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LPWAN: SIGFOX, LoRa and Weightless

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Low Power Wide Area Networks

Precedent

- Late 80s - AlarmNet by ADEMCO[1] and ARDIS by Motorola[2]

Characteristics

- Long Range Communications
- Low Bit Rate
- Low Energy Consumption

Future

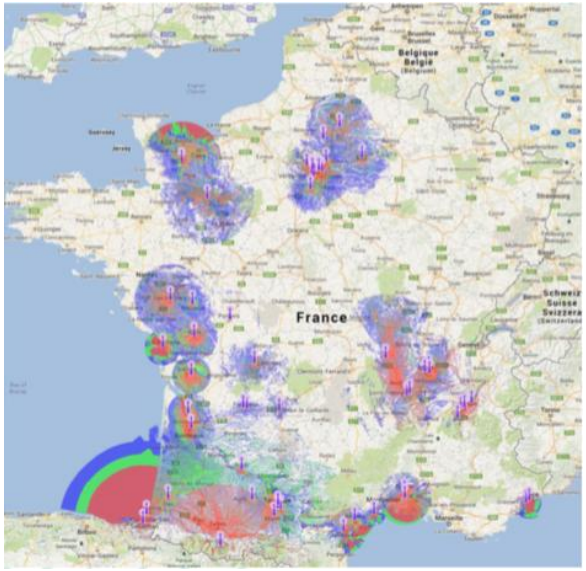
- GSMA Mobile IoT Initiative for standardization[3]

[1] http://www.link-labs.com/past-present-future-lpwan/
[2] http://www.signalharbor.com/ardis.html
[3] http://www.gsma.com/connectedliving/mobile-iot-initiative/

Sigfox. History

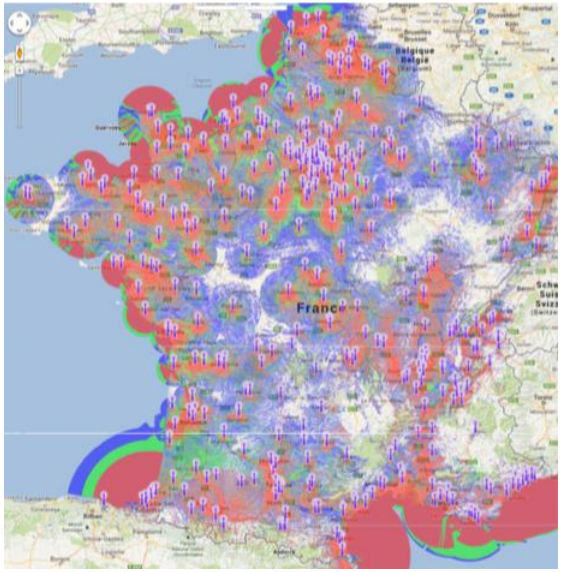
- French Startup. Founded in 2008
- First LPWAN technology proposed in the IoT market
- Goal: Build wireless network to connect low energy-objects
- Global Internet Of Things operator
- 2011: First large suscription signed
- 2013: France fully covered

Sigfox. Deployment (FRANCE)



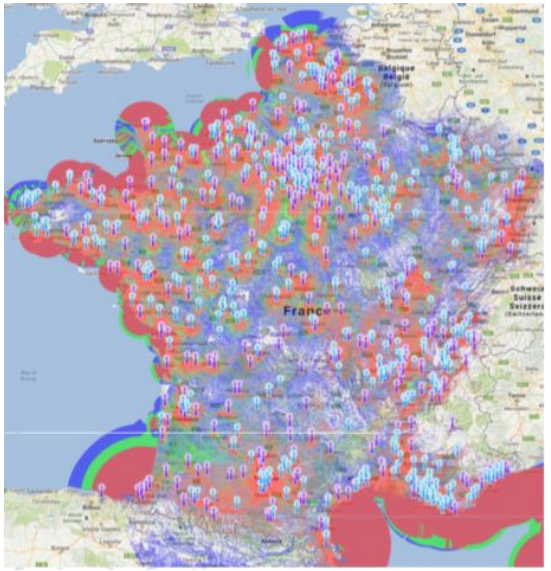
01/01/2013

Base stations deployed:
57 units



31/08/2013

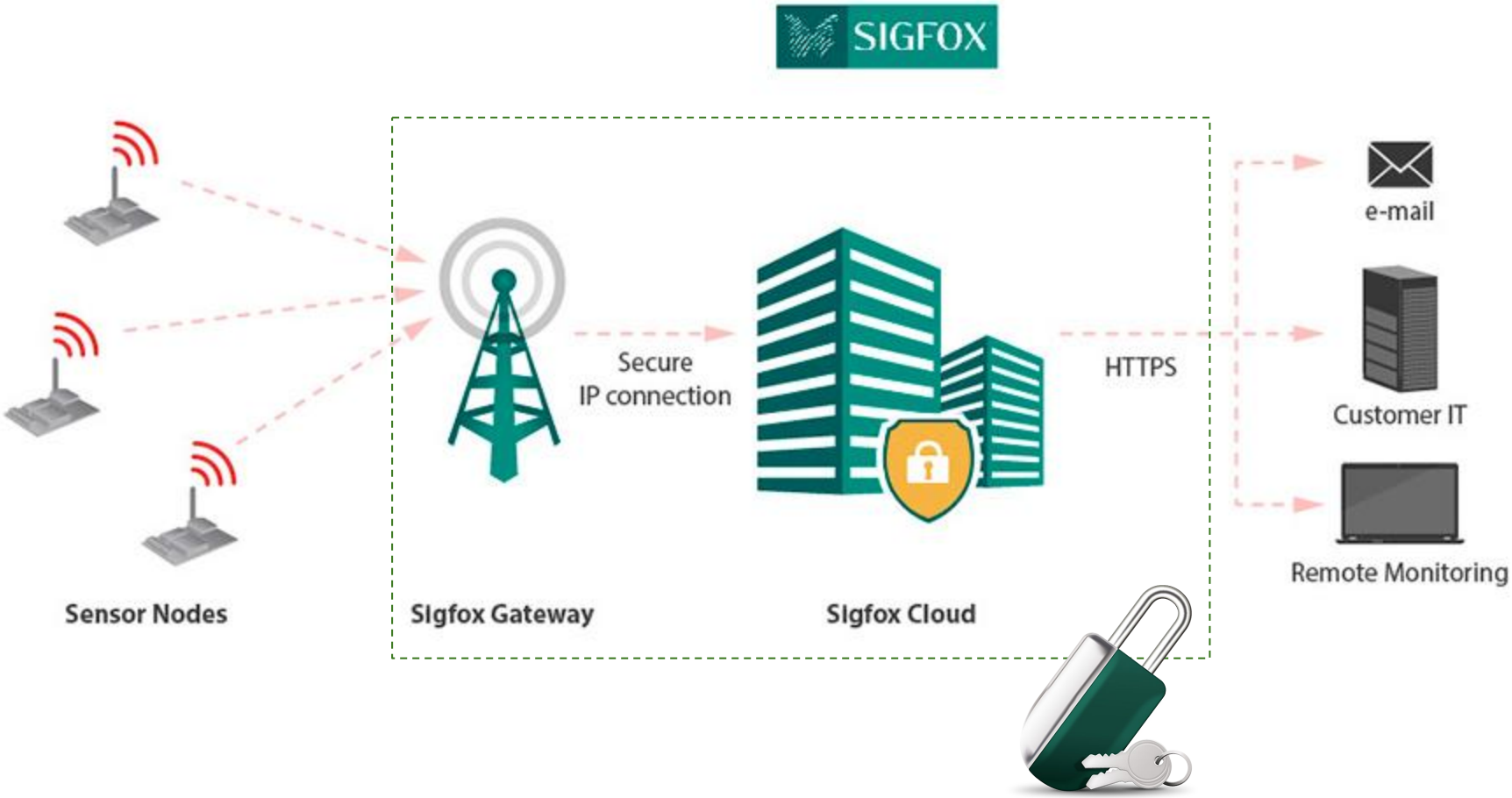
Base stations deployed:
396 units



31/12/2013

Base stations deployed:
770 units

Sigfox. Infrastructure



http://www.sigfox.com/

Sigfox. Specifications

- **Physical layer:** Ultra Narrow Band (UNB) wireless modulation [1]
- **Communication**:
  - First models: Uni-directional communication
  - Last releases: Bidirectional communication
- **Coverage areas**:
  - 30-50 km (rural areas)
  - 3-10 km (urban areas)
- **Network Topology :** Star cell infrastructure [2]
  - Low OPEX

[1] http://www.radio-electronics.com/info/wireless/sigfox/basics-tutorial.php
[2] Paper: Long-Range Communications in Unlicensed Bands: the rising stars in the IoT and Smart Cities scenarios

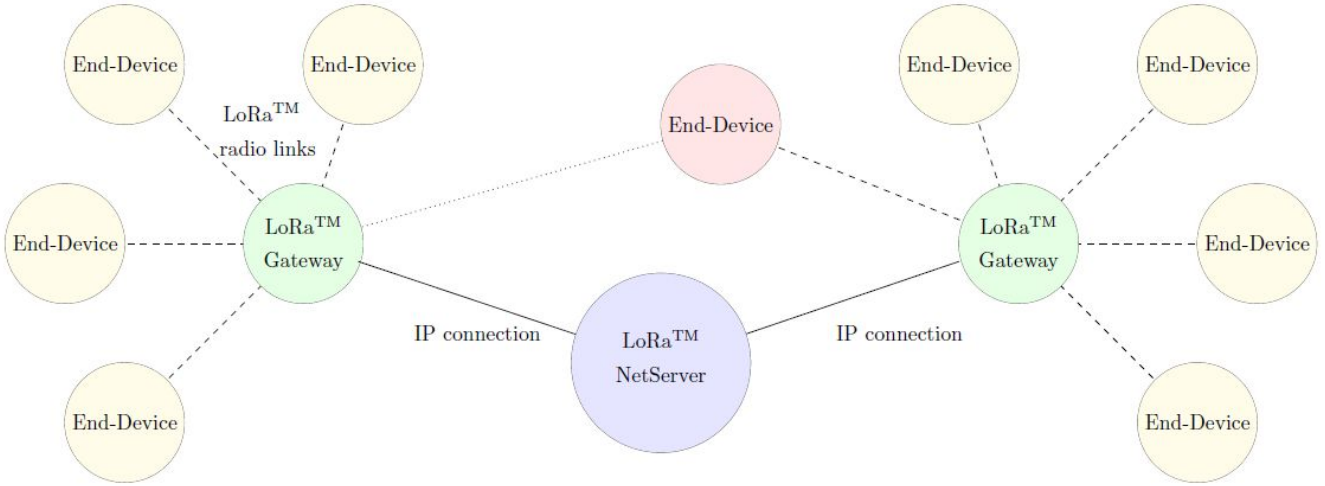
Sigfox. Specifications

- **Frequency band**: ISM bands: 868 MHz in Europe, 902Mhz in US
- **Bandwidth**: Ultra narrow Bandwidth (UNB), 100 MHz
- **Number of channels**: 400
- **Data rate:** 100 bps
- **Coding scheme**: Random-FDMA
- **Receiver Sensitivity:** -120 dBm / -142 dBm
- **Max. Transmission Range:** 50 km
- **Frequency Hopping**: Yes
- **Size of data packets**: 12 bytes (96 bits) per message
- **Maximum number of messages**: 140 every day
- **Duty cycles**: 1% (6 messages/hour)

http://www.markers.sigfox.com/

LoRa

- Modulation at the physical layer by semtech corp
- Chirp spread spectrum(CSS) modulation to reach higher distances
- Legacy wireless-FSK
- LoRaWAN- MAC protocol (LoRa Alliance) mimics 802.15.4
- Star topology



http://www.dei.unipd.it/~zanella/PAPER/CR_2015/Fabulous2015_LoRaDawn_CRp

LoRa

- **Frequency band:** 169, 433 & 915 MHz USA, 868 MHz Europe[1]
- **Frequency hopping:** Yes
- **Number of channels:** 10 EU, 64 USA[4]
- **Channel Bandwidth:** 125/250 kHz EU, 125/500 kHz USA[4]
- **Transmit power:** 14 dBm EU, 20-30 dBm USA[4]
- **Receiver Sensitivity:** -130 dBm[7]
- **Max. Transmission Range:** 10 km[2]
- **Available Data bit rates:** 0.3 to 50 kbps (ADR)[1]
- **Max. Number of simultaneous devices:** 62500 if 1 pack/hour[5]
- **Size of data packets:** max 256 bytes[5]
- **Size of header:** 1 byte[3]
- **ACK transmissions:** 64 default[3]
- **Time Synchronization:** slotted and asynchronous[6]

[1] http://arxiv.org/pdf/1510.00620.pdf
[2] http://www.globalsat.com.tw/en/2-909-30856/product/LoRaWAN%E2%84%A2-Compliant-Module-Supplier-id199329.html
[3] https://www.lora-alliance.org/portals/0/specs/LoRaWAN%20Specification%201R0.pdf
[4] https://www.lora-alliance.org/portals/0/documents/whitepapers/LoRaWAN101.pdf
[5]http://www.semtech.com/wireless-rf/lora/LoRa-FAQs.pdf
[6] http://www.link-labs.com/what-is-lorawan/
[7] https://www.cooking-hacks.com/documentation/tutorials/lorawan-for-arduino-raspberry-pi-waspmote-868-900-915-433-mhz

LoRa

Energy consumption:[1]

- **Transmission:** 125 mA
- **Reception :** 13 mA
- **Sleep:** 0.0025 mA

Use of this technology:

Pros:

- Low power consumption
- Low cost

Cons:

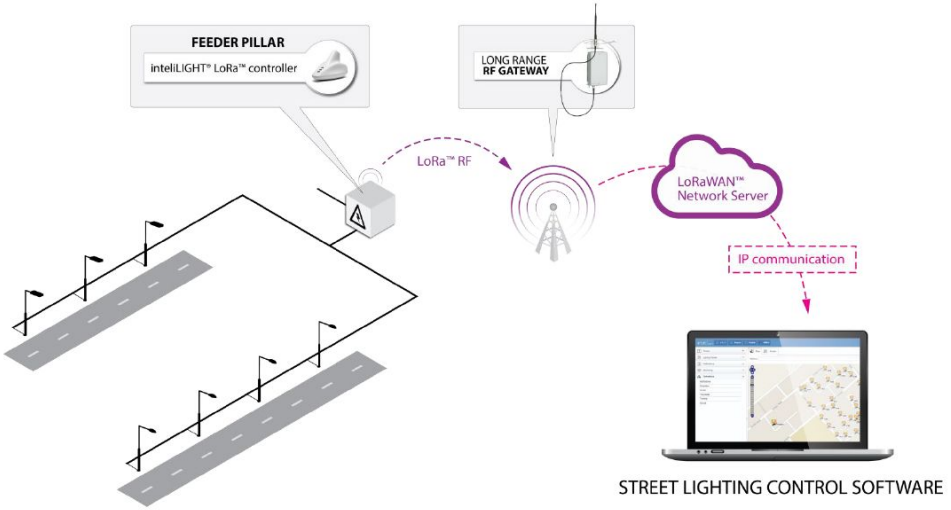
- Emerging standards
- Low data rate
- Actual range is lower than advertised

[1] http://www.globalsat.com.tw/en/2-909-30856/product/LoRaWAN%E2%84%A2-Compliant-Module-Supplier-id199329.html

LoRa

Use cases:

- Streetlight control solution in Szada, Hungary[1]
- Hoosjebootje - flood control on boats in Amsterdam[2]
- I want to ride my bicycle - tracking and alarm system in Amsterdam[2]



[1] (and image) https://www.lora-alliance.org/portals/0/documents/whitepapers/inteliLIGHT_LoRa_-_Szada_Case_Study.pdf
[2] http://thethingsnetwork.pr.co/108437-the-things-network-launches-world-s-first-crowdfunded-internet-of-things-data-network-in-amsterdam-and-the-world-is-next

Weightless

- Weightless-W was the first version of the LPWAN
- Designed to work in the TV white space spectrum
- Good idea in theory but quite complicated to implement

- Appears Weightless-N
- Similar to Sigfox
- Instead of being an end-to-end system uses a network of partners

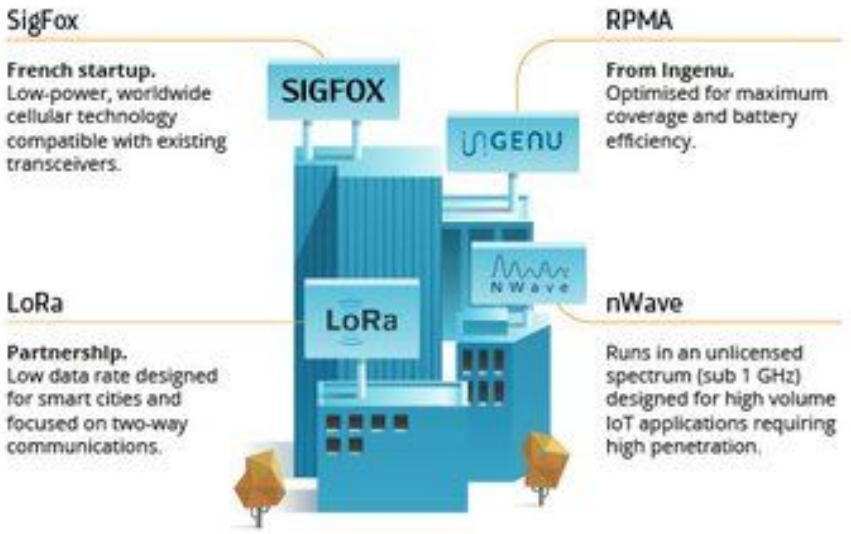
http://www.link-labs.com/what-is-weightless/

http://www.weightless.org/about/what-is-weightless

Weightless

· N-wave is the leader company in weightless-n tecnology

· RPMA



Weightless

WEIGHTLESS vs SIGFOX

- Similar from a tecnological point of view
- Sigfoz offers a complete solution
- Weightless is just a standard wich needs a company to create a solution around it (n-wave)

WEIGHTLESS vs LORA

- Very similar
- Both are uplink-focused data systems

Weightless

- **Channels**: 12,5kHz
- **Bandwidth**: Ultra narrow Bandwidth (UNB), 100 MHz
- **Data Rate:** 200bps - 100kbps
- **Range**: 2km