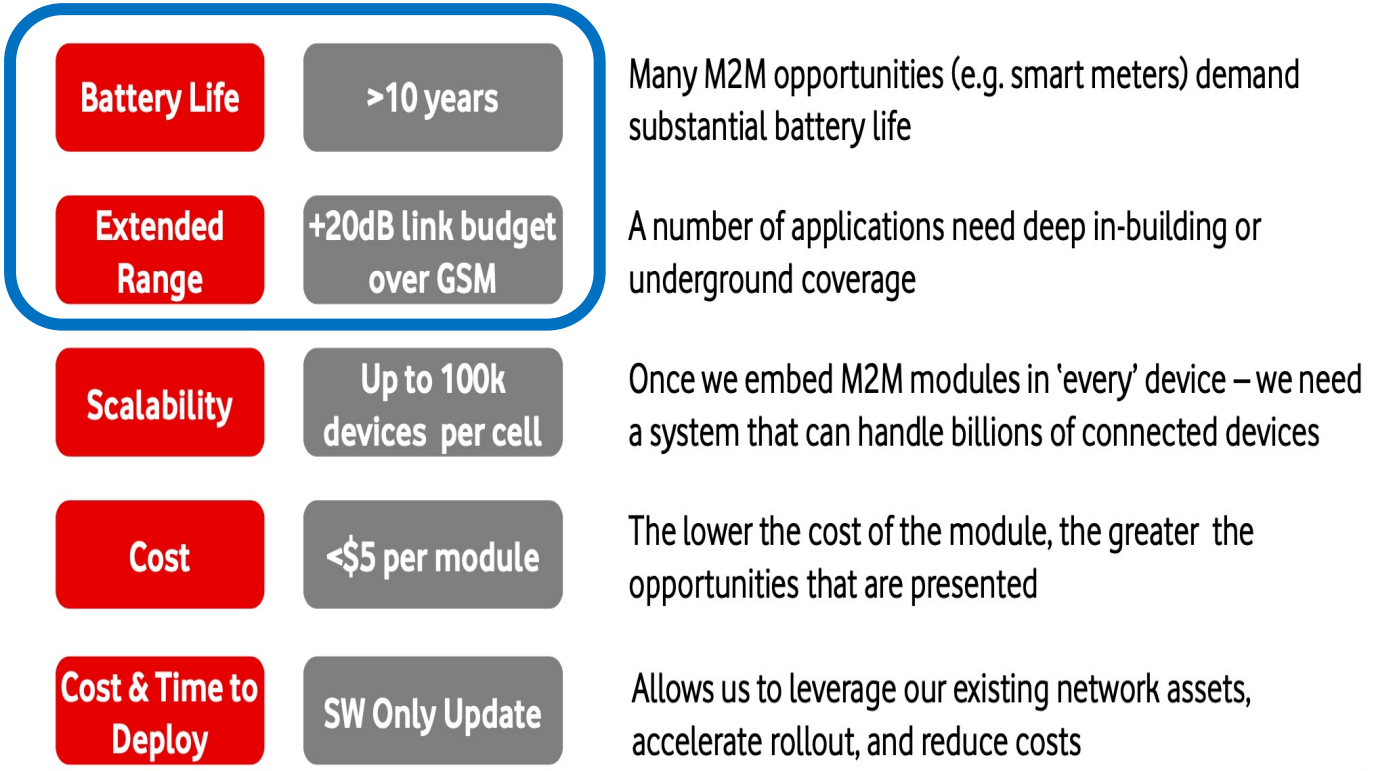
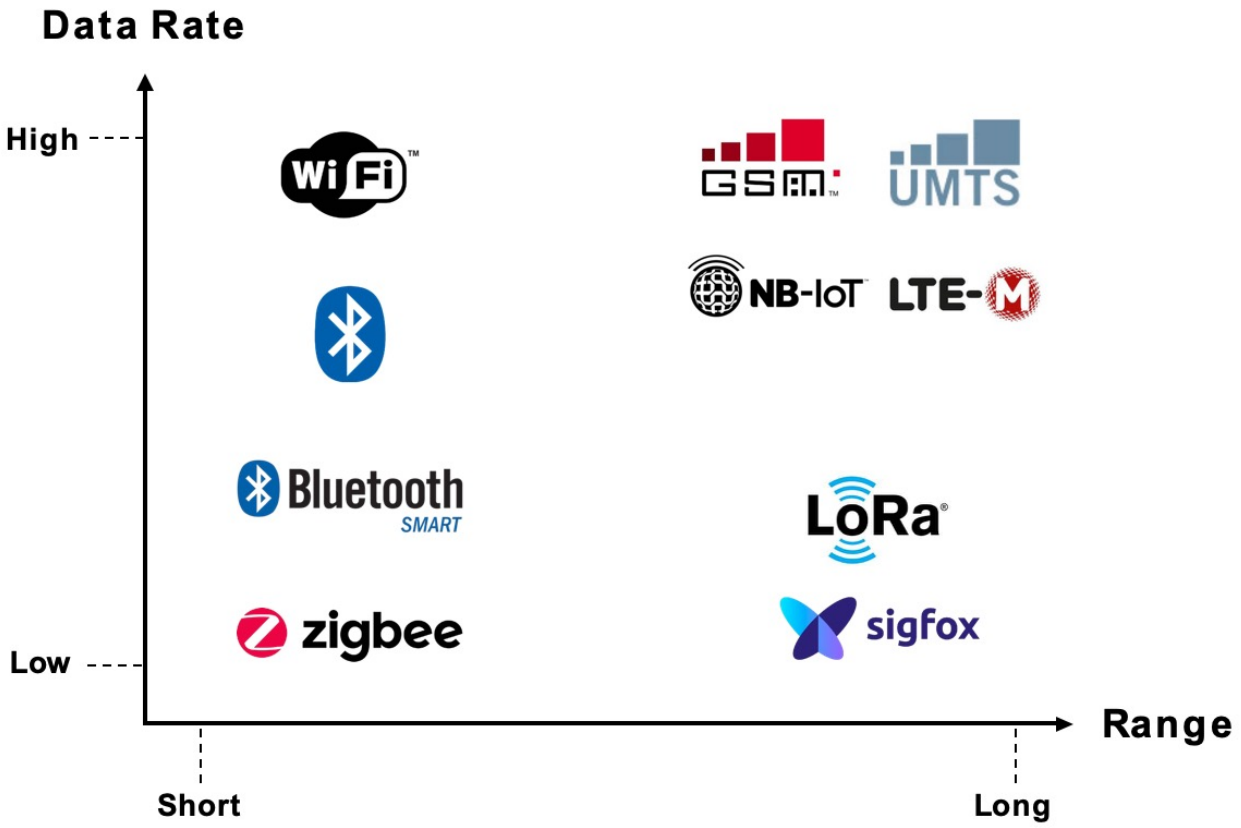
LoRaWAN: a low power IoT networking technology

Low Power Wide Area (LPWA) networks

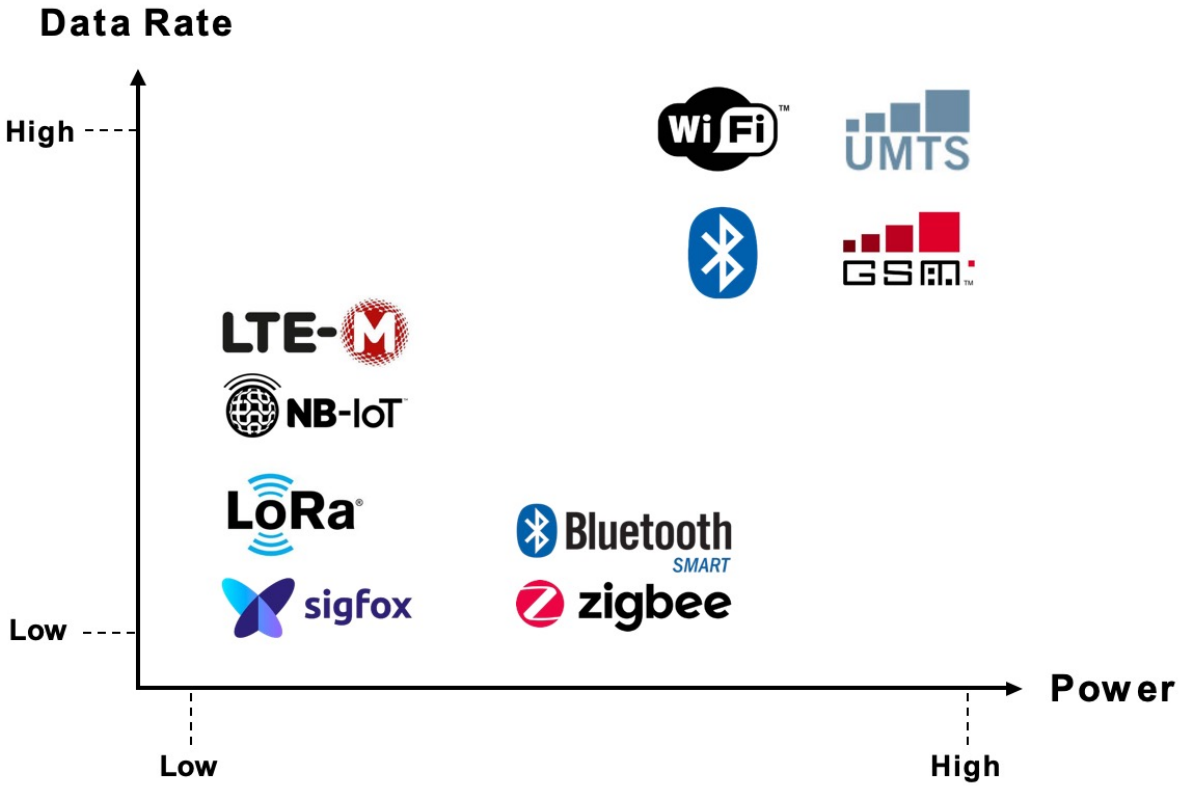


Mabel Pous-Fenollar, Vodafone Group Technology; Networks CoE Sep'16 ©

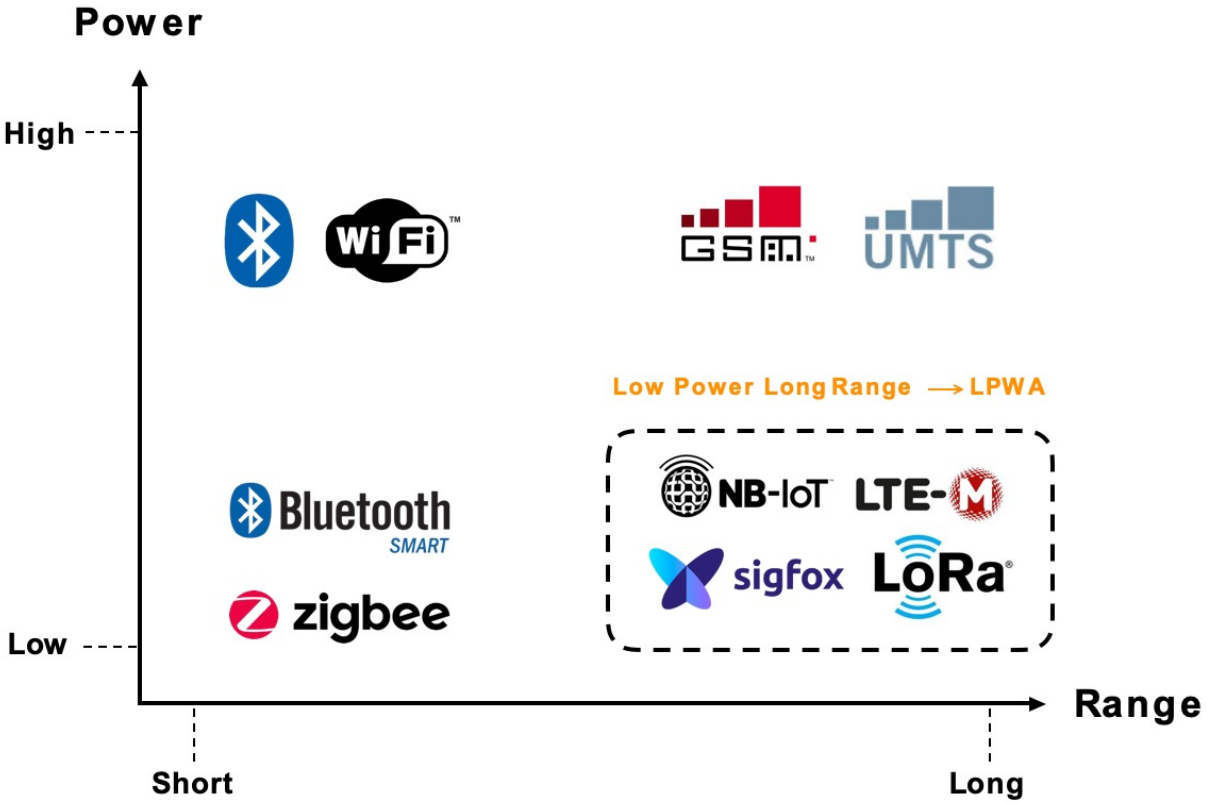
LPWAN: range vs data rate



LPWAN: power vs data rate



LPWAN: range vs power



SIGFOX

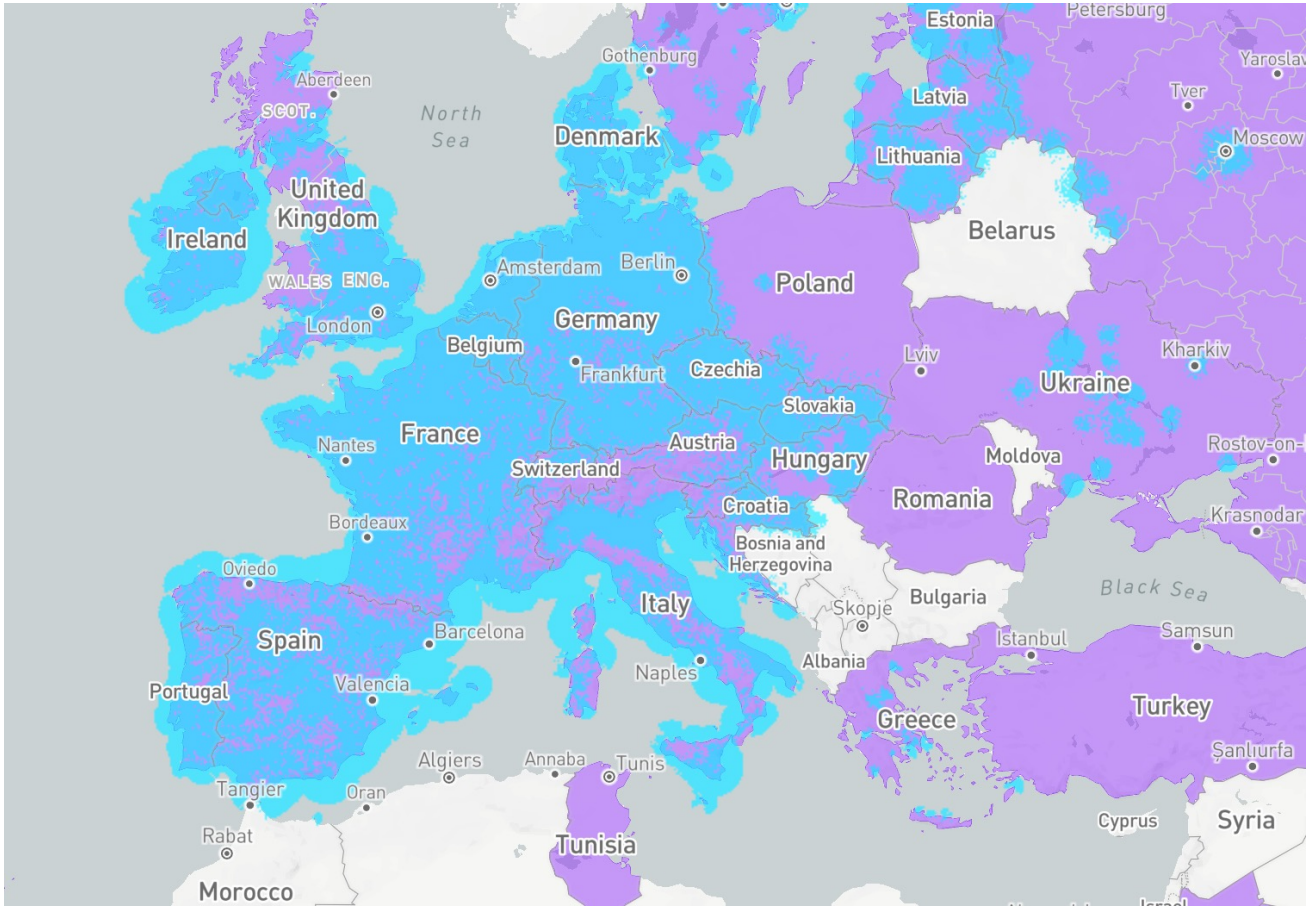
- SIGFOX uses a UNB (Ultra Narrow Band) based radio technology to connect devices to its global network.
- **The network operates in the globally available ISM bands** (license-free frequency bands) and co-exists in these frequencies with other radio technologies.
  - SIGFOX currently uses the European ISM band on 868MHz (as defined by ETSI and CEPT) as well as the 902MHz in the USA (as defined by the FCC), depending on specific regional regulations.
- SIGFOX wireless systems send very small amounts of data (12 bytes) very slowly (**300 baud**) using a standard radio transmission method (frequency shift keying – GFSK). The long range is accomplished as a result of very long and very slow messages.
- Communication on SIGFOX is **secured in many ways**, including anti-replay, message scrambling, sequencing, etc.

SIGFOX

- As an operated long- range network, SIGFOX provides connectivity without the need to deploy specific network infrastructures for each application.
- As a network operator **SIGFOX operates fixed-location transceivers enabling the objects to be connected "out of the box".**
  - the entire SIGFOX connectivity solution has been developed to only serve the low throughput M2M and IoT applications.
- **SIGFOX compatible modems are integrated within the physical objects**
- Available off-the-shelf devices:
  - https://partners.sigfox.com/companies/device-maker

Sigfox coverage

https://www.sigfox.com/en/coverage



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Unfortunately…

IoT Times AI MACHINE LEARNING CONNECTIVITY INDUSTRY POWER MANAGEMENT

TECHNOLOGY TRENDS

Sigfox files for bankruptcy protection to survive the pandemic

By Pablo Valerio

Posted on February 1, 2022

THE FRENCH LPWAN STARTUP, ONCE VALUED OVER HALF A BILLION DOLLARS, IS LOOKING FOR A BUYER TO KEEP OPERATIONS AND SAVE JOBS.

Toulouse. Sigfox, one of the leaders in wireless communication for industrial IoT, has filed for bankruptcy protection in a French court. The Low-Power Wide-Area Network (LPWAN) company, which operates in 75 countries and territories through a network of partner operators, says that the low adoption rate of its technology during the pandemic and the semiconductor shortage has impacted its profits and cash flow. According to its **recent account filings**, the company posted a net loss of nearly €91 million on revenues of just over €24 million and financial debts of €118 million.

In a **statement sent to TechCrunch**, the company outlines the reasons for its decision:

"The decision to place Sigfox under the protection of the Justice through this proceeding was made because of a slower-than-expected adoption cycle for its technology, despite effective shareholder support," it reads. "In addition, the IoT sector has suffered from the Covid-19 pandemic crisis, slowing down activity over the past two years and putting pressure on the electronic components market, now in shortage. These factors combined have strongly impacted the company's financial situation, in particular its debt level, which now makes it difficult to speed up the development of Sigfox and its worldwide recognized technology in an increasingly competitive market."

https://iot.eetimes.com/sigfox-files-for-bankruptcy-protection-to-survive-the-pandemic/

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Sigfox, the French IoT startup that had raised more than $300M, files for bankruptcy protection as it seeks a buyer

Ingrid Lunden @ingridlunden / 4:14 PM GMT+1 • January 27, 2022

Comment

Image Credits: chombosan/iStock

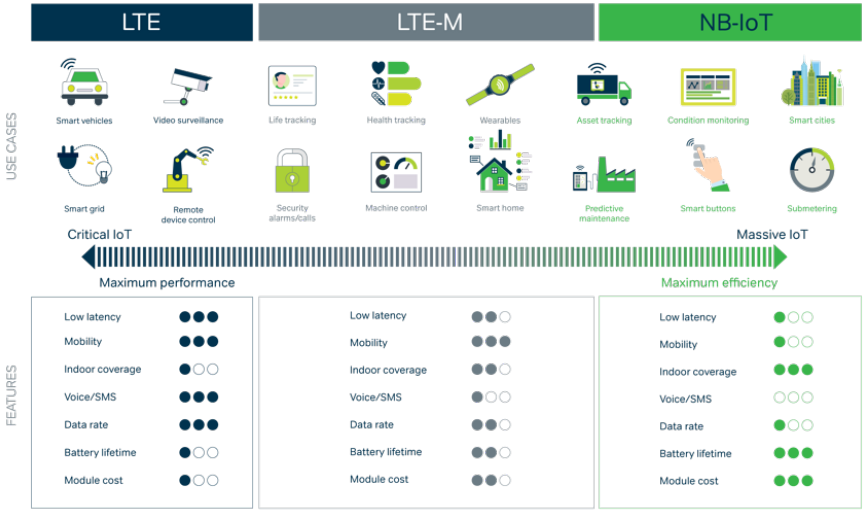
We are continuing to see fallout from the COVID-19 pandemic and its impact on the tech industry, with one of the latest developments coming out from France. Sigfox — a high-profile IoT startup that had raised over $300 million in venture funding and had ambitions to build a global communications network using a new approach to wireless networking — has filed for bankruptcy protection in France, citing slow sales of its products and challenging conditions in the IoT industry due to COVID-19.

It said it would be using the process, which will initially last six months, to seek a buyer "to support Sigfox's long-term development and propose to maintain jobs." It will continue operations in the meantime: Sixfox says says its network spans 75 countries, stitching together capacity from 75 carriers, and that it connects 20 million objects and sends 80 million messages per day.

https://techcrunch.com/2022/01/27/sigfox-the-french-iot-startup-that-had-raised-more-than-300m-files-for-bankruptcy-protection-as-it-seeks-a-buyer/

LTE scaling to IoT → LTE-M

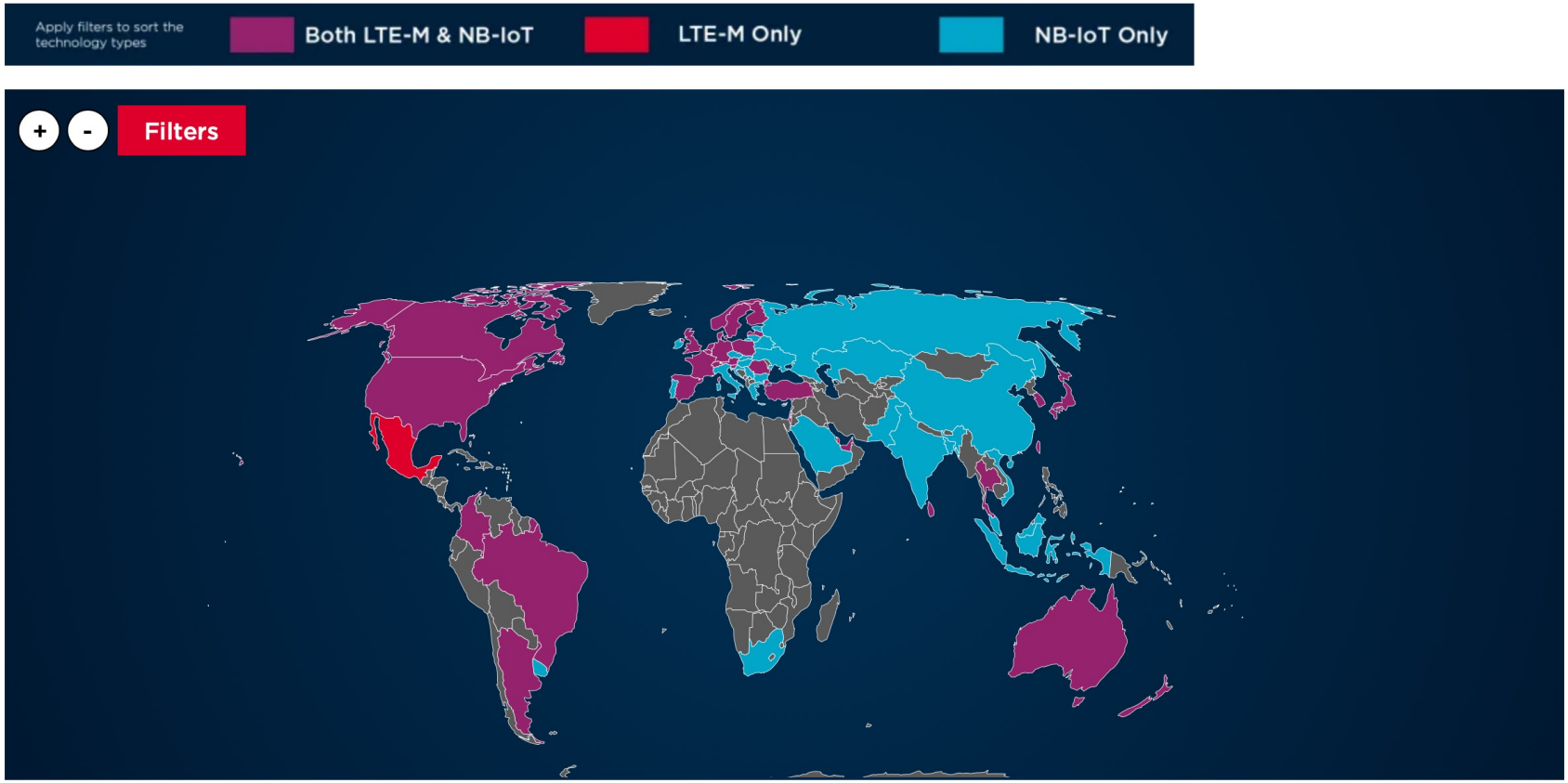
- Long-Term Evolution for Machines (LTE-M) refers to **LTE CAT-M1**, which works by using the existing LTE infrastructure to send out lower frequency waves.
- **NB-IoT** stands for Narrow Band Internet of Things, which uses low-frequency channels that went unused as they could only send small amounts of data. It can be deployed as an addition of new software to the existing LTE infrastructure.



Technologies comparison

	NB-IOT	LTE-M
Bandwidth	180 KHz 3GPP Licensed	1.4 MHz 3 GPP Licensed
Peak data rate	<100	384 Kbps
Uplink / Downlink speed	27.2 / 62.5 Kbps (DL/ UL)	Up to 1 Mbps
Latency	1.5 - 10 sec.	50 - 100 ms.
Battery life	+ 10 years (depending on the use case)	10 years (depending on the use case)
Power consumption	Best at low data rates	Best at medium rates
Cost per module	5 - 10 dollars	10 - 15 dollars
Frequency deployment	Flexible	In LTE band
Penetration in indoors	Excellent	Good
Voice	No	Yes. VoLTE

Mobile IoT Deployment Map

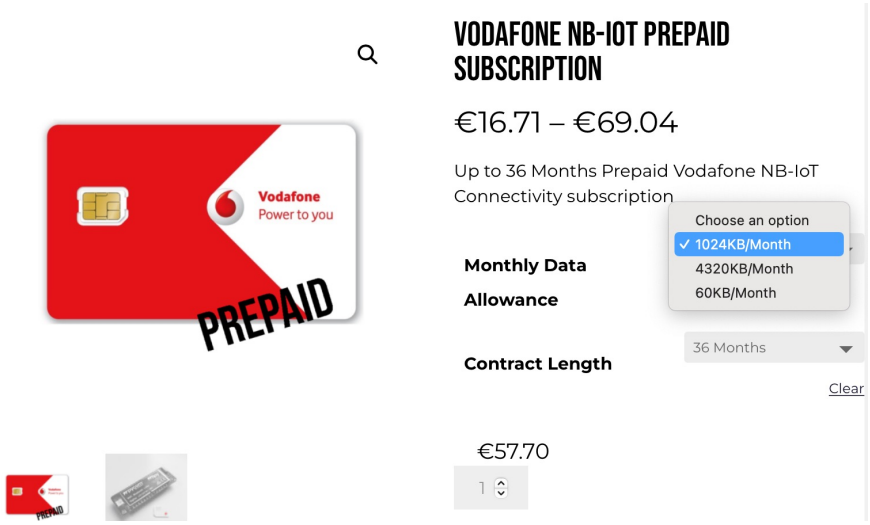


9mar2022

Fuente: https://www.gsma.com/iot/deployment-map/

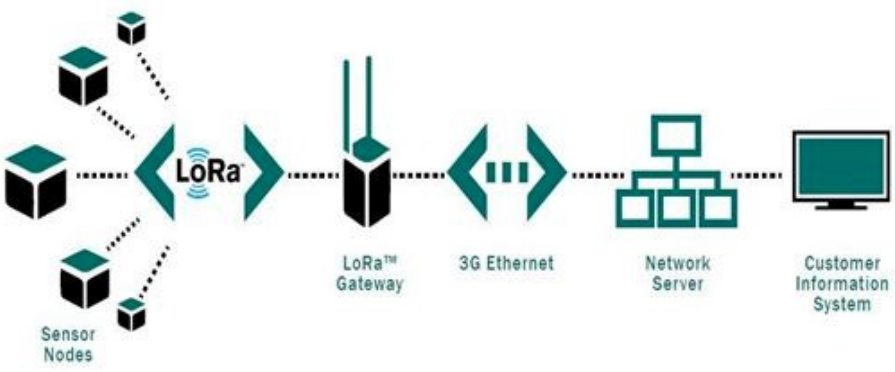
Costs… for example…

https://pycom.io/product/vodafone-nb-iot-prepaid-subscription/



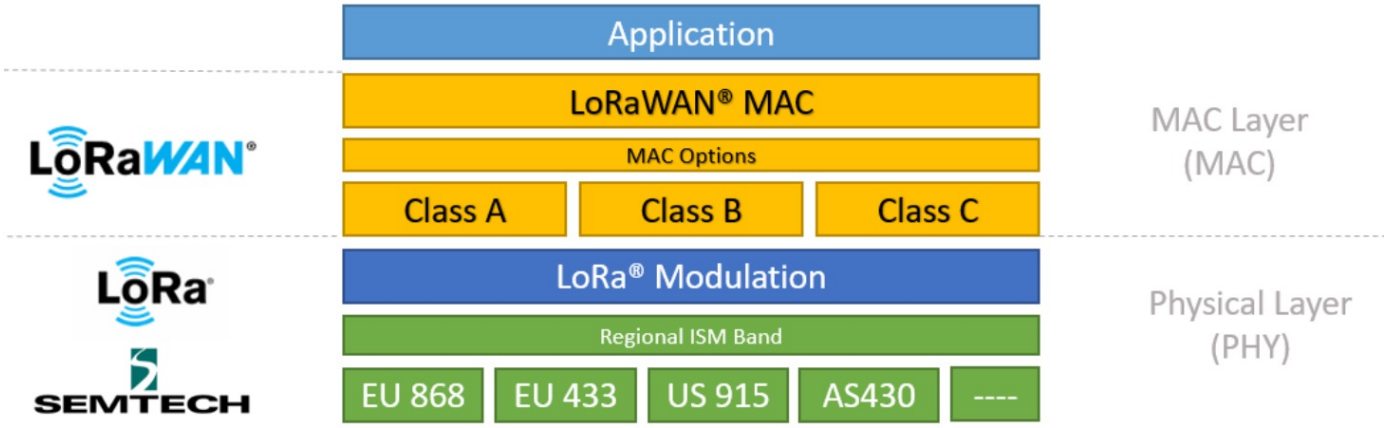
LoRaWAN basics

- https://lora-alliance.org/



LoRaWAN: a sub-gigahertz wireless technology

- LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery-operated Things in a regional, national or global network
  - by Semtech Corporation (http://www.semtech.com/)
- LoRaWAN™ defines the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link.



https://lora-developers.semtech.com/library/tech-papers-and-guides/lora-and-lorawan/ ©

LoRa® Alliance

https://lora-alliance.org/

- The LoRa® Alliance is an open, non-profit association of members whose mission is:
  - "..promote and drive the success of the LoRaWAN® protocol as the leading open global standard for secure, carrier-grade IoT LPWAN connectivity…"
  - "To develop and promote LoRaWAN® technology and its ecosystem to deliver massive IoT"
- Specification is free to download:
  - https://lora-alliance.org/resource-hub/lorawan-104-specification-package

LoRa Alliance®

LoRaWAN® L2 1.0.4 Specification (TS001-1.0.4)

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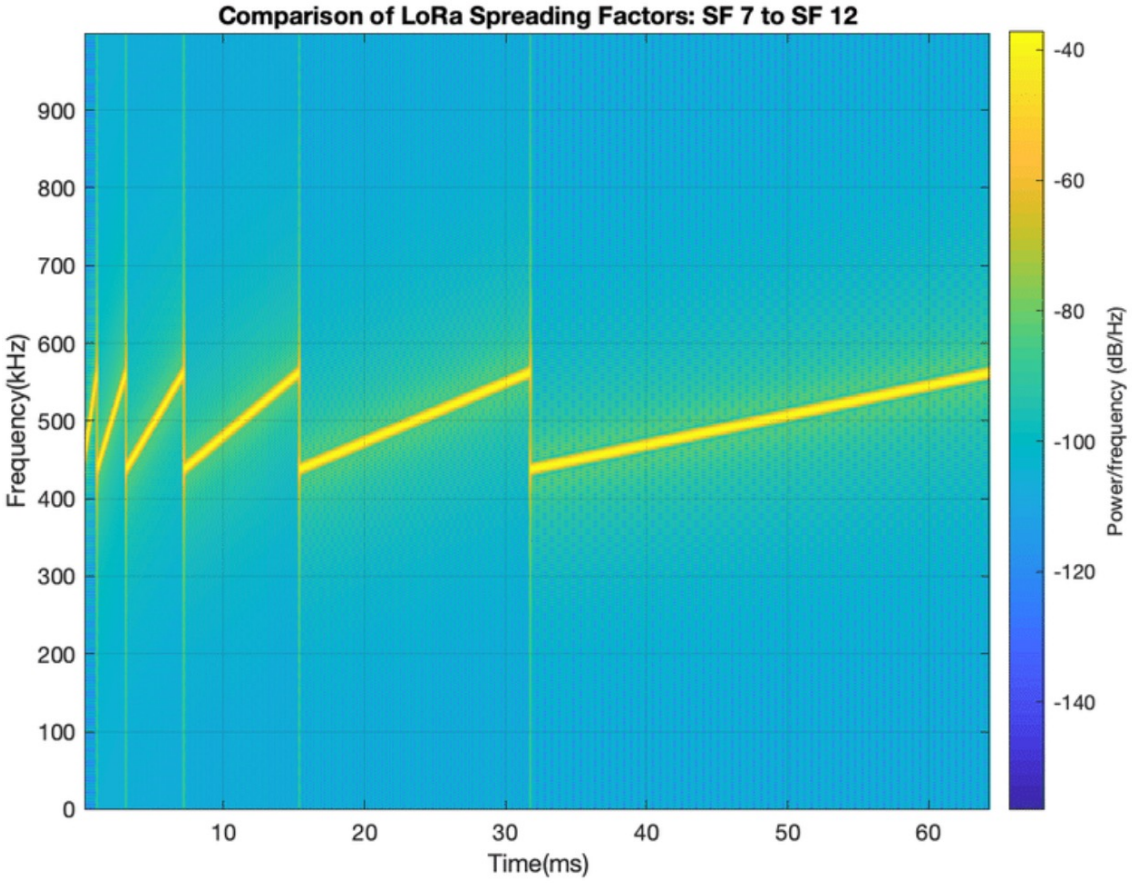
Version: 1.0.4
Date: October 2020
Status: Released

LoRaWAN specification depends on the region

	Europe	North America
Frequency band	867-869MHz	902-928MHz
Channels	10	64 + 8 +8
Channel BW Up	125/250kHz	125/500kHz
Channel BW Dn	125kHz	500kHz
TX Power Up	+14dBm	+20dBm typ (+30dBm allowed)
TX Power Dn	+14dBm	+27dBm
SF Up	7-12	7-10
Data rate	250bps- 50kbps	980bps-21.9kpbs
Link Budget Up	155dB	154dB
Link Budget Dn	155dB	157dB

https://lora-alliance.org/resource-hub/rp2-101-lorawanr-regional-parameters-0

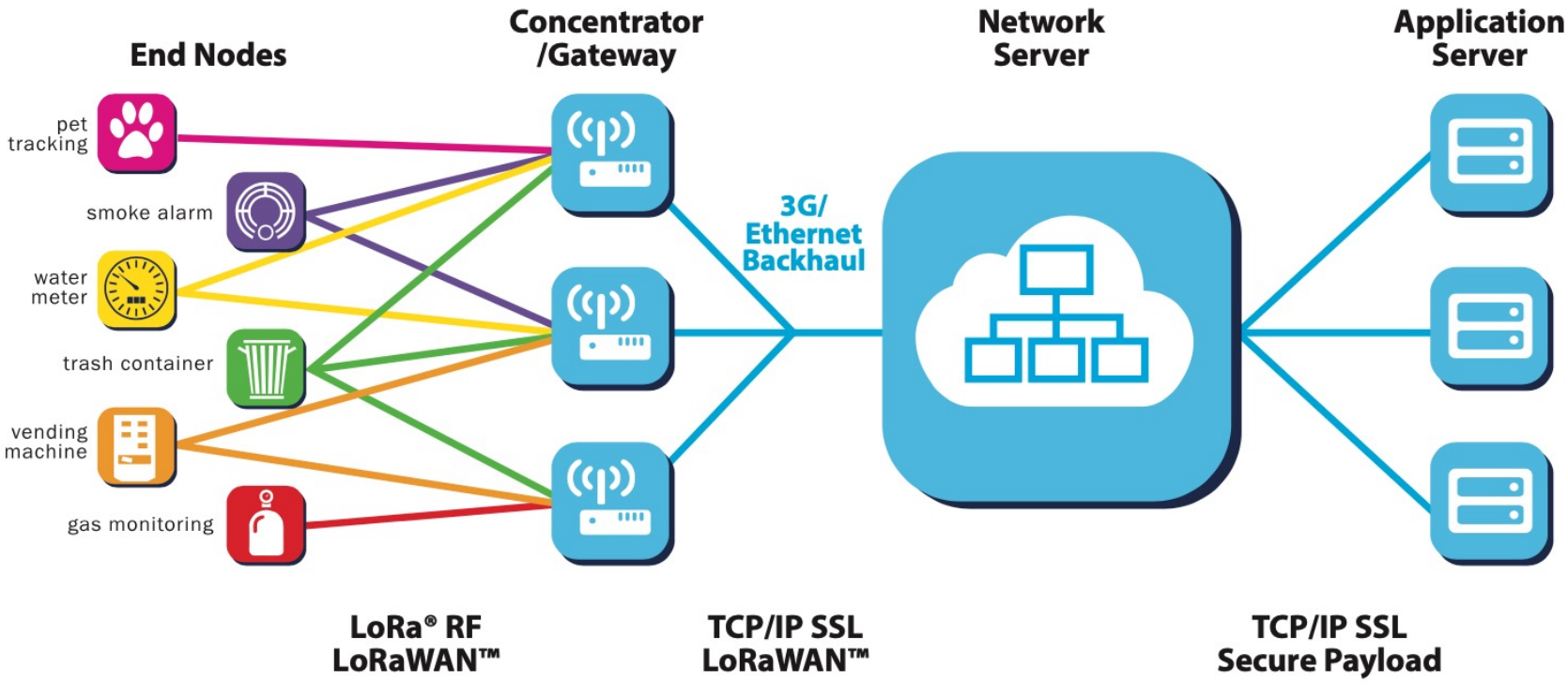
Chirp Modulation



https://www.youtube.com/watch?v=dxYY097QNs0

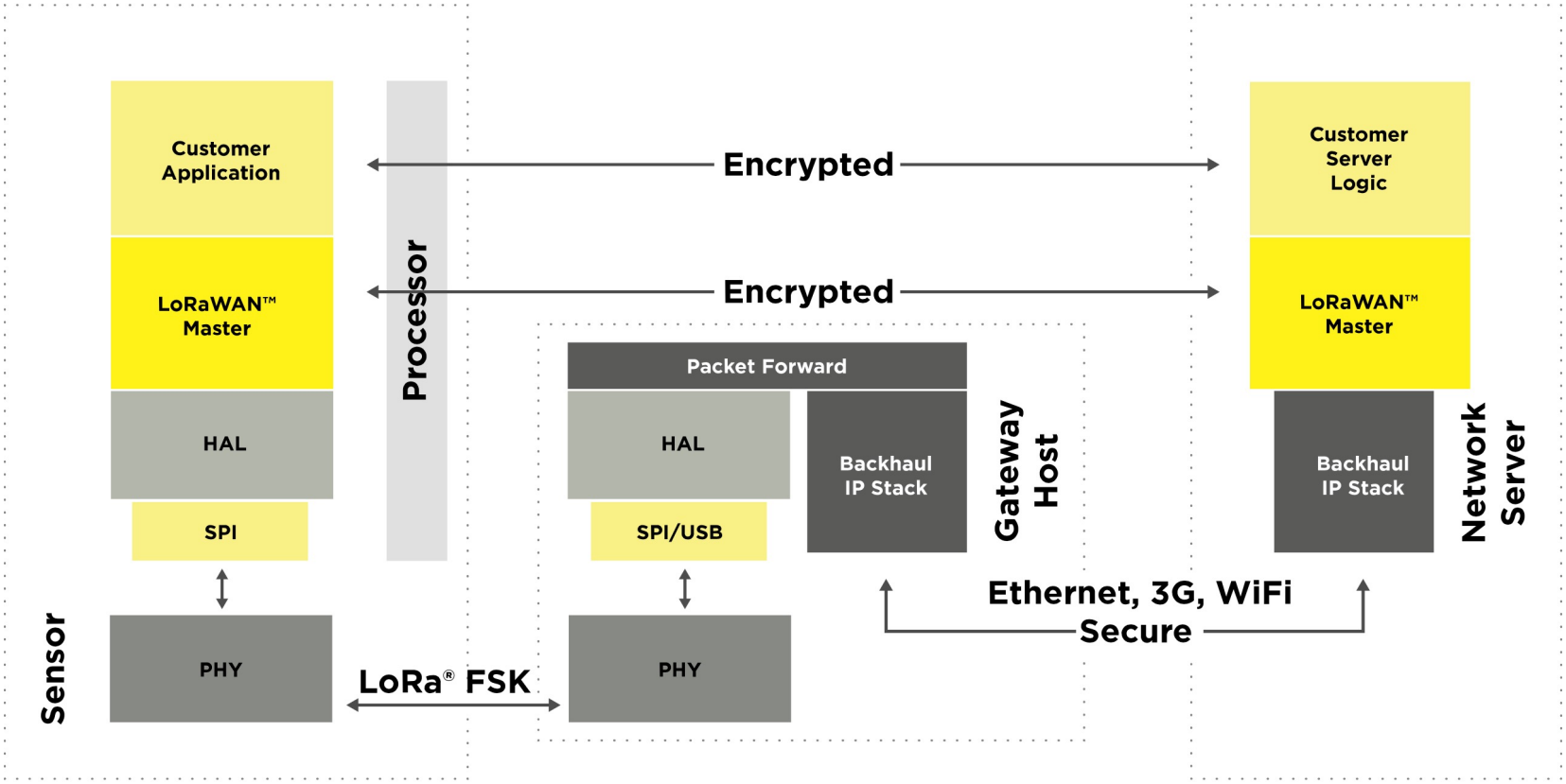
Kim, Dong-Hoon & Lee, Eun-Kyu & Kim, Jibum. (2019). Experiencing LoRa Network Establishment on a Smart Energy Campus Testbed. Sustainability. 11. 1917. 10.3390/su11071917.

LoRaWAN network architecture



LoRa Alliance ©

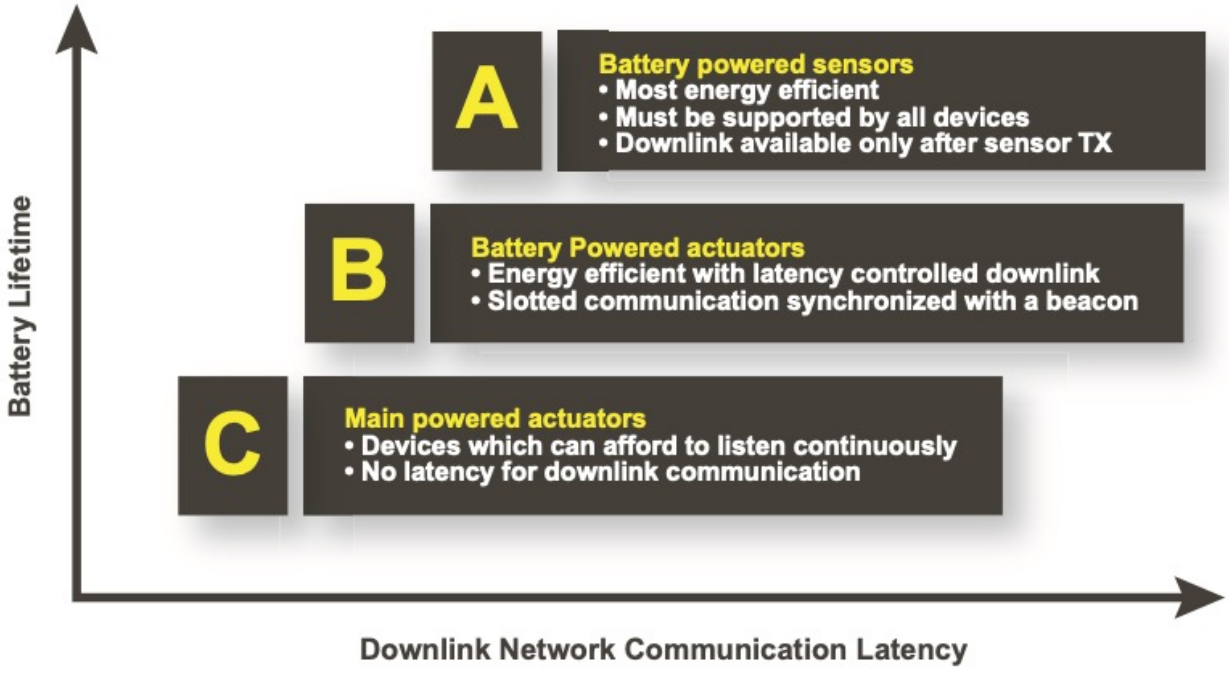
LoRaWAN data flow



HAL: Hardware Abstraction Layer

Three types of devices

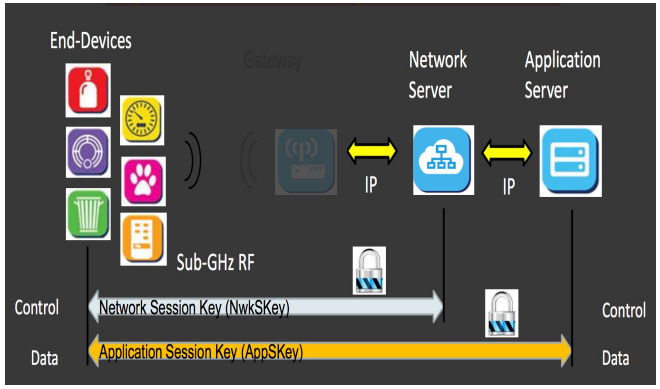
- LoRaWAN has three different classes of end-point devices to address the different needs reflected in the wide range of applications:



LoRa® Alliance Technical Marketing Workgroup

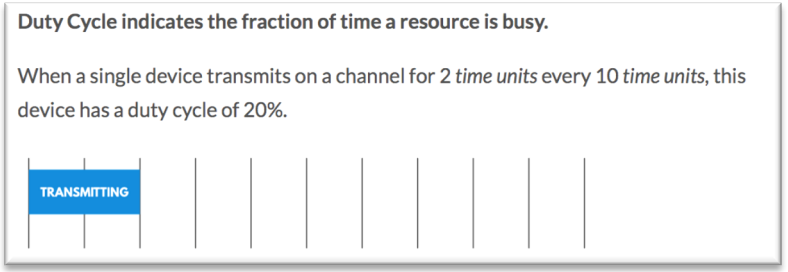
Devices activation

- LoRaWAN devices have a 64-bits unique identifier (`DevEUI`) that is assigned to the device by the chip manufacturer.
- However, all communication is done with a dynamic 32 bit device address (`DevAddr`) of which 7 bits are fixed (Network Server), leaving 25 bits that can be assigned to individual devices with a procedure called **Activation**.
- To exchange this information, two activation methods are available:
  - Over-the-Air Activation (OTAA)
    - Devices perform a join-procedure with the network, during which a dynamic DevAddr is assigned and security keys are negotiated with the device
  - Activation By Personalization (ABP)
    - Hardcode the DevAddr as well as the security keys in the device.



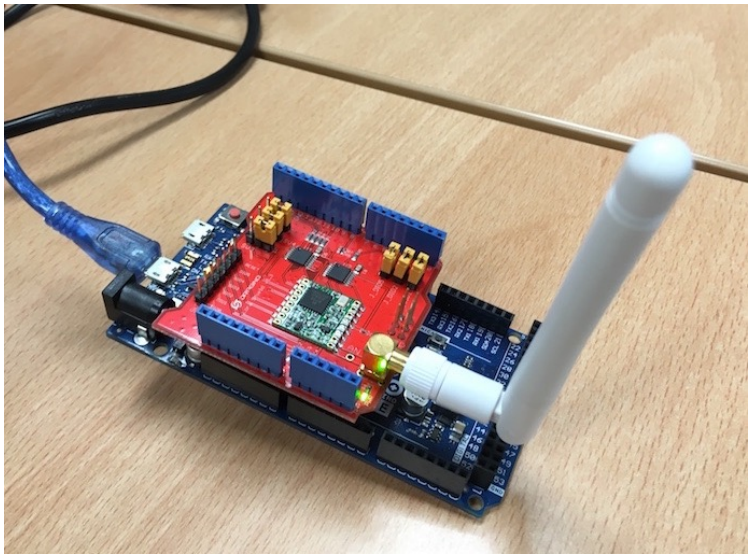
Maximum Duty Cycle

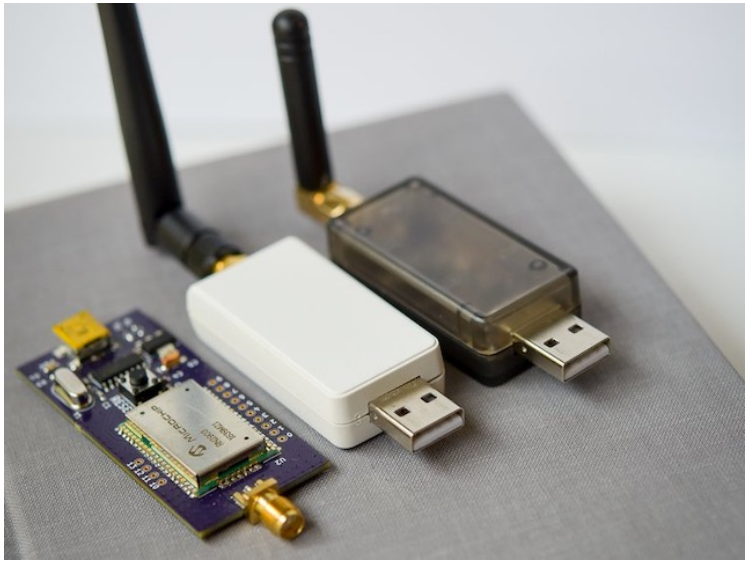
- The **duty cycle of radio devices is often regulated by government**.
  - In Europe, duty cycles are regulated by section 7.2.3 of the ETSI EN300.220 standard.



- Additionally, the **LoRaWAN specification dictates duty cycles for the join frequencies**, the frequencies devices of all LoRaWAN-compliant networks use for over-the-air activations (OTAA) of devices. In most regions this duty cycle is set to 1%.
- Finally, on "community network" like TTN there typically is a **Fair Access Policy** that limits the uplink airtime to 30 seconds per day (24 hours) per node and the downlink messages to 10 messages per day (24 hours) per node.

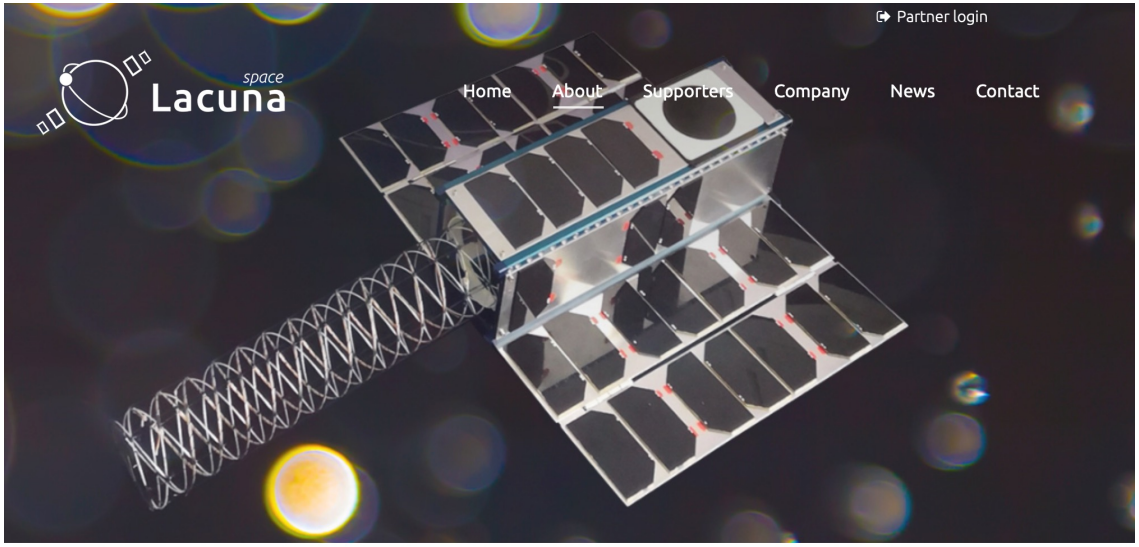
Some devices





Nice project

https://lacuna.space

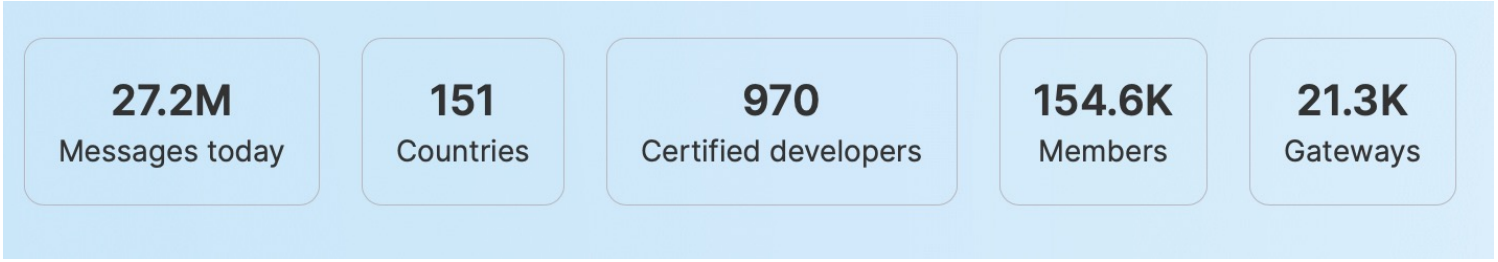


An ultra-low cost tracking and sensor detection service for small amounts of data

– think of it as 'things' rather than people tweeting short messages.

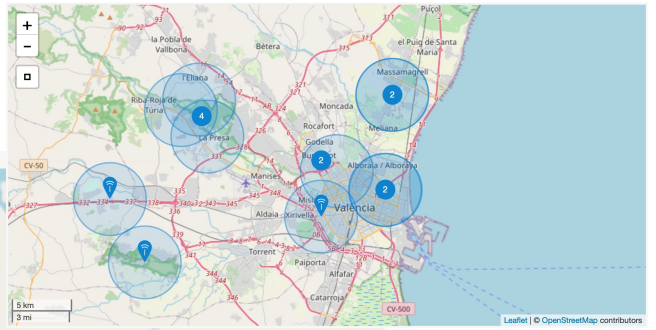
The Things Network (TTN)

https://www.thethingsnetwork.org



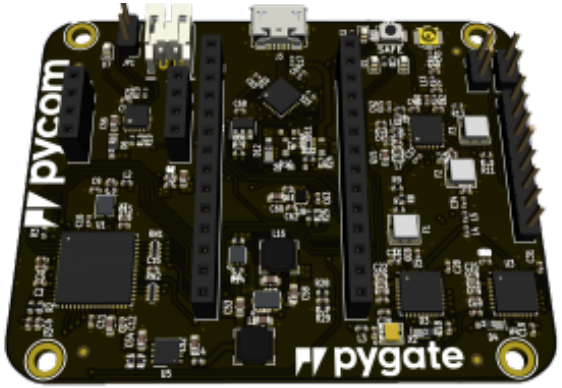
The Things Network (TTN)

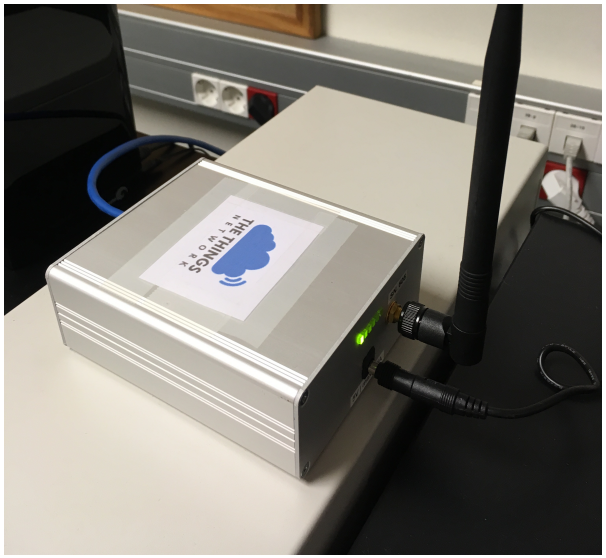
Currently (1oct2021) 21300 gateways active worldwide

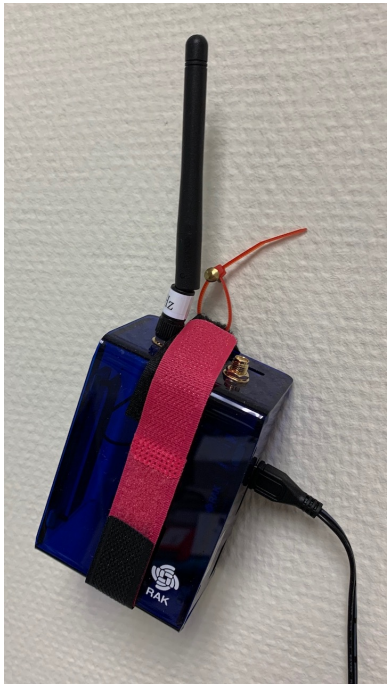


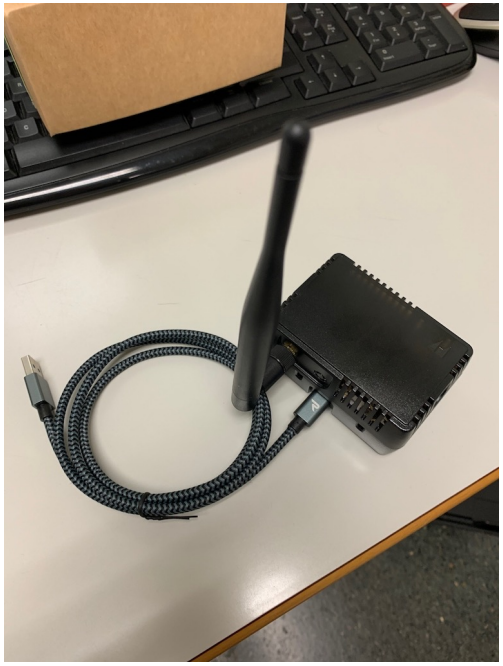
https://www.thethingsnetwork.org/community

GRC Gateways









The Things Network (TTN)