Empirical study of LoRaWan on the study case of Genova

Measure performance LoRaWan communication standard on packed cities and with moving end nodes

UNIVERSITÀ DEGLI STUDI
DI GENOVA

upna
Universidad
Pública de Navarra
Nafarroako
Unibertsitate Publikoa

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Bachelor's thesis for the Degree of Telecommunications Engineering: international variant

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LPWAN

Low-Power Wide-Area Network

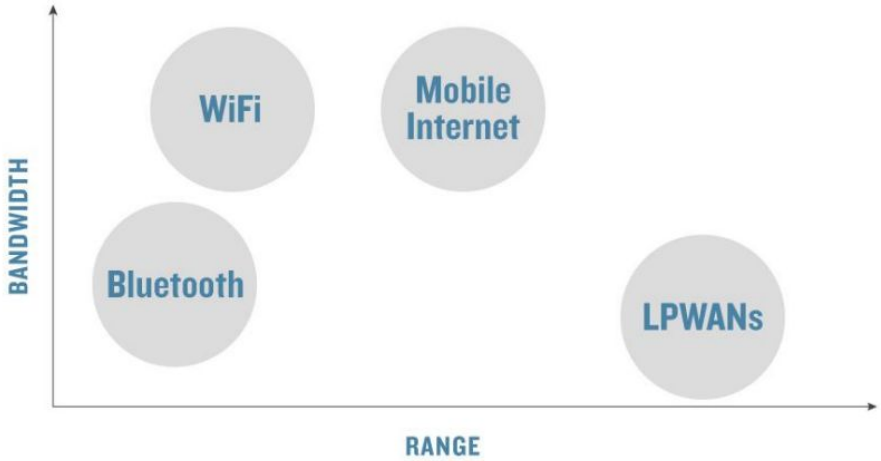
LTE-M

LoRaWAN

sigfox

Make Things Come Alive

NB-IoT

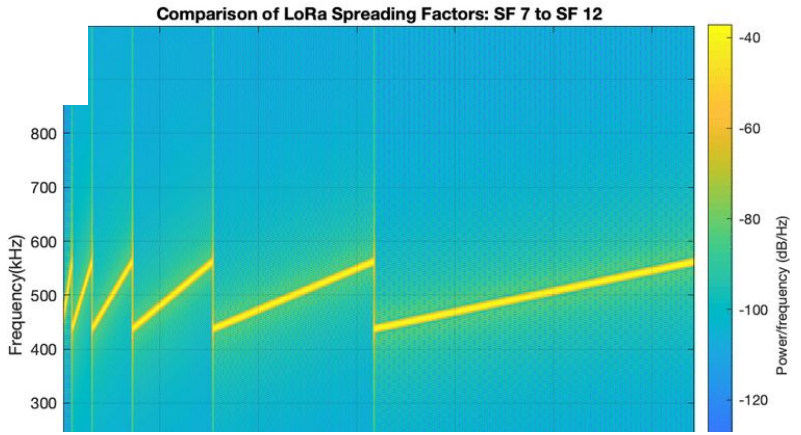


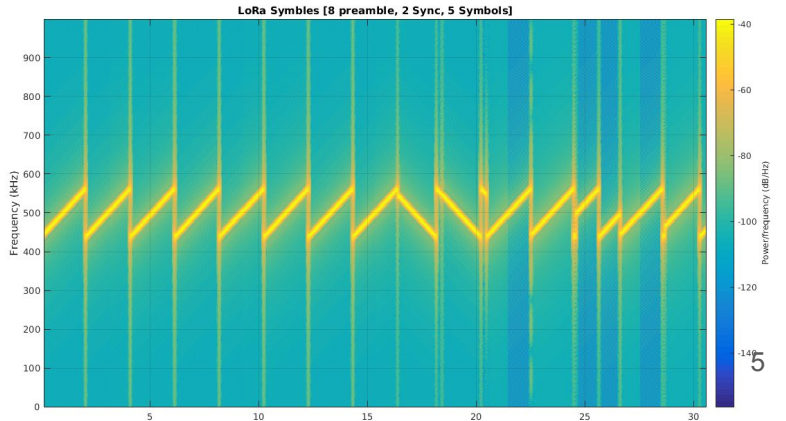
Frequency band depending on the region	
Region	Frequency (Mhz)
Asia	433
Europe	863-870
US	902-928
Australia	915-918
Canada	779-787
China	470-510

- **g** (863.0 – 868.0 MHz): 1%
- **g1** (868.0 – 868.6 MHz): 1%
- **g2** (868.7 – 869.2 MHz): 0.1%
- **g3** (869.4 – 869.65 MHz): 10%
- **g4** (869.7 – 870.0 MHz): 1%

Limit SNR by Spreading factor:

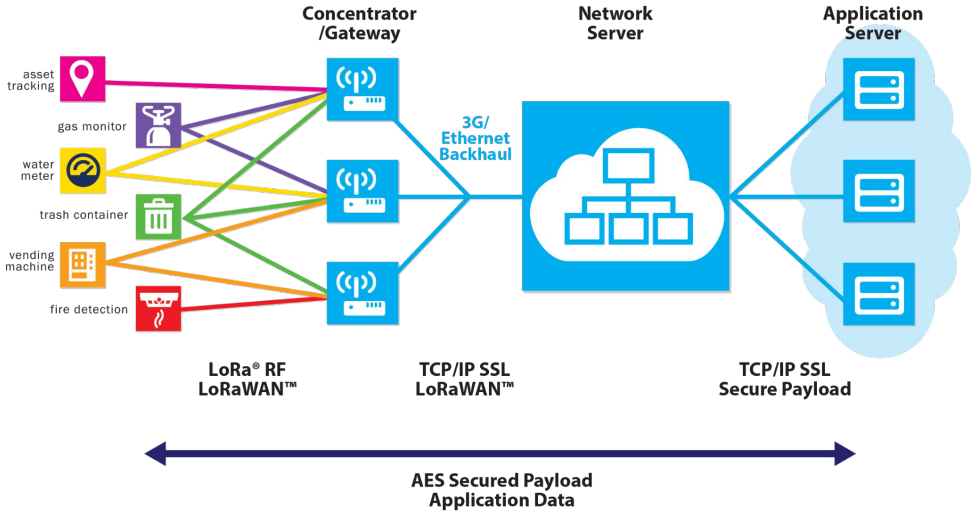
-20 + ((12 - SF#) * 2.5) [dB]

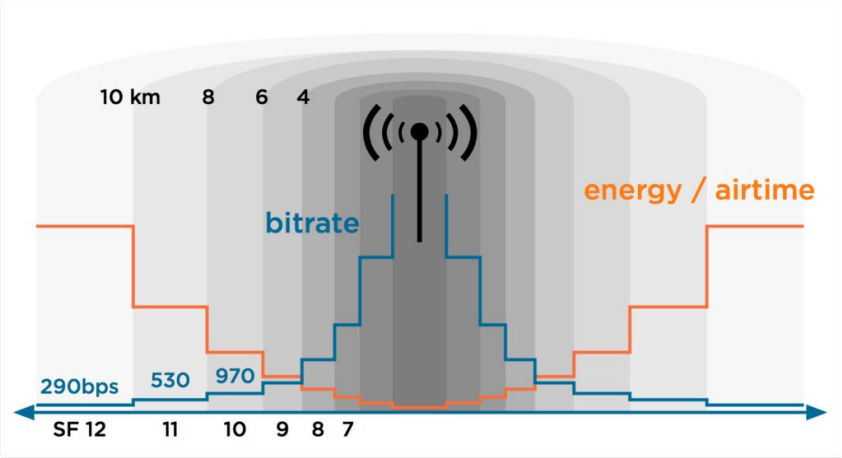




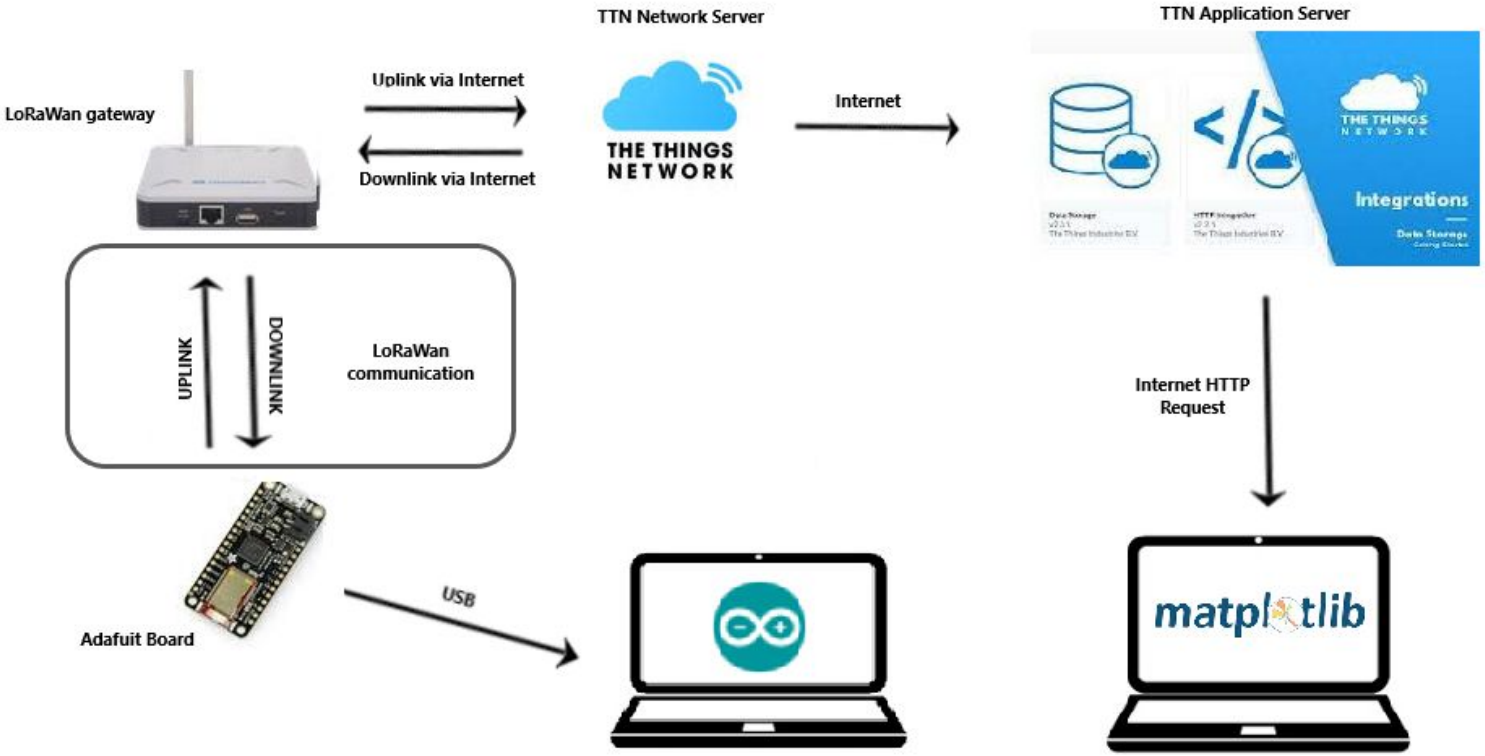
LoRaWAN®

THE THINGS NETWORK

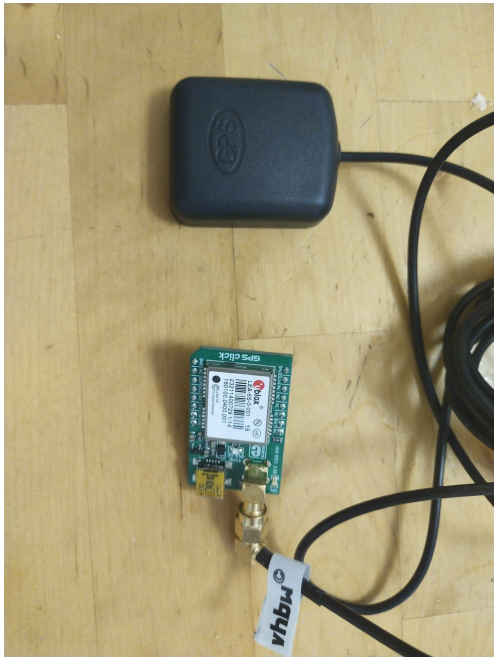




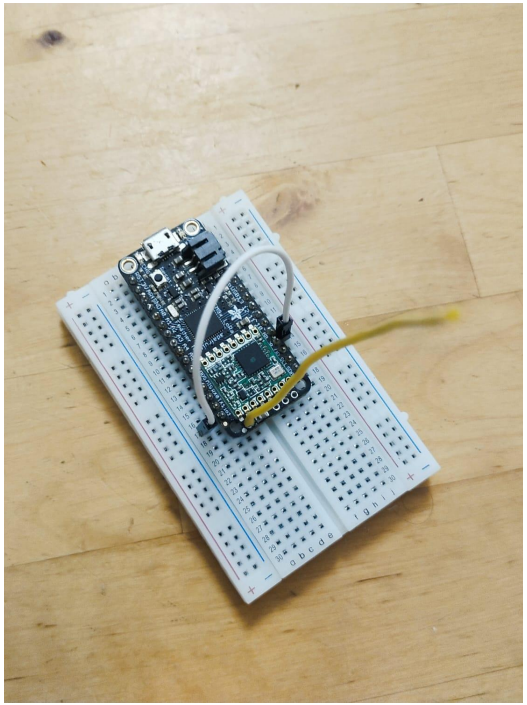
System architecture



Devices used



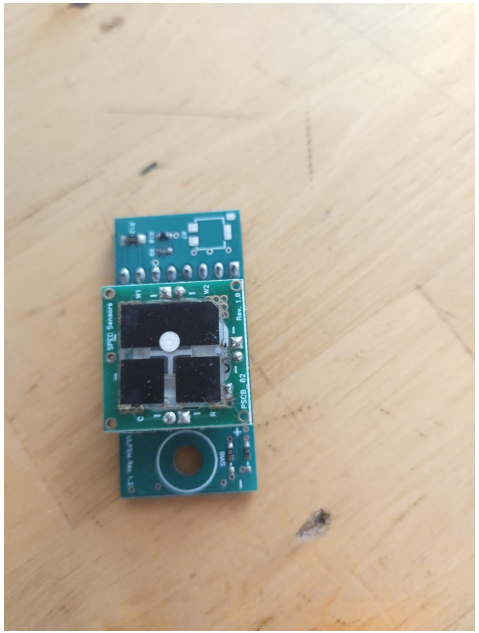
GPS module with the respective antenna



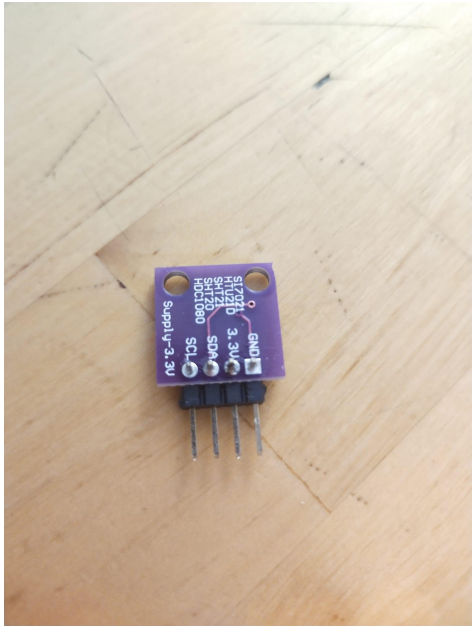
Adafuit feather m0 board

Dragino gateway

Devices used



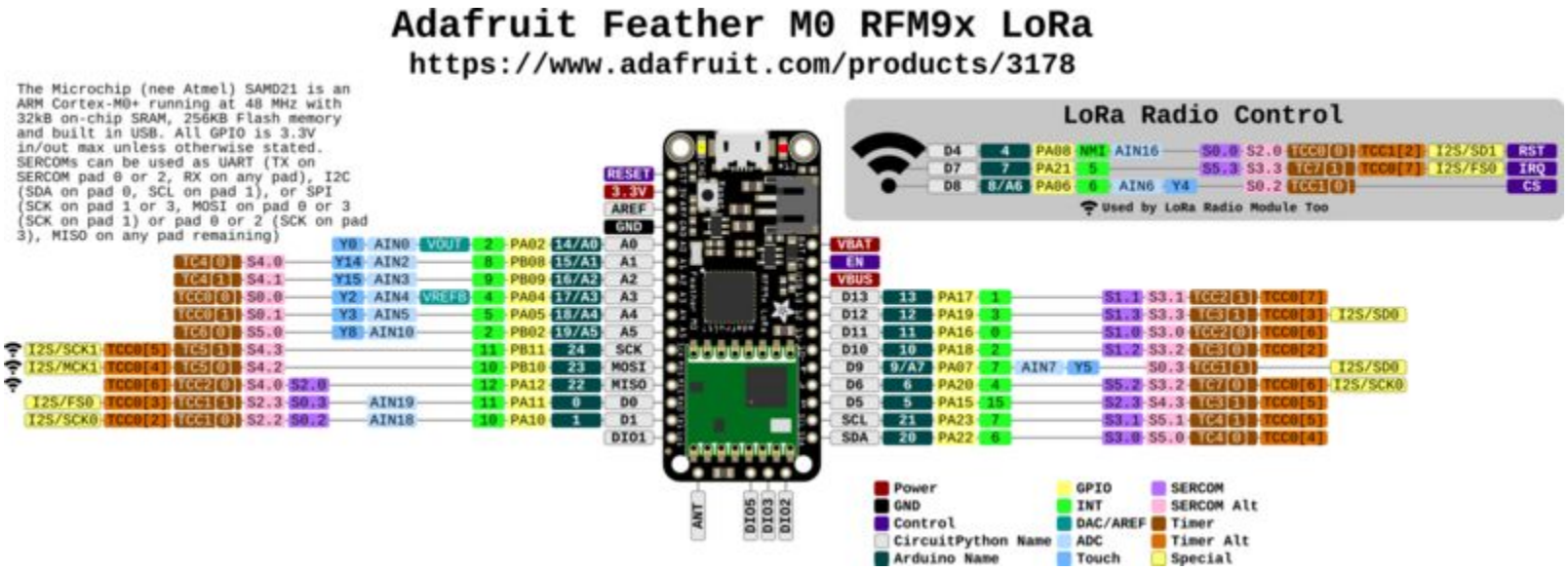
Air quality sensor



HDC1080 humidity and temp sensor

BME280 humidity, temp and pressure sensor

Adafruit pinout



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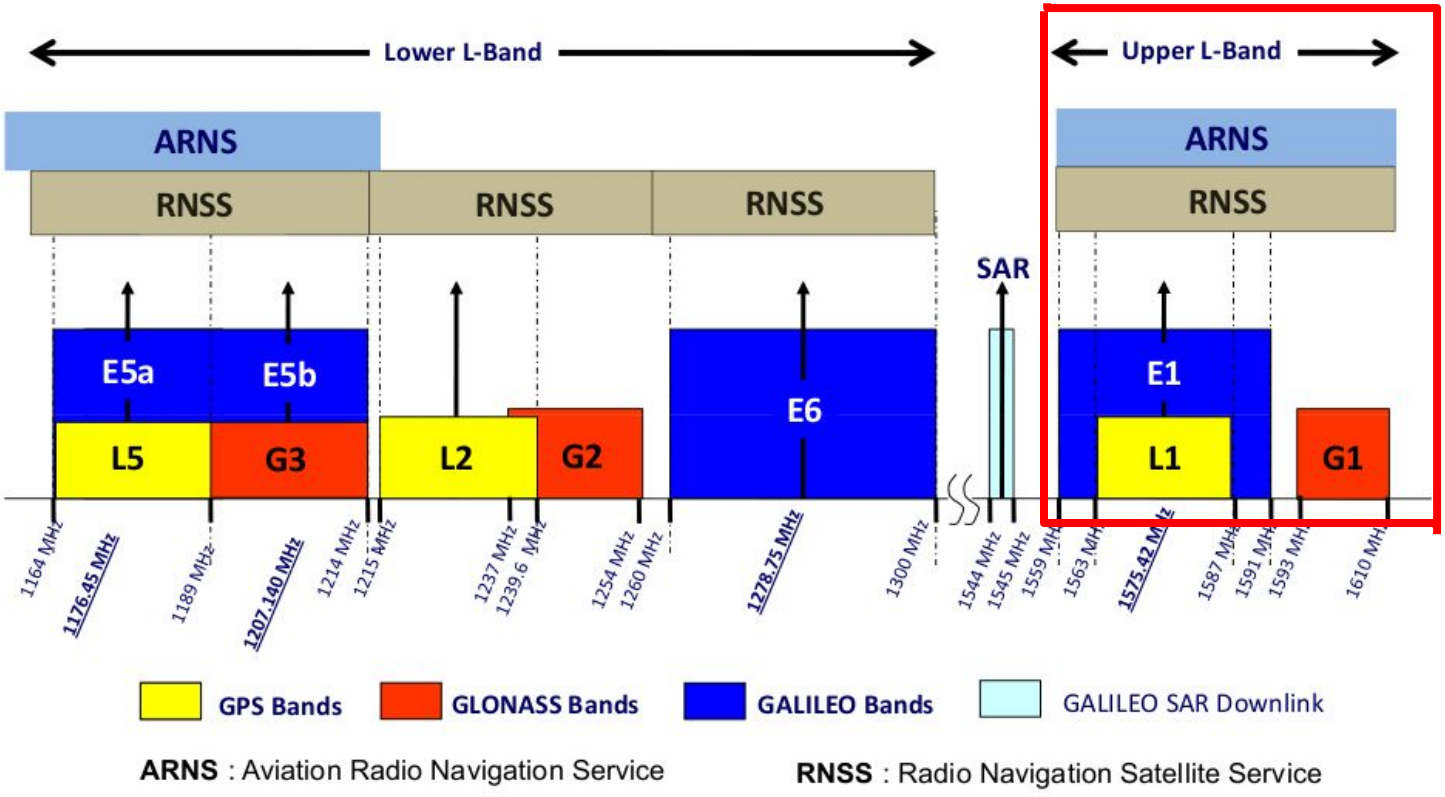
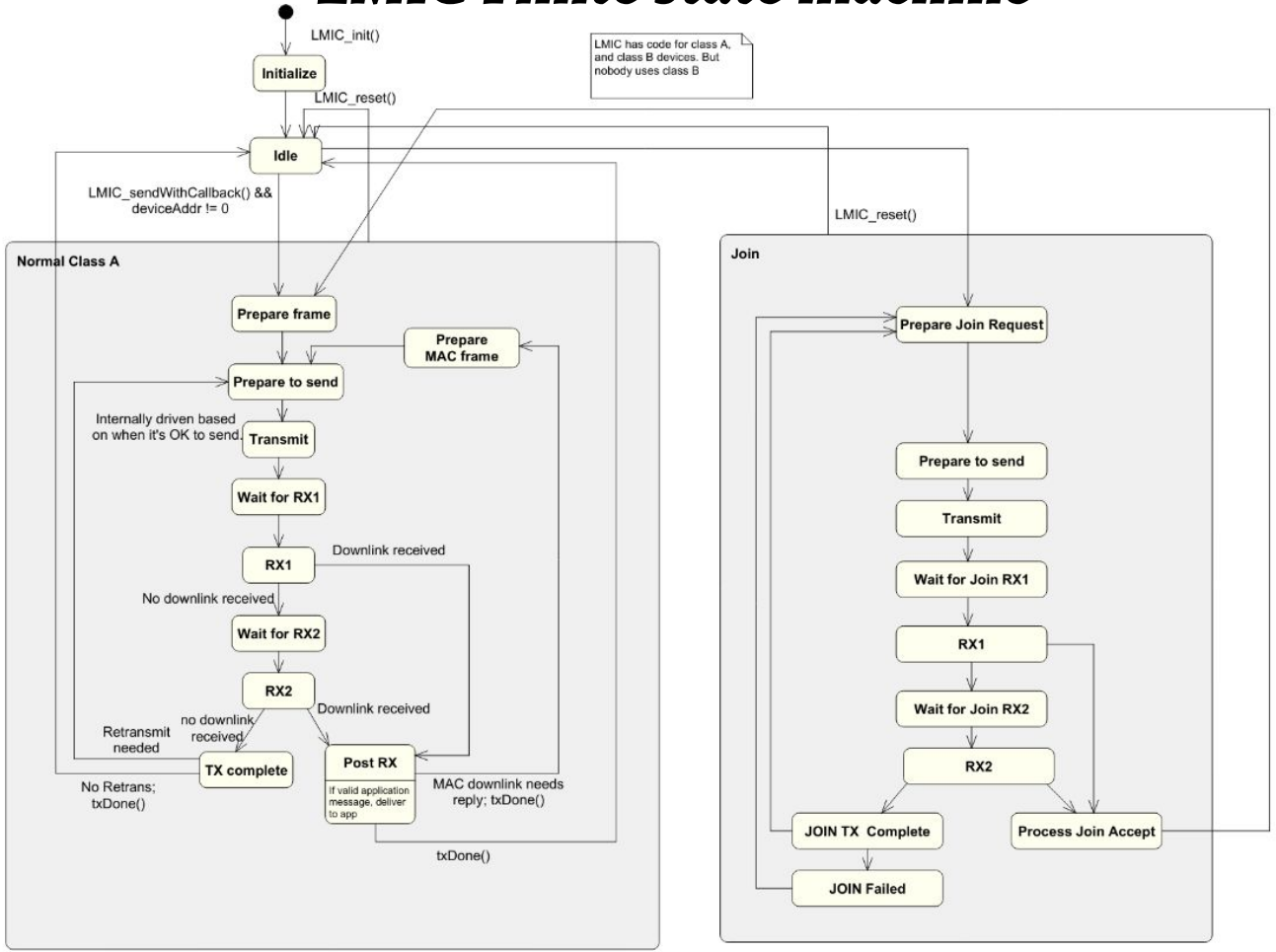
GPS frequency band



LMIC Finite state machine



Real application model

Experiment 1: Objectives and methodology

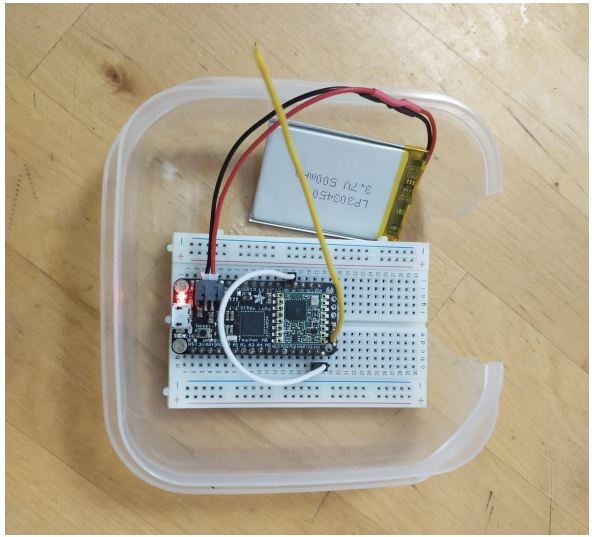
- Follow the same route with an end node with ADR disabled and enabled.

- Mode ADR disabled with SF10 and TX pow of 14dBm.

- Show that ADR for moving devices is not useful.

- Show the difference between the landscapes of the route

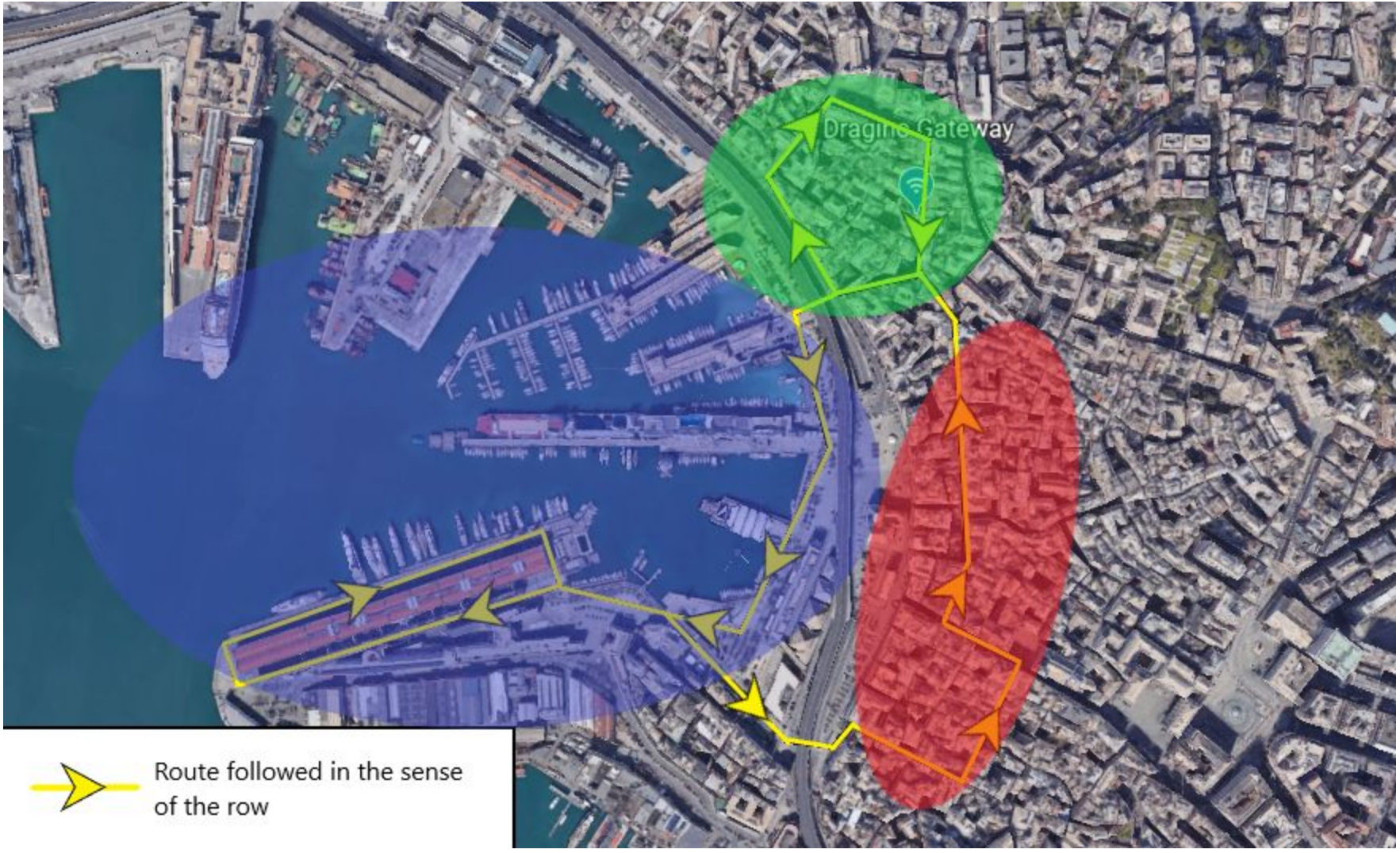
End device builded for experiment 1:



Divided zones and route

In the next slide the different zones are depicted with:

- Red for ‘vicoli’ area, with poor reception
- Blue for port area, where it approximates free space
- Green for OK reception, where we are near enough so that there are not enough buildings in between the end node and the gateway


Dragino Gateway
Route followed in the sense of the row

Results for experiment 1

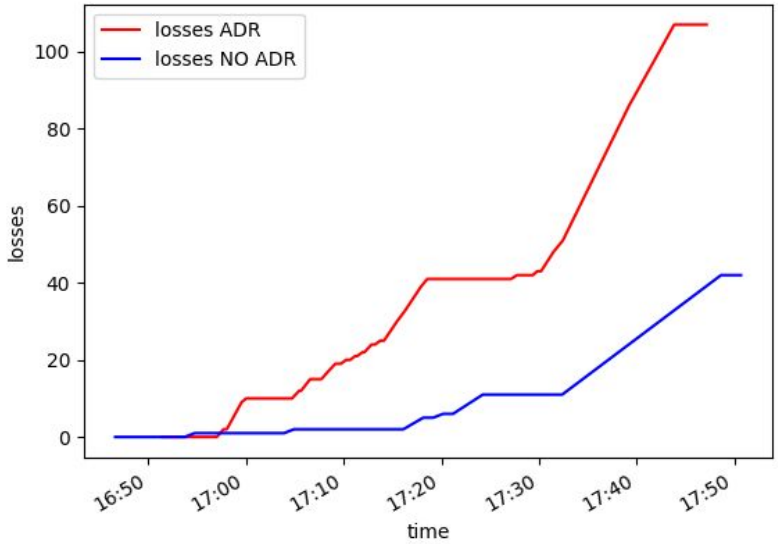
- ADR mode pointless as the SF was not changing from 7 because we were moving.

- Big differences in results between the different landscapes of Genova.

- Little difference between the two configuration as what was decing the results was the different areas inside the route we planned.

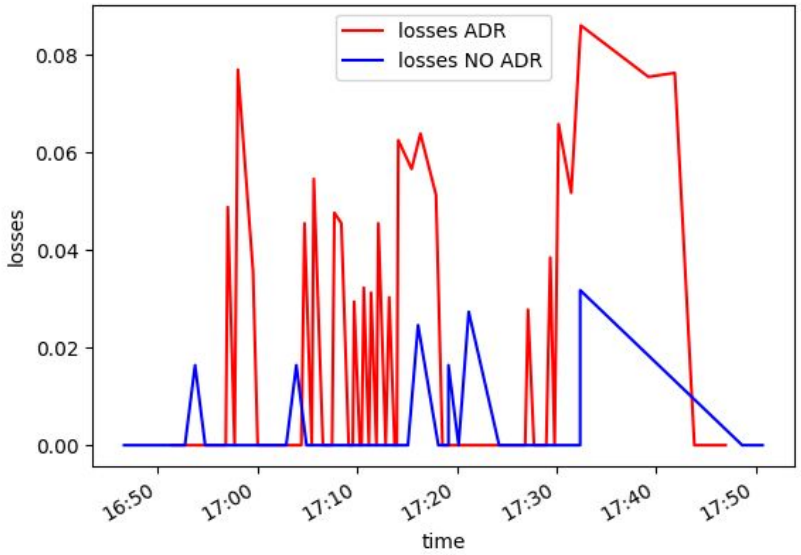
- Better performance with the ADR disabled as the SF was fixed in 10r.

Results for experiment 1 (Accumulative packet loss)



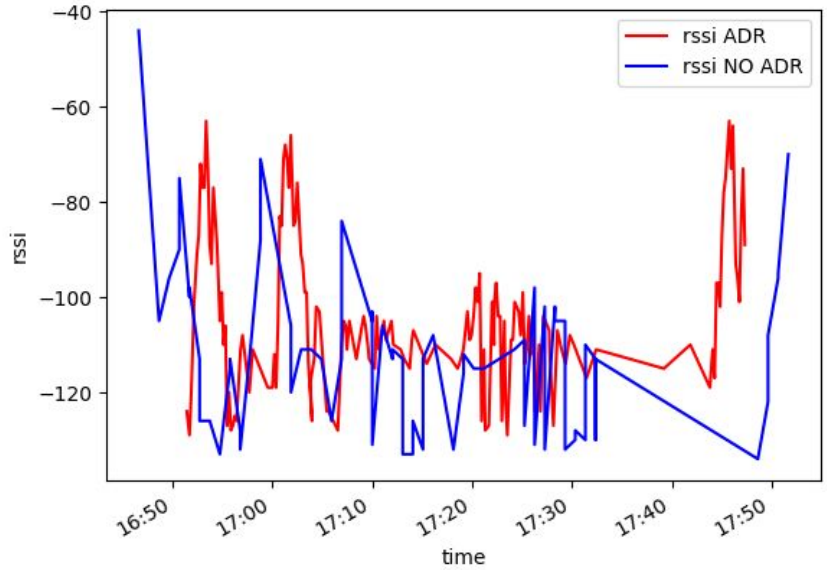
ED configuration	Packets sent	Packets received	Packet loss
ADR activated	263	156	40.68%
SF10 and 14 dBm	112	70	37.5%

Results for experiment 1 (Instant packet losses)



ED configuration	Packets sent	Packets received	Packet loss
ADR activated	263	156	40.68%
SF10 and 14 dBm	112	70	37.5%

Results for experiment 1 (SNR & RSSI)



ED configuration	Medium SNR (dB)	Medium RSSI (dBm)
ADR activated	2.07	-103.68
SF10 and 14 dBm	-2.11	-111.85

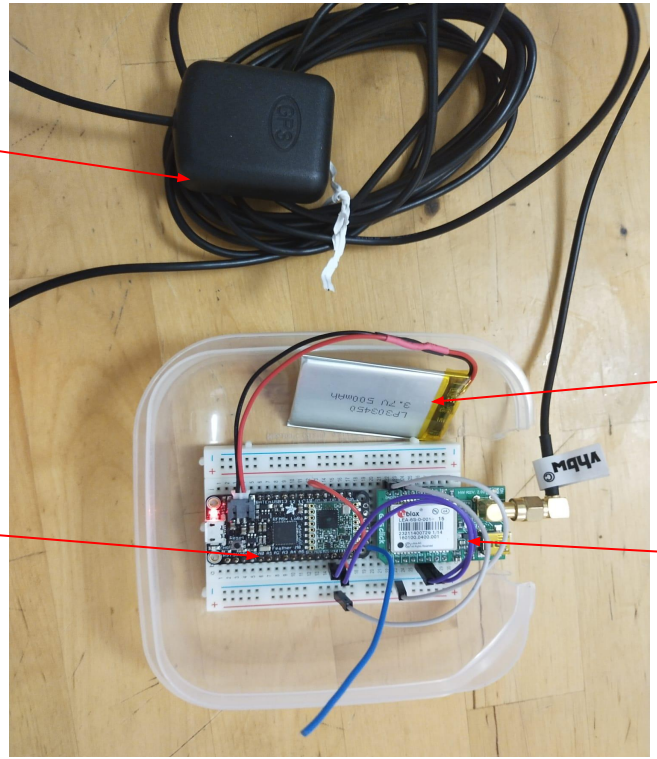
Experiment 2: Objectives and methodology

- Perform measurements in LoRaWan communication with a free mobile end device that sends its position thanks to a gps module.

- Show how different SF and tx power selected for the end node affects the communication for a mobile device.

- Further analyze the impact of the environment in the received signal over distance.

Experiment 2: End device built



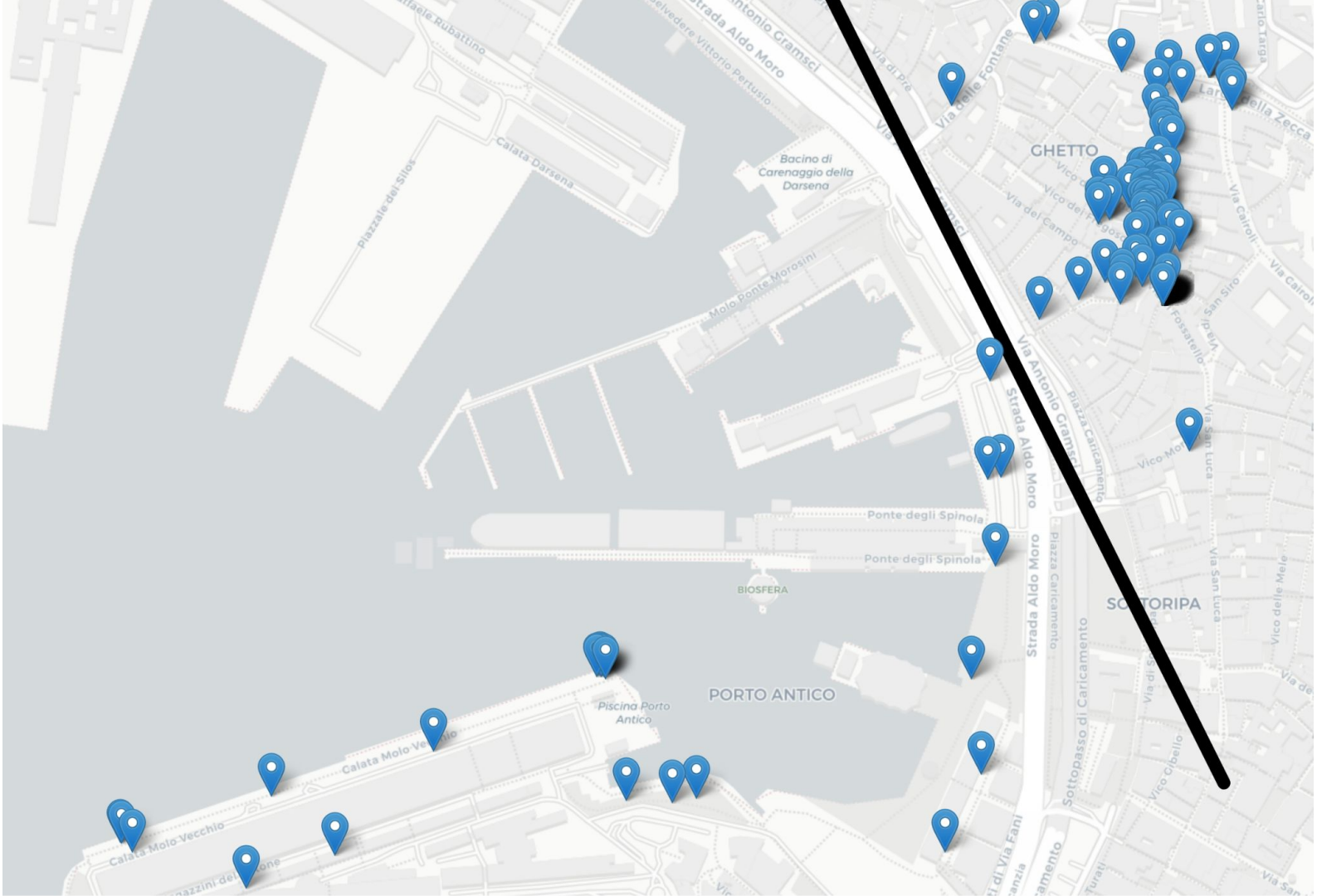
Results of experiment 2

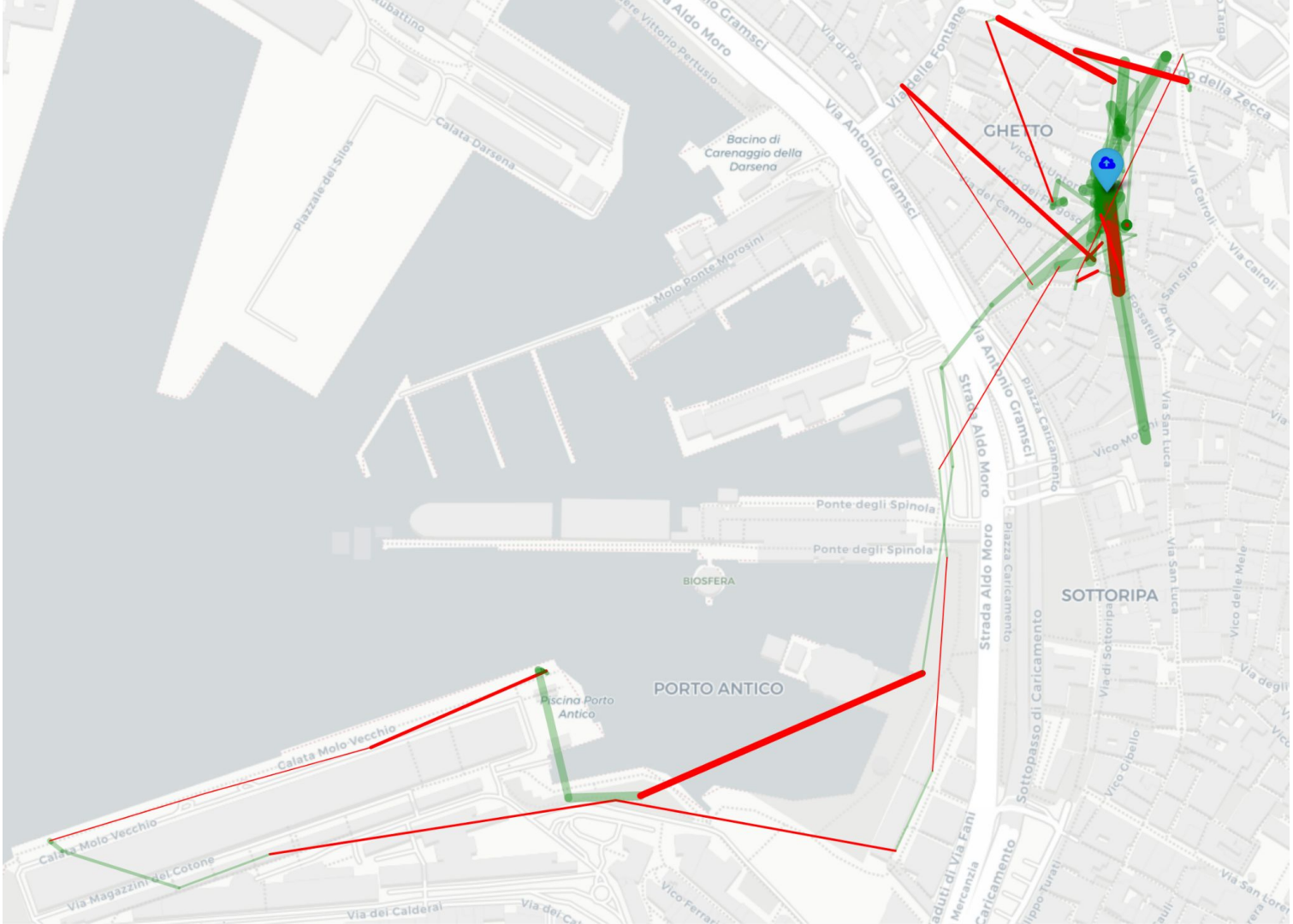
- Again the landscape in which we were measuring was the key factor for our LoRaWan communication.

- The map was divided in two areas, the ‘vicoli’ area and the port area.

- In the ‘vicoli’ area for small variations in distance the communication was lost.

- In the port area the results were easily correlated with the hypothesis but on the ‘vicoli’ area, due to the high variance of the scenery, the results were inconclusive.


GHETTO
PORTO ANTICO
SOTTORIPA
BIOSFERA
Piscina Porto Antico
Ponte degli Spinola
Ponte degli Spinola
Strada Aldo Moro
Strada Aldo Moro
Via Antonio Gramsci
Via Antonio Gramsci
Bacino di Carenaggio della Darsena
Calata Darsena
Molo Ponte Morosini
Piazzale dei Silos
Calata Molo Vecchio
Calata Molo Vecchio
Via delle Fontane
Via del Campo
Via Cairoli
Via San Luca
Vico delle Mele
Vico Cibello
Piazza Caricamento
Sottopasso di Caricamento
Via San Siro
Via Turati


GHETTO
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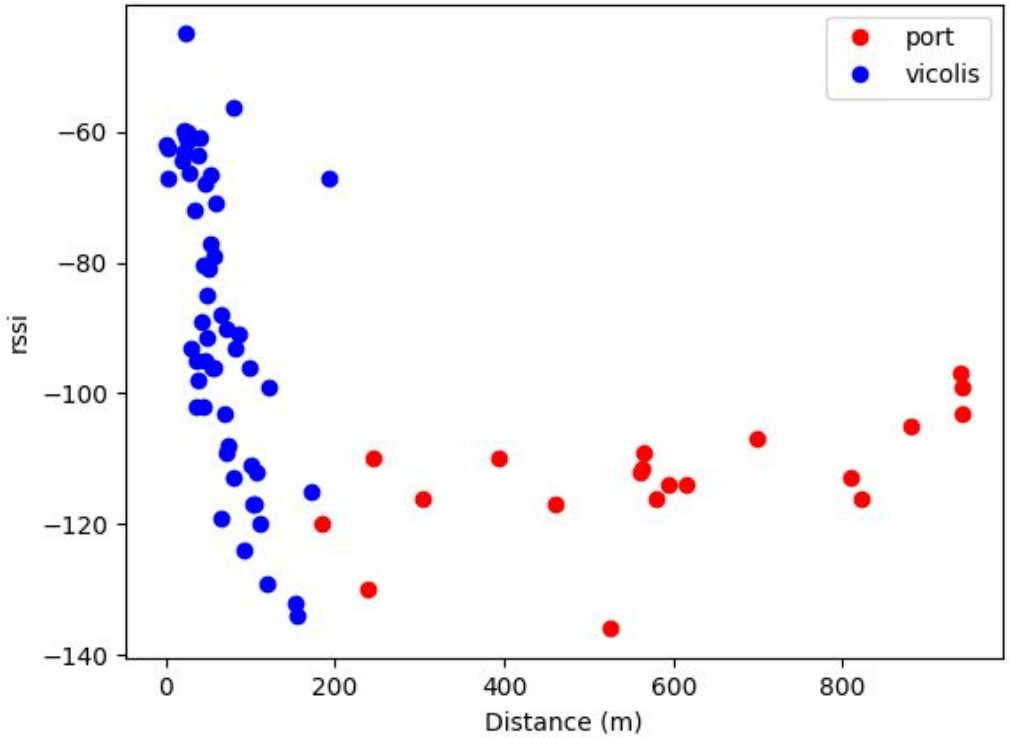
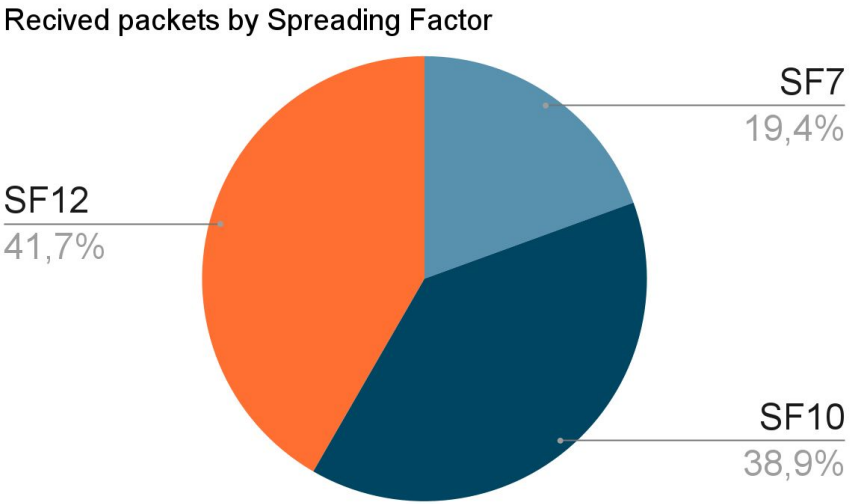
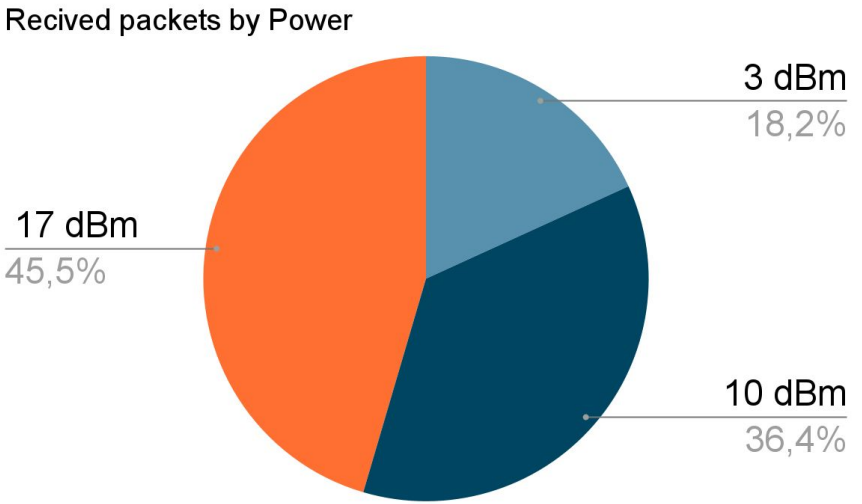
Calata Molo Vecchio
Calata Molo Vecchio
Via Magazzini del Cotone
Via dei Calderai
Bacino di Carenaggio della Darsena
Calata Darsena
Piazzale dei Silos
Molo Ponte Morosini
Via delle Fontane
Via di Pra
Via Cairoli
Via San Luca
Vico delle Mele
Vico Cibello
Sottopasso di Caricamento
Piazza Caricamento
Via di Sottoripa
Via San Siro
Via Fani
Via Mercanzia

Results for experiment 2: RSSI for received packets

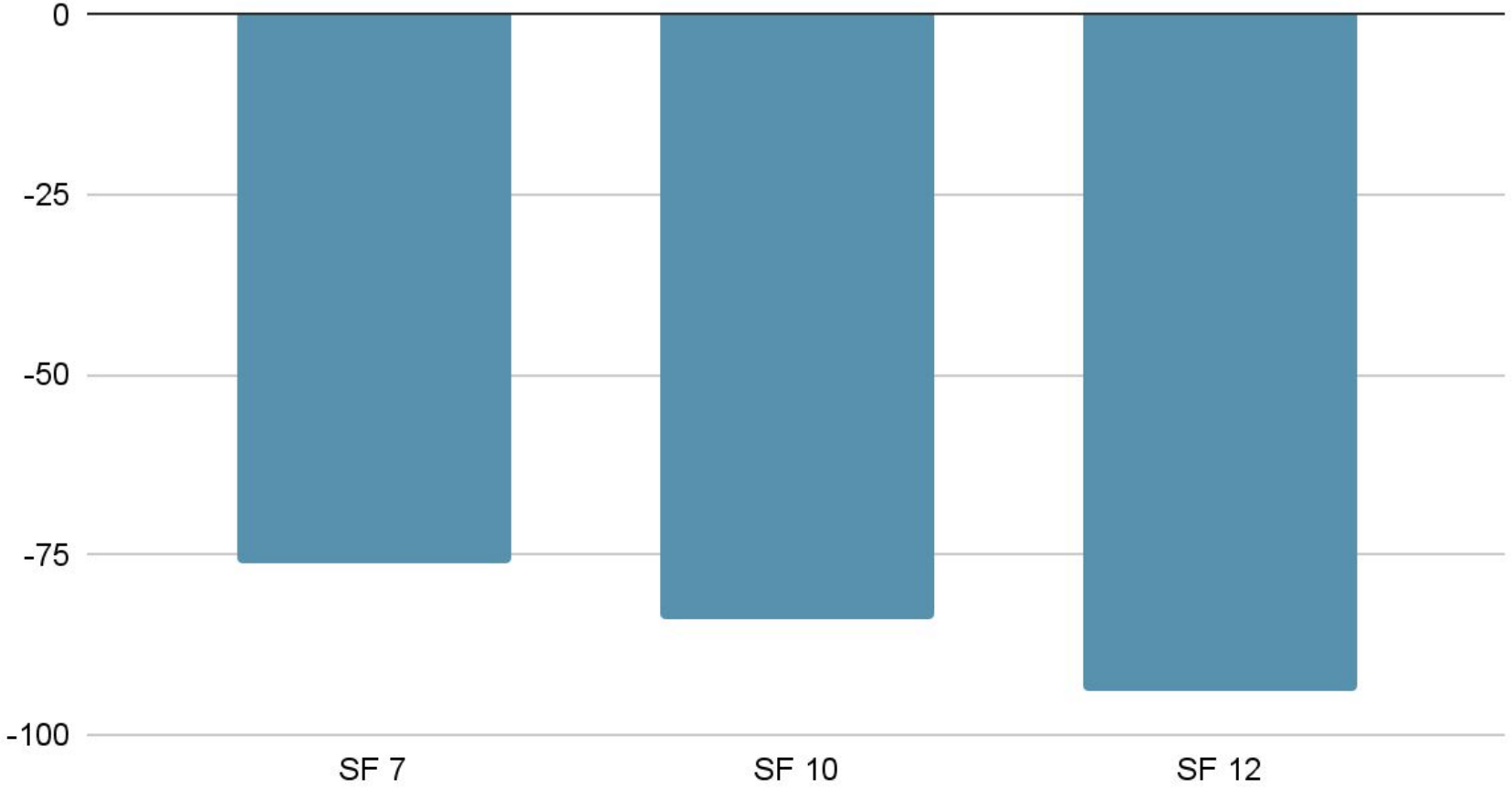


Results for experiment 2: Packets received for different SF and Tx power in the port area





Mean RSSI Port Area



Final conclusion

- The results of this work show that the most relevant factor for LoRa communication is the landscape between the gateway and the end node.
- There exists a huge difference depending on the area your end device is sending information for a mobile end node application in a complex urban area.
- The less obstacles in the “direct vision” path, the better.
- The ADR for mobile cases is useless
- For open-space scenarios, with little data we were able to prove the hypothesis, but for the packed city scenario, much more data is needed and a better model of reality is needed

Thanks for watching