LoRa in a haystack: a study of the LoRa signal behavior

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LPWANs and LoRA

LPWANs → Long range & low energy consumption BUT low data rate

LoRa → Semtech Long Range technology

Chirp Spread Spectrum

Sub-GHz frequency

Spreading factors → trade-off between range and data rate

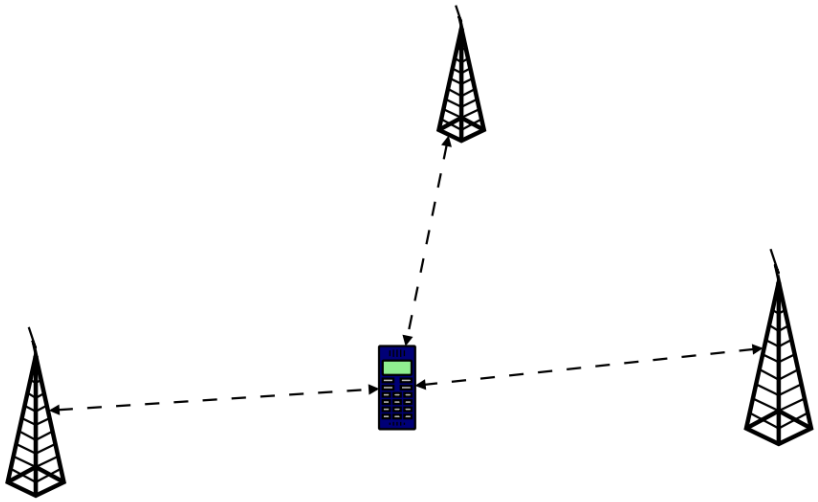
https://www.semtech.com/uploads/images/LoRa_Overview_Applications.png

LoRa for geolocation

Time Difference of Arrival

Very inaccurate (from meters to kilometers errors)

Accuracy can improve with math magic
→ but cost more energy



Motivations

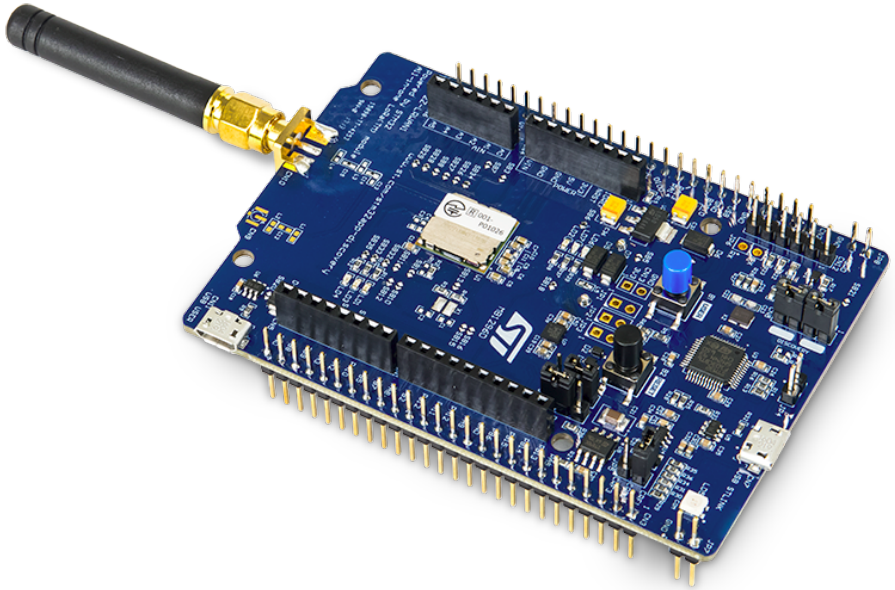
Why inaccurate? Stability of the signal?

→ study LoRa signal characteristics in relation to the environment

→ study LoRa signal under mobility

→ in field experiments

System setup



https://www.st.com/en/evaluation-tools/b-l072z-lrwan1.html

B-L072Z-LRWAN1 LORA®/Sigfox TM discovery kit

Two devices (no gateway → P2P)

Firmware → ping pong

No line of sight in scenarios!

Parameter	Values
Spreading factor	[7, 8, 9, 10, 11, 12]
Bandwidth	[125, 250] kHz
Coding rate	4/5
Transmission power	+14 dBm
Carrier frequency	868.1 MHz
Payload size	32 bytes

First scenario

Peri-urban environment

Static devices (~122.5 m)

Signal goes through the building

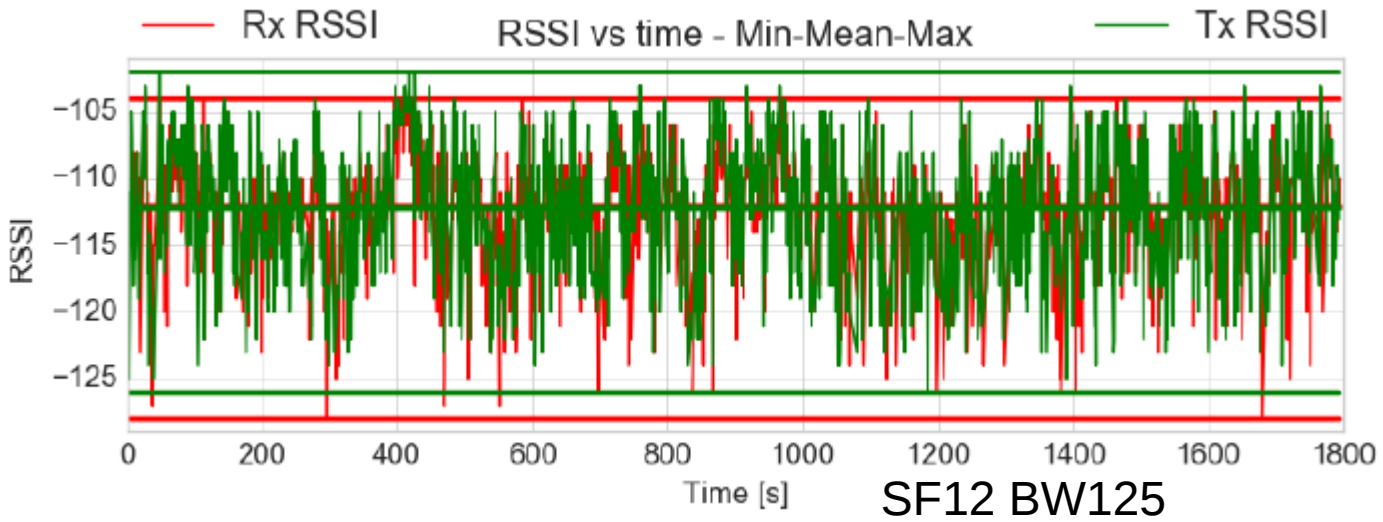
First scenario: results

Independently of spreading factor and bandwidth:

- « stable » RSSI

- small variance

→ good for geolocation



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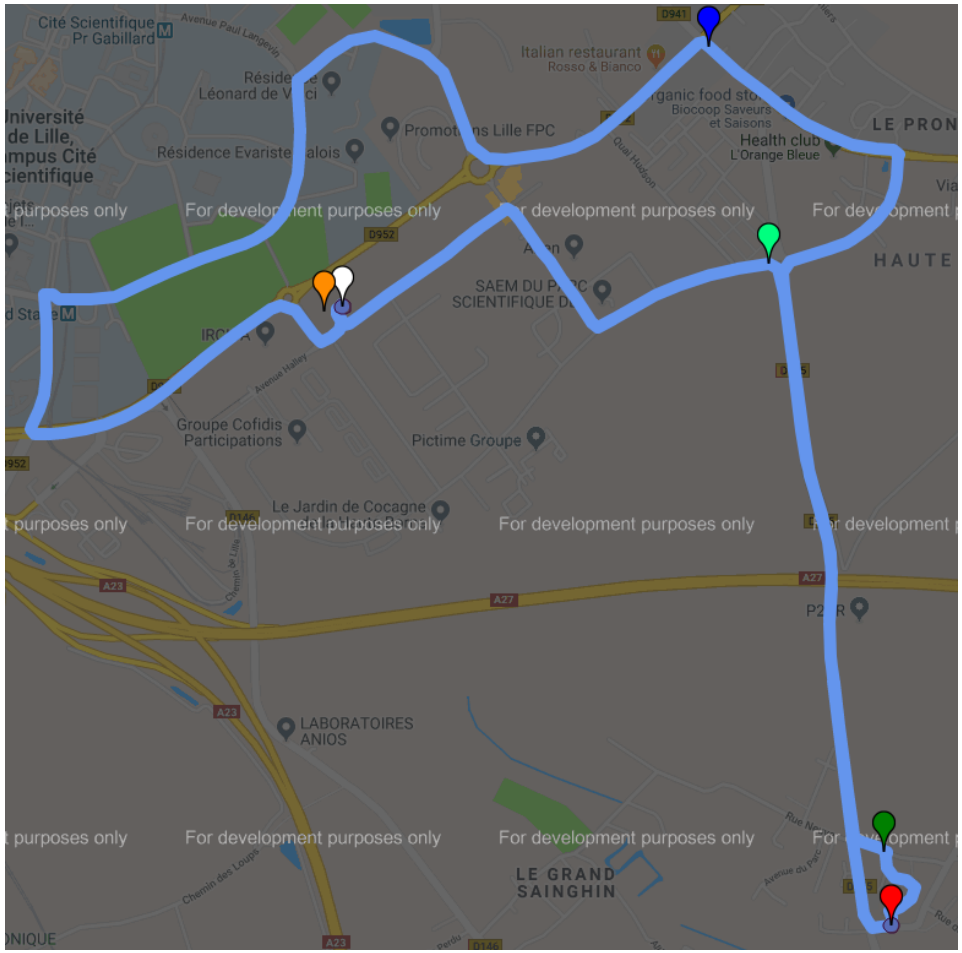
Second scenario

Peri-urban environment

One static device, one mobile device (in car)

Car speed ~30-90 km/h

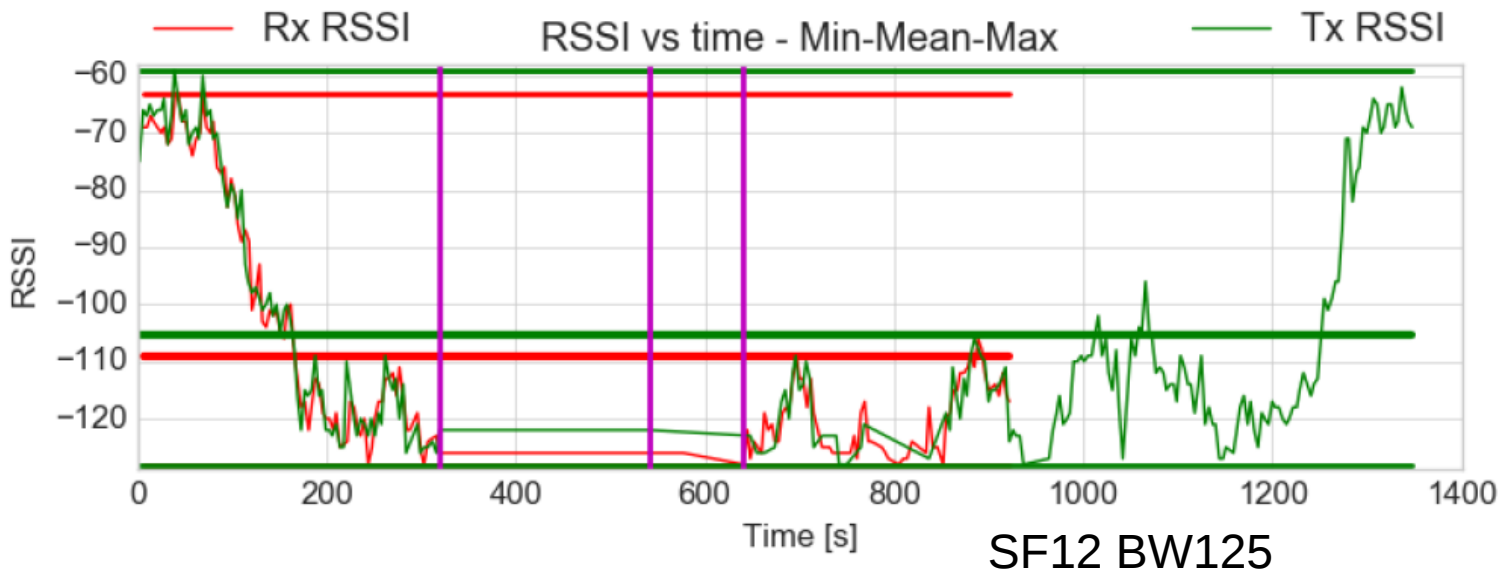


Second scenario: results

Distance increase → RSSI decrease

Three phases: symmetric → asymmetric (cut) → symmetric

Max symmetric communication distance → 1.12 km

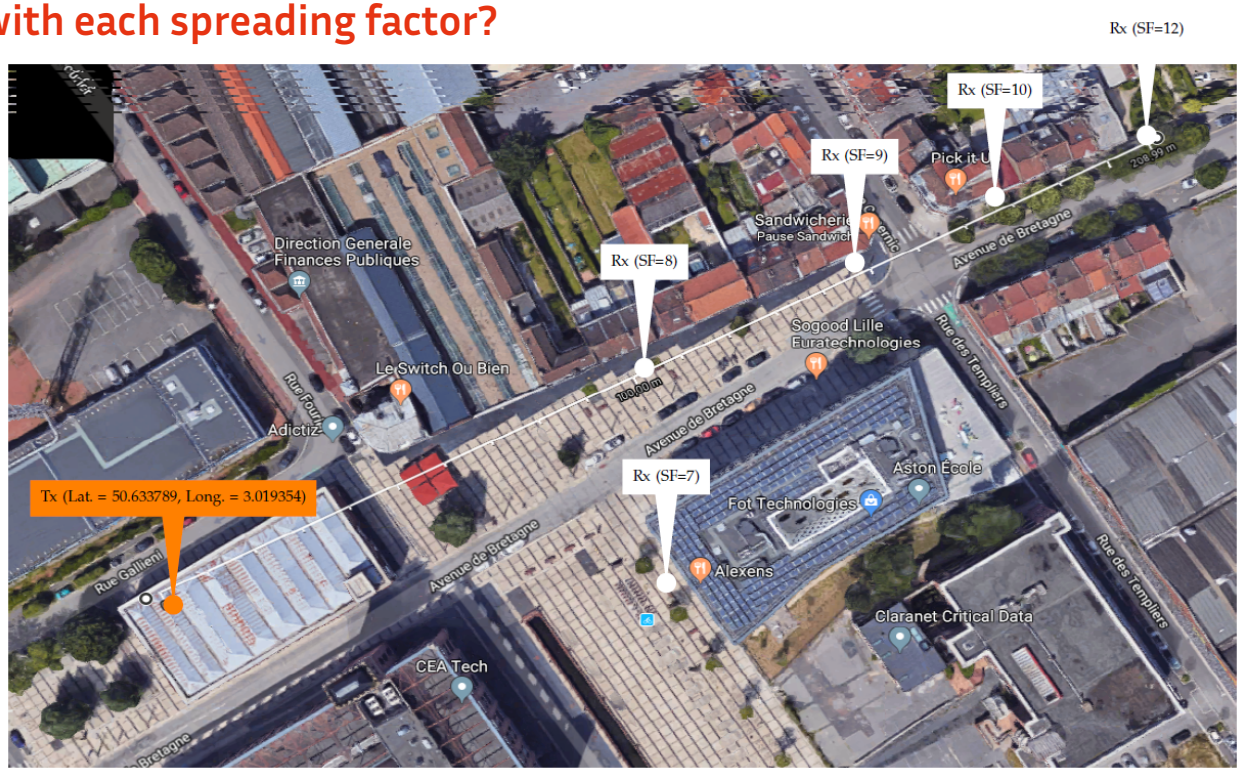


SF12 BW125

Third scenario

Dense urban environment

How far can we go with each spreading factor?

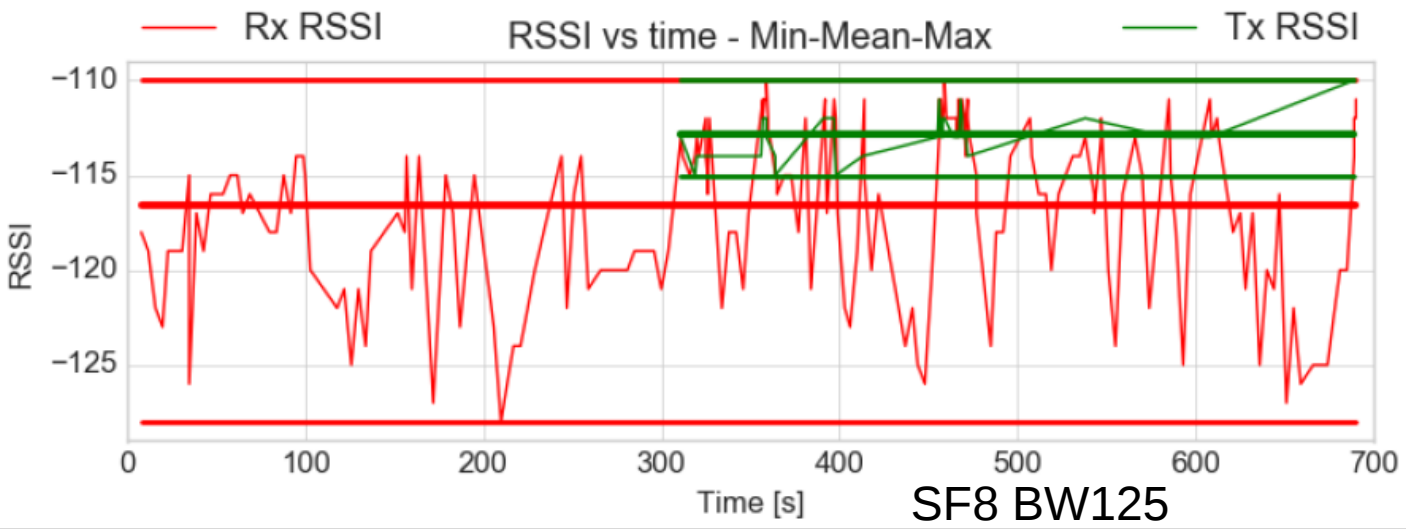


Third scenario: results

Assymetric signals (greater bandwith → more assymetric)

Max distance →

SF	7	8	9	10	11	12
Range (m)	104.22	122.91	164.98	184.49	208.30	208.96



SF8 BW125

Takeaways

- P2P LoRa & no line of sight → greatly reduce max range
- Moderate speed (40km/h) is OK
- High speed (90km/h) is not!
- LoRa signal stability highly depends on the environment
- Rural more stable than urban → less obstacles & less movement

→ Future work: further investigate the impact of the environment (e.g. air humidity, pressure, etc.) on LoRa performance

Thank you for your attention!

Any question?

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