Low power & High accuracy trackers for IoT network combining multiple geolocation technologies

Hend Affes[1], Leonardo Lizzi[2], Fabien Ferrero[2], Stephane Boudaud[1]
[1]*Abeeway, Sophia-Antipolis, France;* [2]LEAT,UCA,Sophia-Antipolis

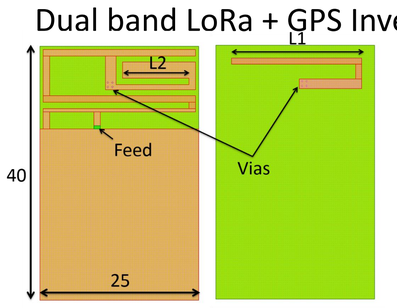
Abstract

The fast emergence of new wireless networks operating in the ISM bands known as Low Power Wide Area Network (LPWAN) is changing the connectivity landscape of IoT devices. Those new technologies are designed to support services which need long range communication to reach devices with an ultra-low power consumption budget in order to operate for several years. Asset tracking and geolocation services are becoming one of the biggest use case in IoT that will benefit from LPWAN and in particular from LoRa technology. The combination of LoRa location with intelligent sensor fusion logic will create an efficient geolocation system to monitor any kind of objects anywhere. This work presents the design of a miniature antenna for geolocation applications and the different geolocation technologies that enable dynamic optimization of the power/accuracy trade-off.

Antenna Design and Measurements

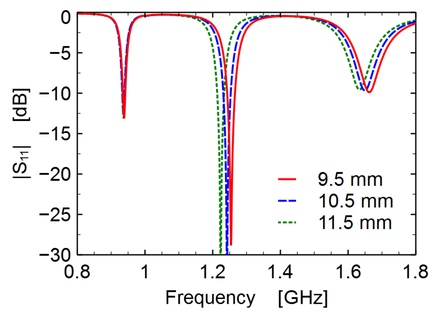
ANTENNA GEOEMTRY

Dual band LoRa + GPS Inverted F Antenna

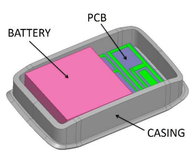


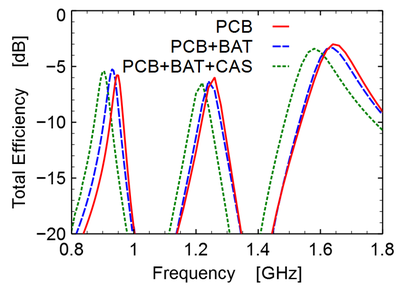
Antenna size:
12x25mm
0.04λ x 0.08λ
at 915MHz

S11 OPTIMIZATION

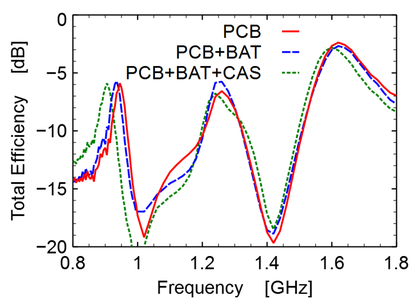


INTEGRATION EFFECTS



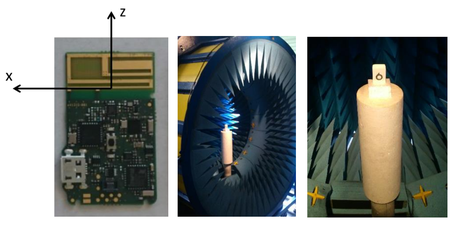


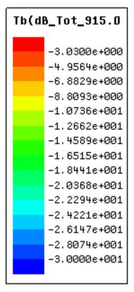
ANTENNA MEASUREMENTS



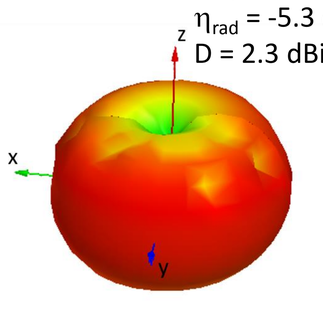
FINAL DEVICE MEASUREMENTS

- Received power measurements at 915 MHz
  - TX mode: CW with P_{out} = 14 dBm
  - Comparison with reference antenna



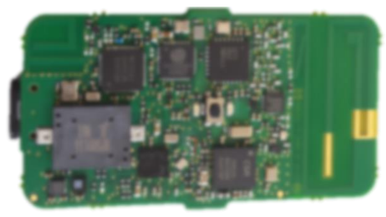


G_{max} = -3 dBi
η_{rad} = -5.3 dB (30%)
D = 2.3 dBi

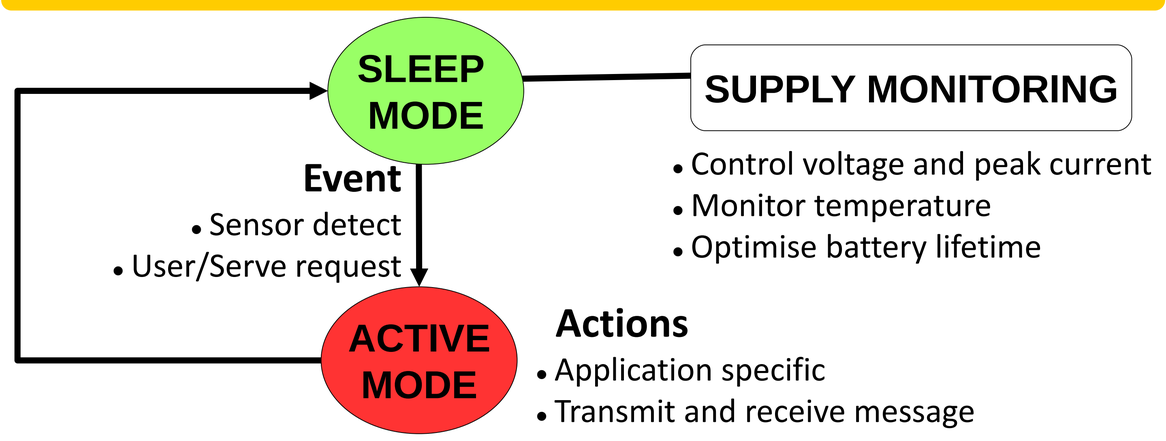


Low power consumption tracker

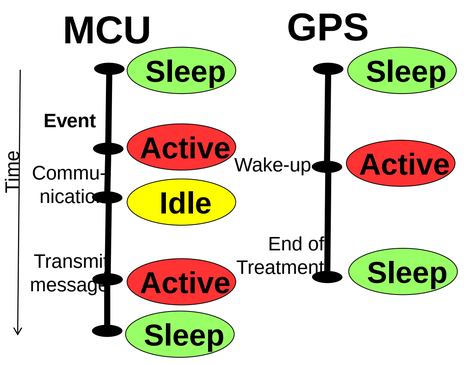
- Support primary and rechargeable batteries
- Low leakage current in sleep mode
- Low duty cycle activity
- Minimise peak current



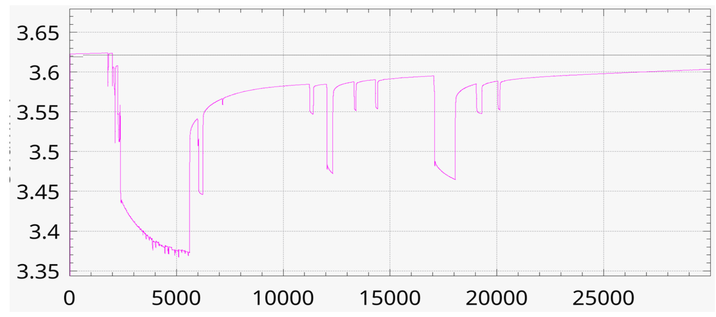
GENERIC AND DYNAMIC POWER MANAGEMENT



POWER MANAGEMENT USE CASE



PMU Use case

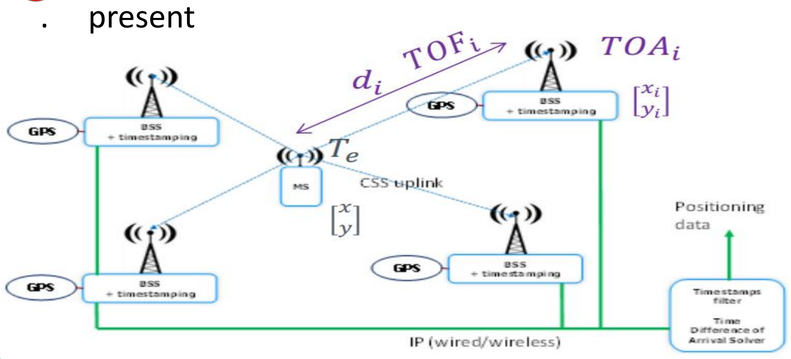


Primary battery supply voltage

Geolocation Technologies

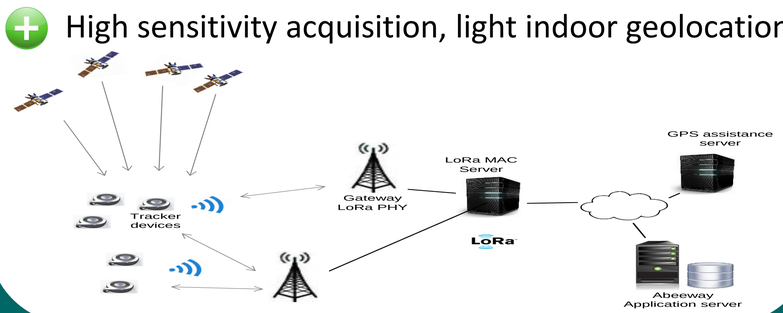
LORA GEOLOCATION

- **Cell triangulation based on RSSI**
  - ⊖ Simple but very poor accuracy
- **DTOA** (Differential Time Of Arrival)
  - Uplink received by a minimum of 3 gateways
  - Position calculates the difference in time of arrival of a tracker at multiple gateways yielding hyperbolic curves when device is situated
  - ⊕ Very low power solution
  - ⊖ Accuracy limited to 50-150m if multi-path is present



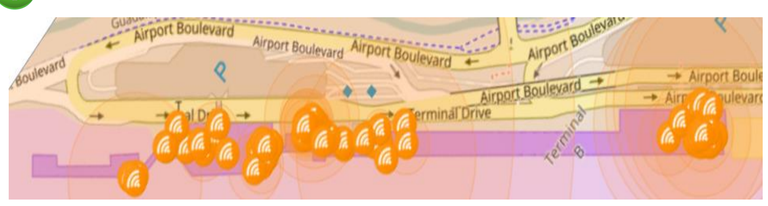
GPS/AGPS GEOLOCATION

- **GPS**
  - ⊕ 2 - 10 m accuracy solution for outdoor geolocation
  - ⊖ High power consumption at cold start : TTFF of 1 - 2 minutes
  - ⊖ Higher cost solution
- **A-GPS (Assisted GPS) for LPWAN network**
  - Collect raw data from a GPS front-end
  - Transmit raw data to GPS assisted server
  - Combined with satellite's trajectories to calculate position
  - ⊕ Low power solution TTFF<15sec
  - ⊕ High sensitivity acquisition, light indoor geolocation



INDOOR GEOLOCATION

- **Wi-Fi**
  - Listen to Wi-Fi Access Points to transmit nearby SSID and *Received Signal Strength (RSSI) to* the server
  - Search in database the position and return the most likely position based on signal strength.
  - ⊕ Simplicity and low cost implementation
  - ⊖ Limited accuracy depending on Wi-Fi hotspot density
- **Beacon fingerprint**
  - Transmit periodic radio signal with limited information content on a specified radio frequency
  - Notify nearby devices of their presence with RSSI to determine position based on trilateration algorithm.
  - ⊕ Accurate localization technique for short range
  - ⊕ Low power solution



Conclusion

Multi-mode Abeeway's tracker offers ubiquitous outdoor and indoor geolocalisation by associating the low power network-based location capability of LoRa technology with new AGPS techniques outside and Wi-Fi or BLE beacon technologies to provide precise location indoors