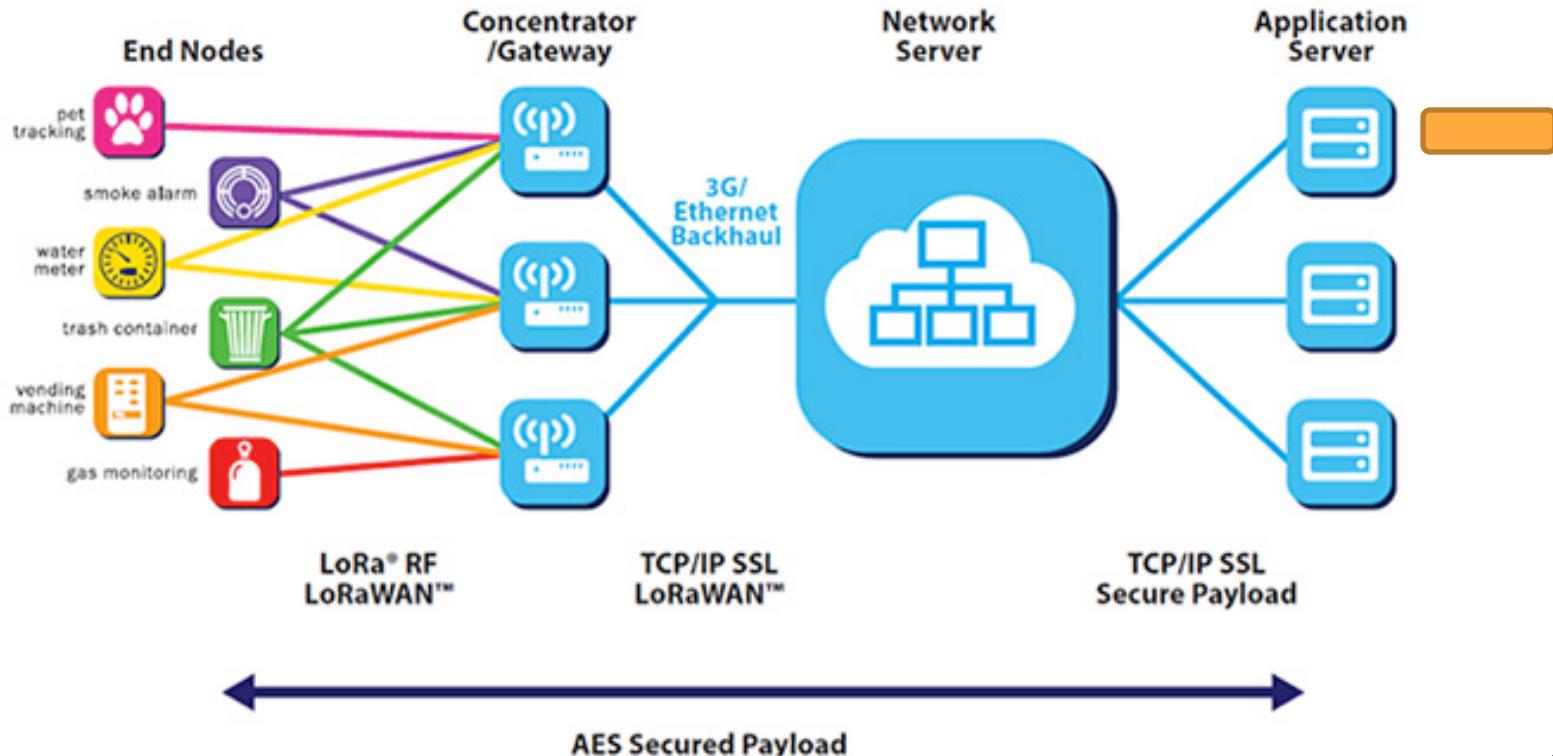
# LoRaWAN architecture



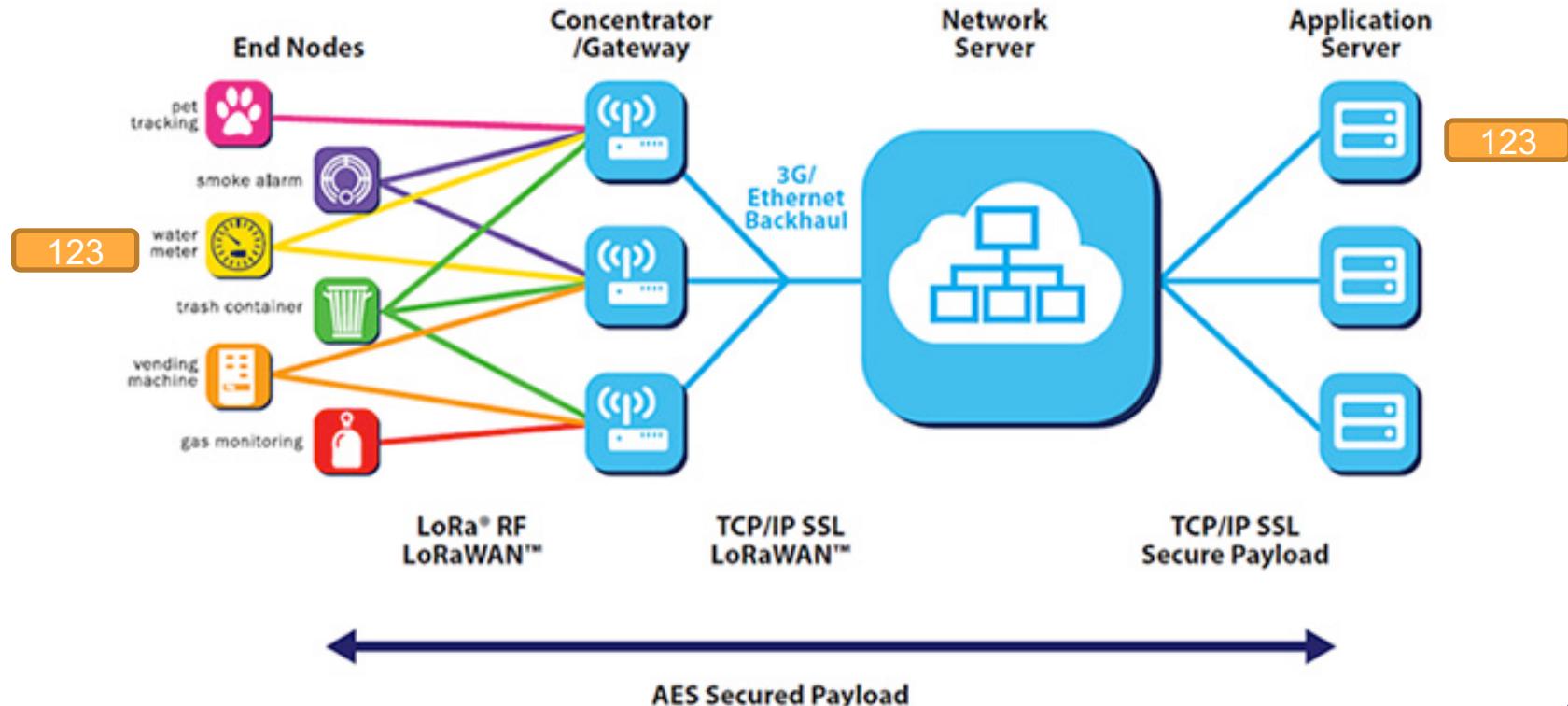
# LoRaWAN architecture



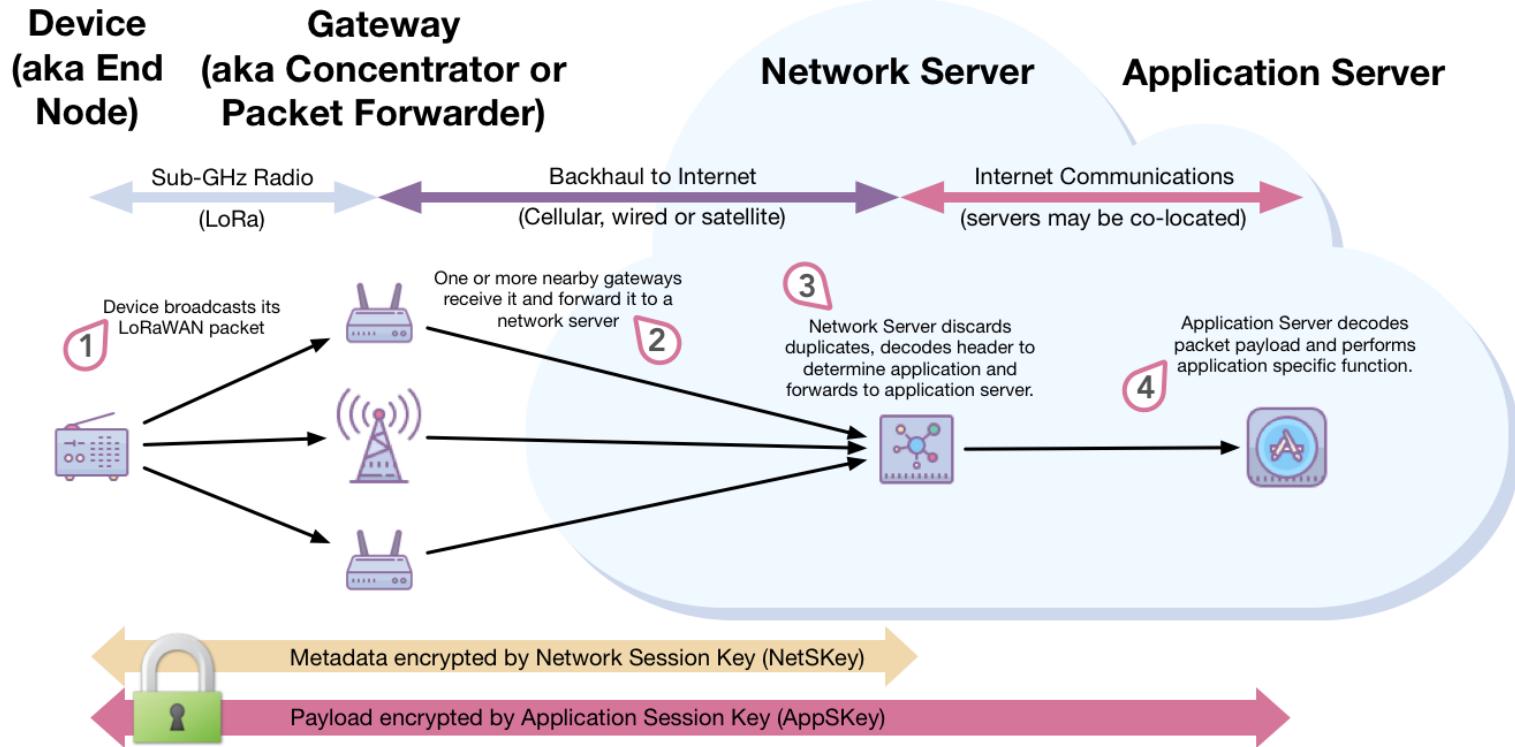
# LoRaWAN architecture



# LoRaWAN architecture

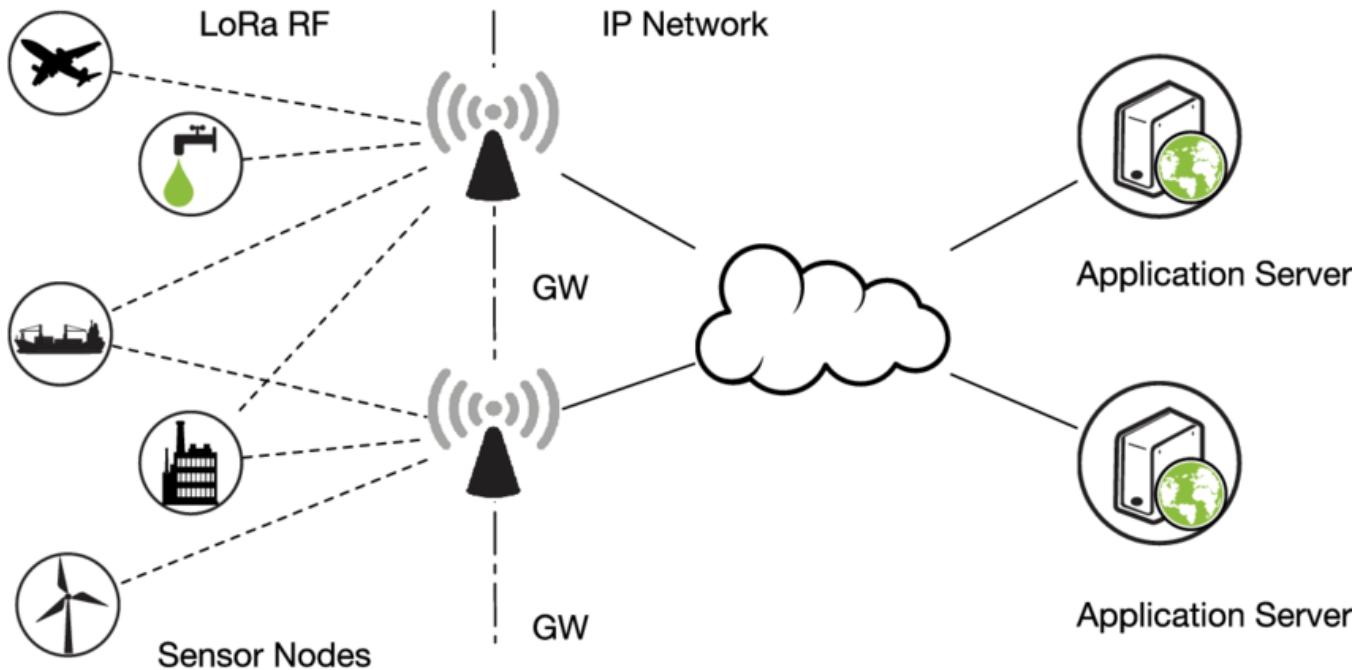


# TTN: authentication

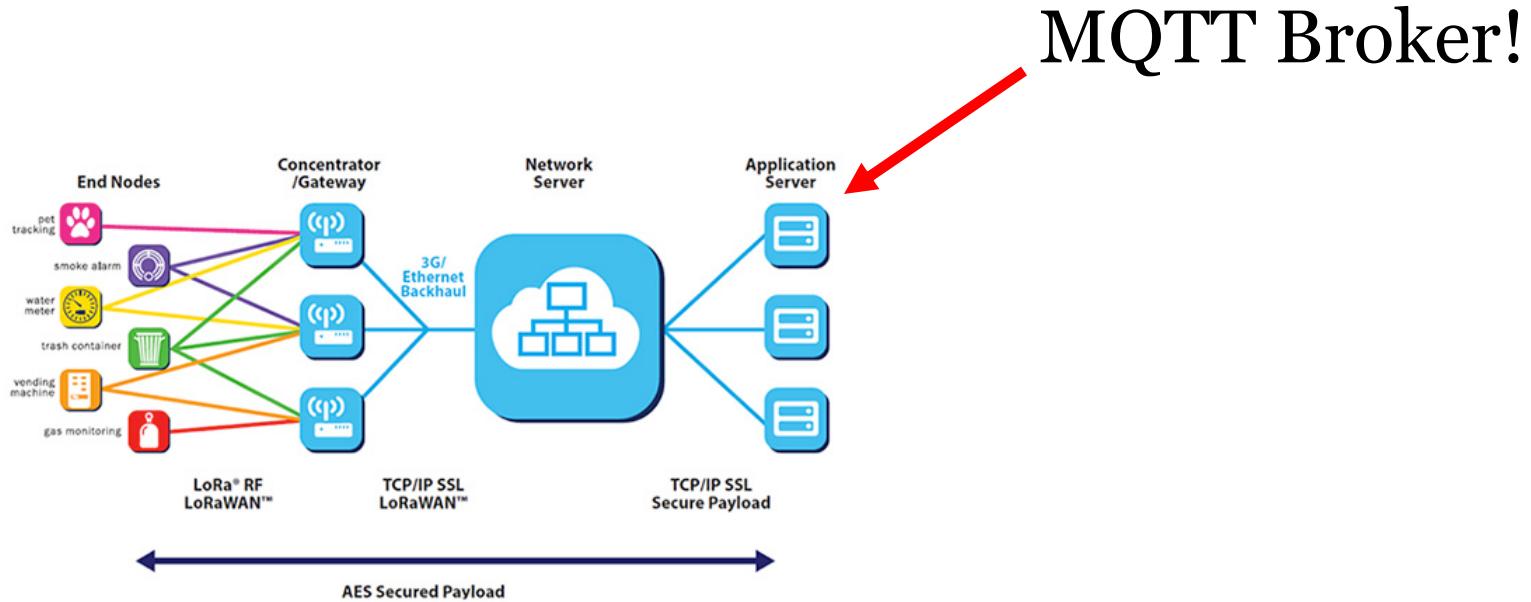


Credit: <https://www.newieventures.com.au/blogtext/2018/2/26/lorawan-otaa-or-abp>

# LoRaWAN architecture



# LoRaWAN architecture



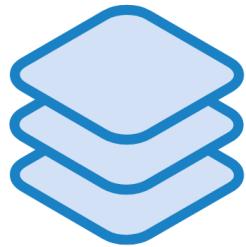
# TTN in practice

# 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



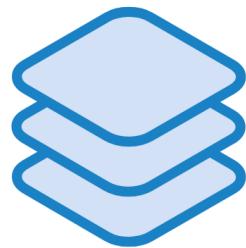
GATEWAYS

# 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

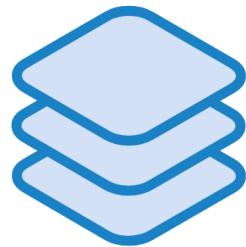
Connected!

# 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

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

 0 registered devices

## COLLABORATORS

[manage collaborators](#)

 marcozennaro [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

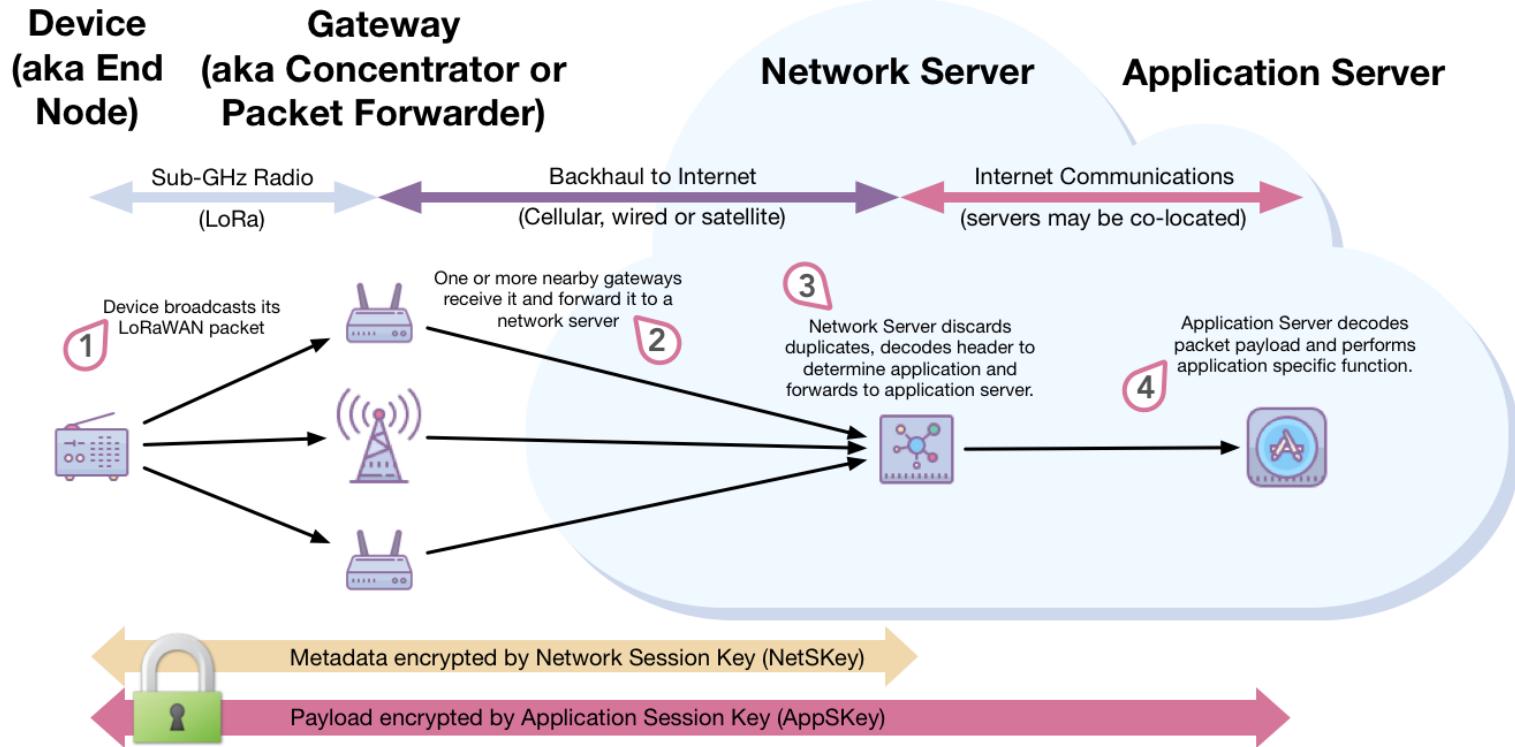
Frames up 0 [reset frame counters](#)

Frames down 0

Authentication

Never seen!

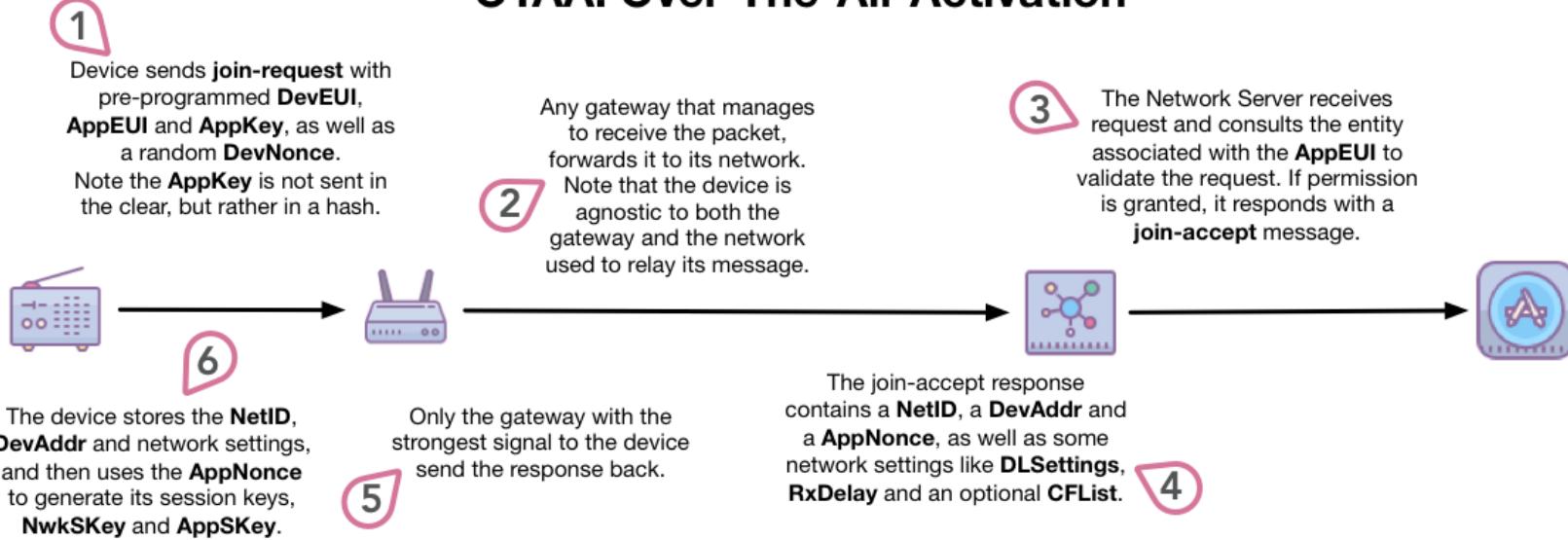
# TTN: authentication



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 contains several fields with device information:

- 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



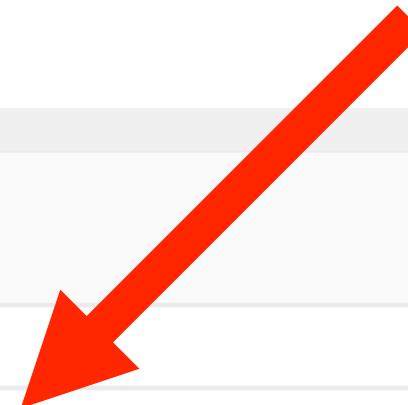
App Session Key will be generated

# 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

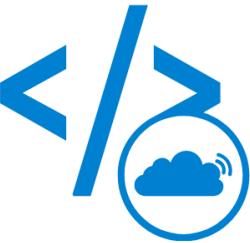


The screenshot shows a user interface for managing integrations in a TTN application. At the top, there is a navigation bar with tabs: Overview, Devices, Payload Formats, **Integrations**, Data, and Settings. The "Integrations" tab is currently active. Below the navigation bar, the word "INTEGRATIONS" 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!".

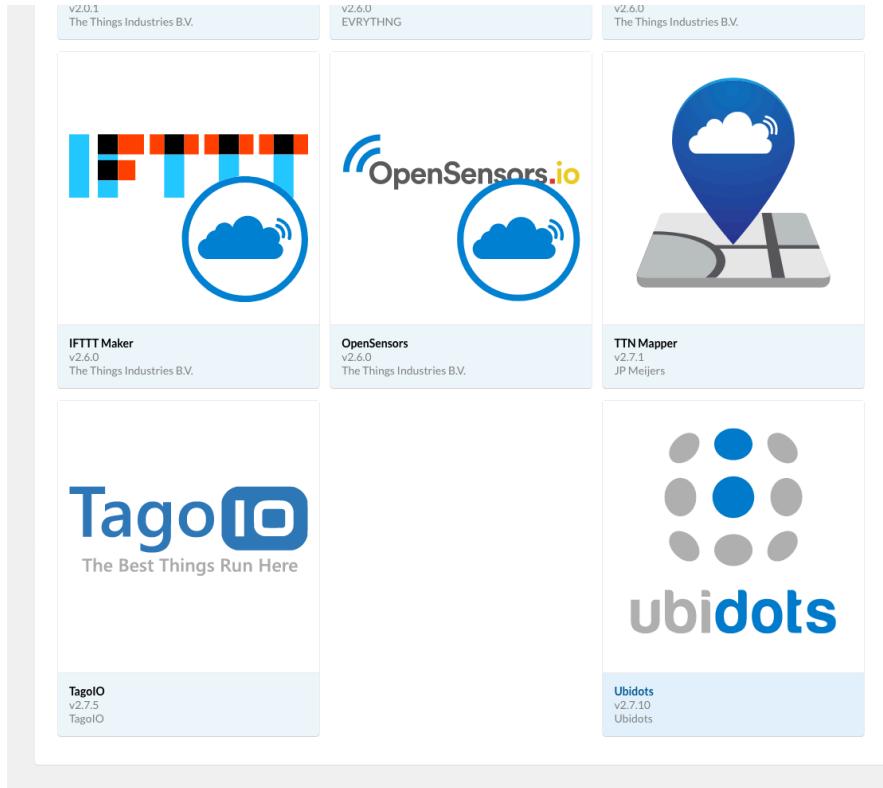
# TTN: integrations

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](mailto:mzennaro@ictp.it)