



... in the Internet of Things

Bachelor Project (PO)  
Introduction to LoRaWAN  
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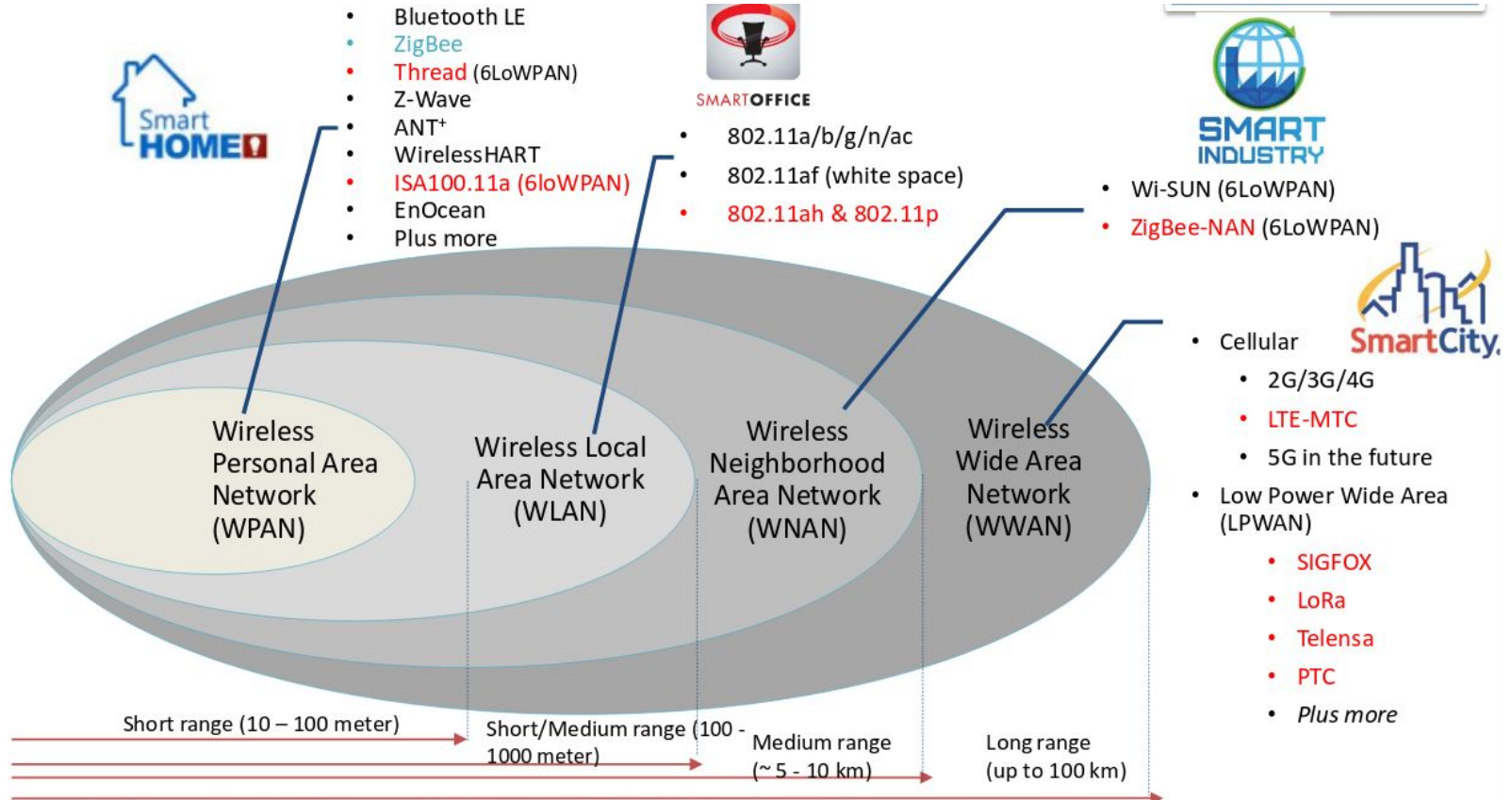
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# Summary of IoT Protocols



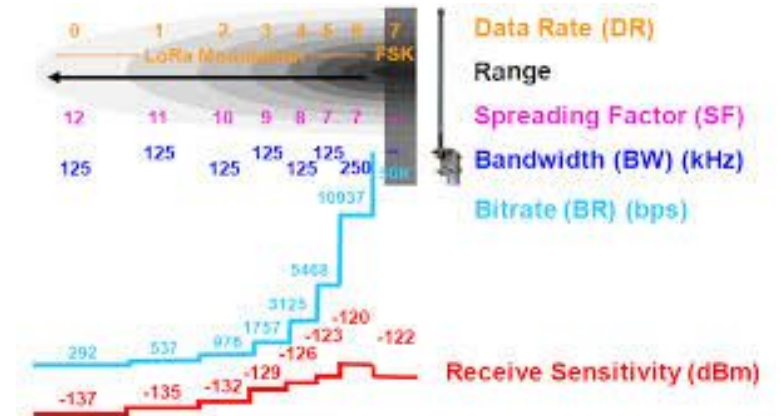
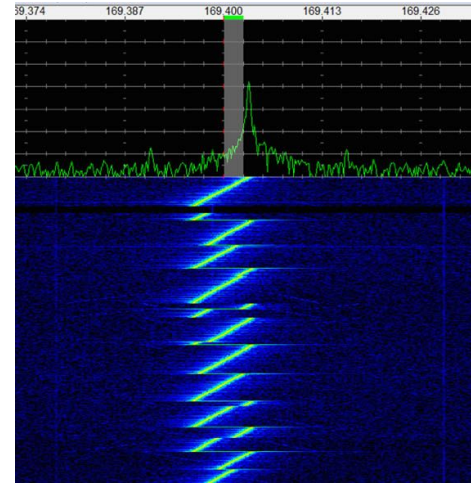
# Overview of LoRaWAN

- **Open** LPWAN specification over the proprietary **LoRa** wireless modulation
  - **Low** power (**mJ** per second)
  - **Long** transmission range (up to **15 Km**).
  - **Low** throughput (**bytes** per second).

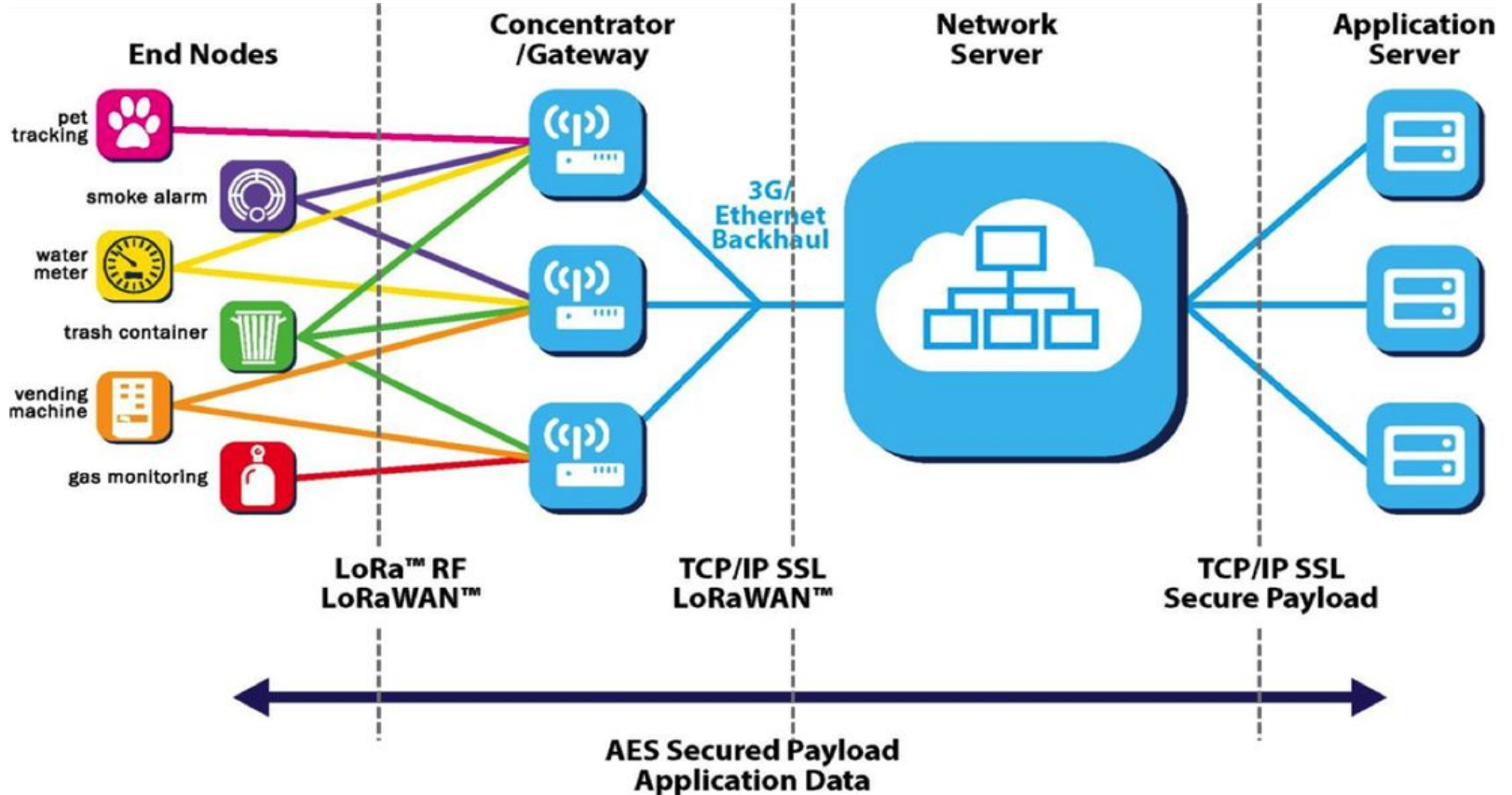


# A few words about LoRa

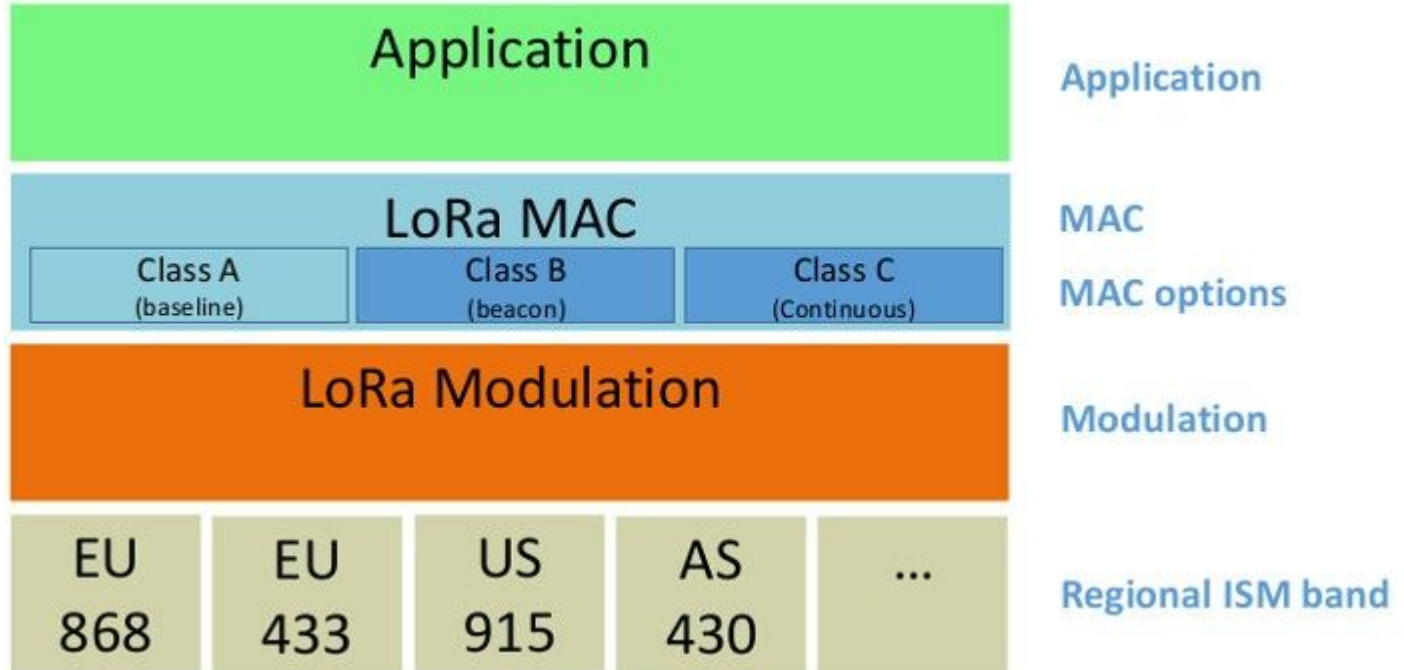
- **Chirp Spread Spectrum** (CSS) modulation.
  - Robust against **interference** and **Doppler** effect.
- **Flexible** PHY configuration
  - Trade-off between **transmission range** and **throughput**.
- Available in **Sub-GHz** and **2.4 GHz** bands



# LoRaWAN Architecture



# LoRaWAN Stack



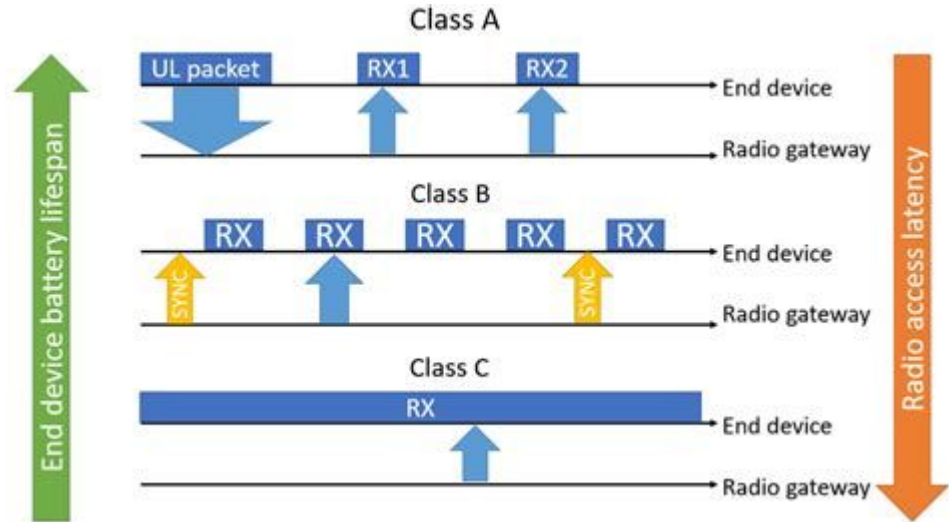
# Regional Regulations

- Open sub-GHz spectra are typically subject to **regional** regulations
- **1%** Duty Cycle restriction in **EU868** band (Europe)
  - Developers should estimate **TX interval** based on transmission **Time on Air**.
  - See <https://loratools.nl>



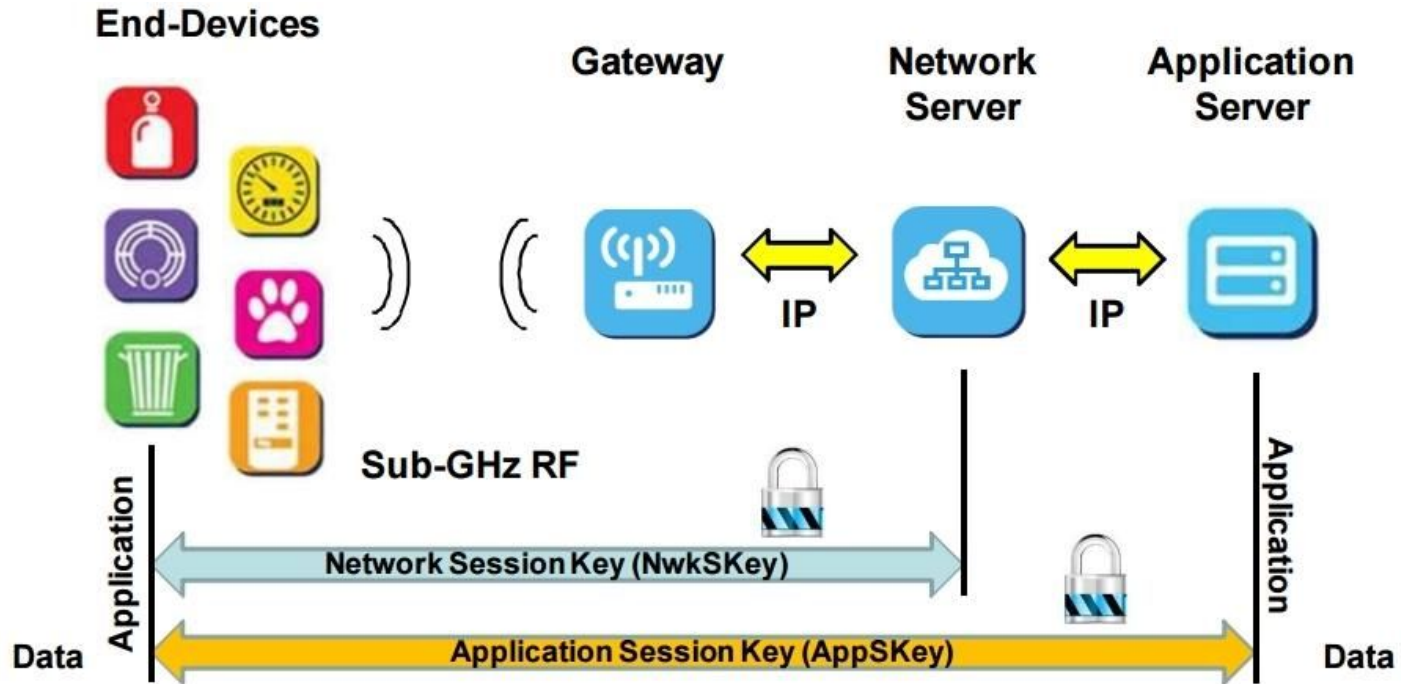
# LoRaWAN Classes

- Trade-off between **energy consumption** and **downlink latency**
- Class **A** and **C** are the most common



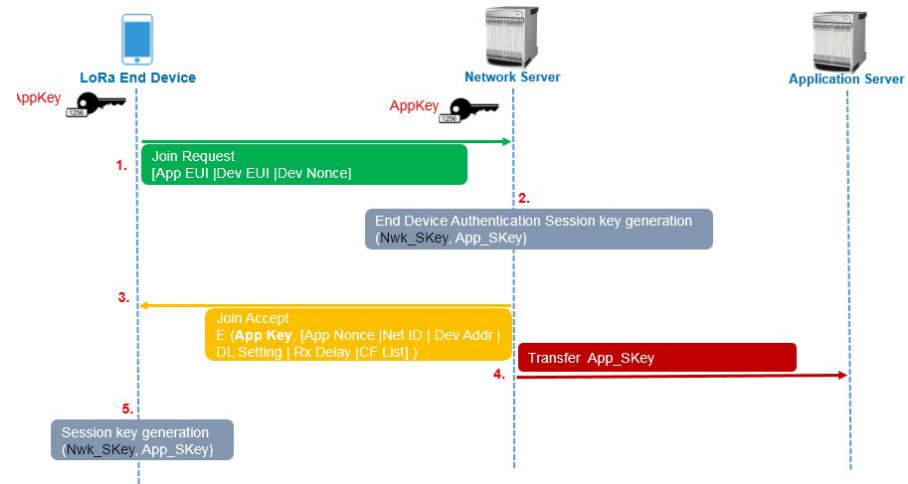


# Encryption scheme



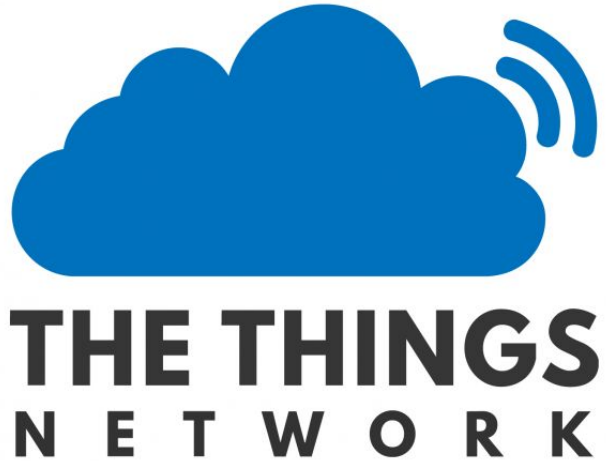
# Device Activation

- **Activation By Personalization (ABP)**
  - Keys are directly provisioned to the device
  - Shouldn't be used in real deployments.
- **Over The Air Activation (OTAA)**
  - Keys are **derived** from a handshake with the LoRaWAN **Network Server**
  - More **secure** than ABP.



# The Things Network (TTN)

- **Community-oriented** LoRaWAN Network Server and Application server
- **Fair Use Policy**
  - Uplink: **30** seconds ToA/device/day.
  - Downlink: **10** packets/device/day.
- **Integration** with well-known technologies
  - MQTT
  - Webhooks
  - AWS



# LoRaWAN on RIOT

Hands-On **tutorial**

# LoRaWAN Support

RIOT provides **two** LoRaWAN implementations

- Semtech **LoRaMAC**
  - Reference implementation by Semtech
  - Current port supports up to LoRaWAN v1.0.3
  - Port provides wrapper functions on top of LoRaMAC pkg .
- **GNRC** LoRaWAN
  - In-House LoRaWAN implementation
  - Support LoRaWAN v1.0.3 and v1.1
  - Integrates **tightly** with the **GNRC** Network Stack

# Tutorial objectives

- Learn the **basics** of LoRaWAN communication on RIOT using **GNRC** LoRaWAN.
- Develop a **LoRaWAN sensor** that periodically transmits data to The Things Network
- Receive data from the sensor using **MQTT**.

# Prerequisites

- Setup a **TTN** Account
  - <https://www.thethingsnetwork.org/>
- Create a new **Application**
  - <https://console.thethingsnetwork.org/>
- **Register** and End Device
  - Select “Select the end device in the LoRaWAN Device Repository”
  - Choose “STMicroelectronics -> Nucleo-WL55JC1->1.0 -> v1.0.0 ->EU\_868\_870
  - Choose **Frequency Plan** “Europe 863-870 MHz (SF9 for RX2)
  - Generate a **JoinEUI** with <https://loratools.nl/#/keys> and click “Generate” on remaining keys.
  - On creation, make sure **LoRaWAN version** is 1.0.3 and **regional parameters** RP001!

# Hands-On!

- Clone Smartuni **exercises** repo
  - git clone <https://github.com/smartuni/exercises.git>
- Follow tutorials **09-lorawan-basic** and **10-lorawan-sensor**



**Questions?**