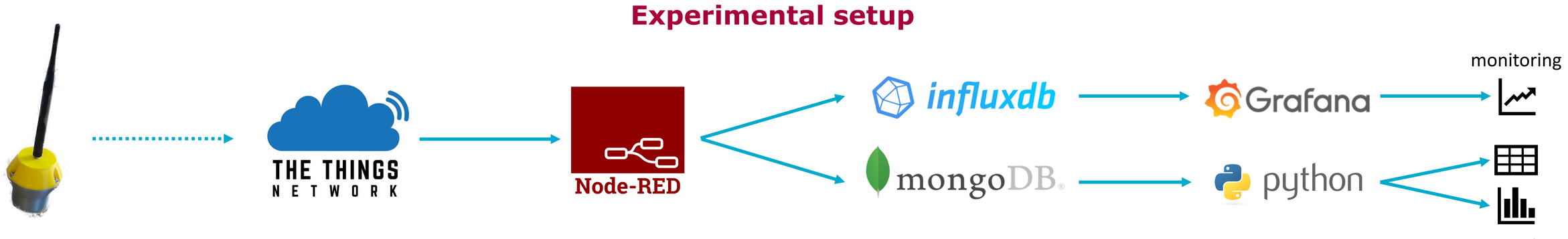
Experimental setup to monitor environment impact on LoRa

François Roland[1], Nikola Jovicic[1], Olivier Debauche[2], Sébastien Bette[1], Véronique Moeyaert[1]
[1] Electromagnetism & Telecom Department, University of Mons; [2] Computer Sciences Department, University of Mons

Experimental setup



Modulation	LoRa
TX power	14 dBm
Bandwidth	125 kHz
Coding rate	4/5
Preamble	8 symbols
Payload	5 bytes
Frequency	867.1-868.5 MHz
TX rate	6 frames/h

Figure 1: LoRa transmission parameters

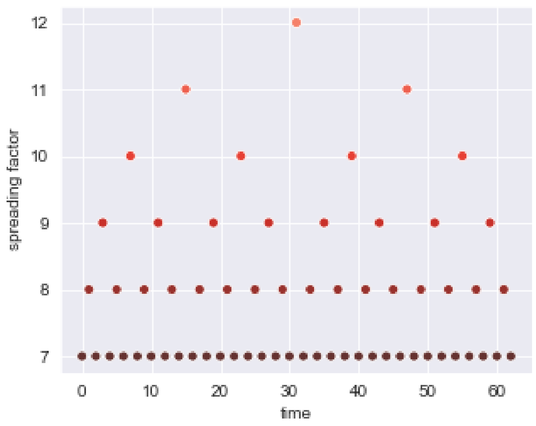


Figure 2: Spreading Factor sequence

Eight LoPy modules were deployed in different locations of the city of Mons, Belgium. They emitted 1 packet every 10 minutes. These were relayed by a LoRa gateway to TheThingsNetwork (TTN), a free LoRaWAN infrastructure.
Spreading factor is modulated over time according to the pattern of figure 2.
The packet payload and metadata are retrieved by a Node-RED server and stored in 2 databases:

- InfluxDB which is then used to produce Grafana monitoring dashboards;
- mongoDB which stores raw data to generate reports using python scripts.

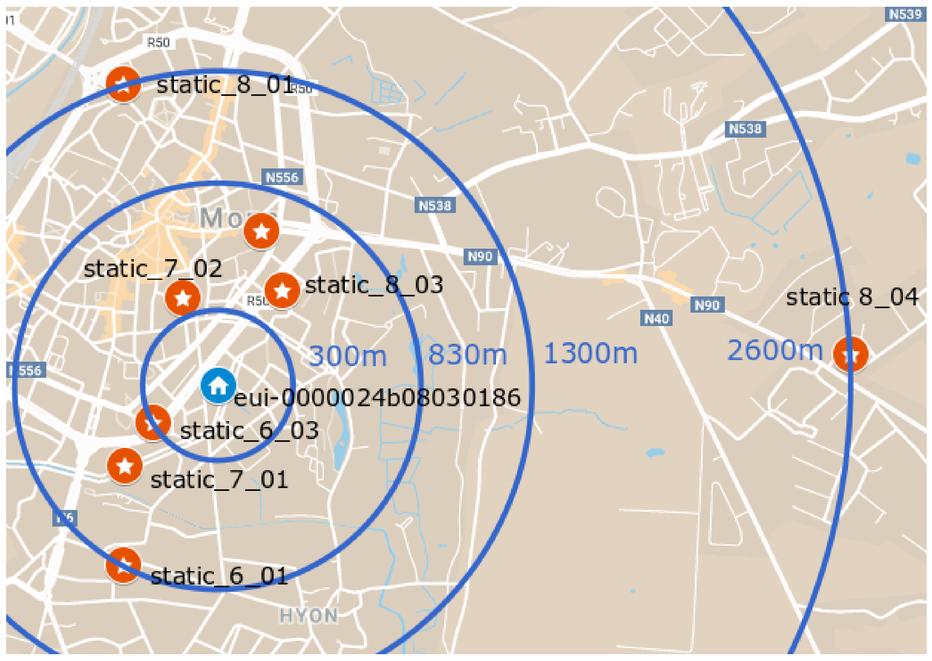


Figure 3: Device deployment map

Results

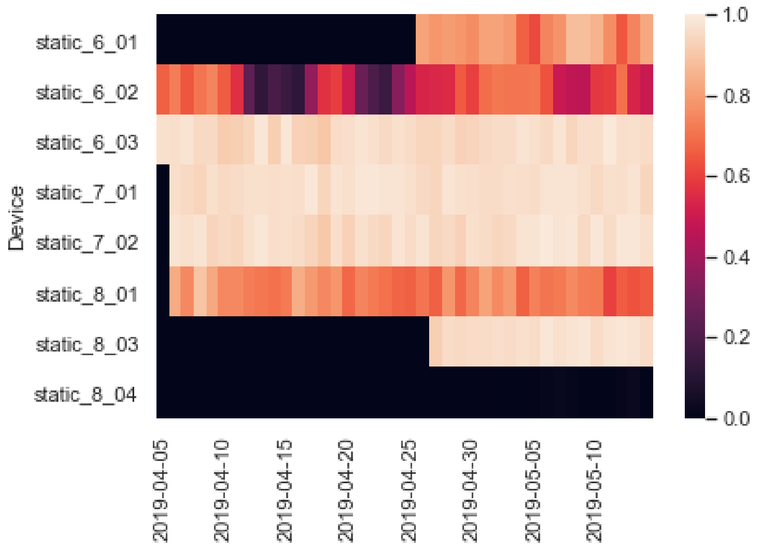


Figure 4: Daily packet delivery rate by device

The difference between devices observed in figure 4 can partially be explained by the distance to the gateway (figure 3). But unlike [4], there remain variations to be explained.

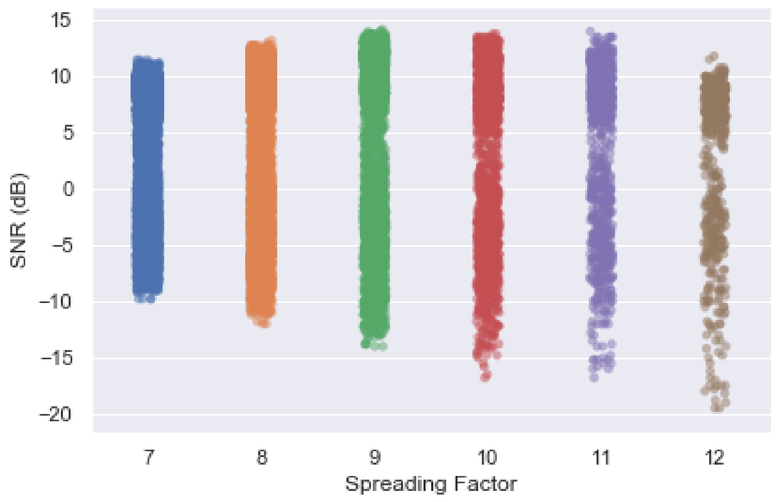


Figure 5: SNR distribution by spreading factor

Figure 5 exhibits the expected LoRa behavior: higher spreading factors allow successful transmission with lower SNR as stated in [3].

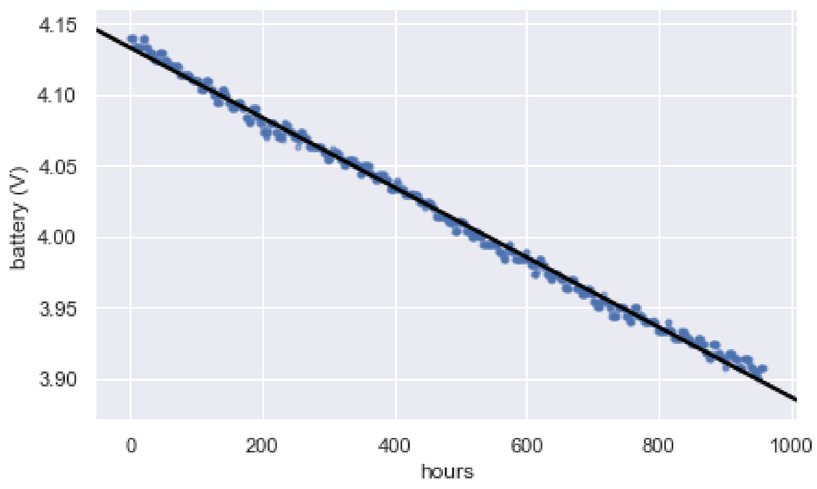


Figure 6: Energy consumption

The device energy consumption can be estimated using figure 6 to about 3400 hours (~140 days).

Conclusion

The monitoring dashboard provided by InfluxDB and Grafana offers a useful insight to drive the experiment without high maintenance cost.

Modulating the spreading factor allows the device to send more packets while respecting the 30 sec / 24 h maximum airtime of the fair access policy of TheThingsNetwork [1] as computed thanks to [2]. It also lowers the collision risk as a byproduct.

The experimental setup behaves as expected and provide enough variations to investigate the environmental impact on the transmission.

The energy consumption is low enough to gather data for 4 months without interruption.

Future work

Now that the experimental setup is validated, collected data will be analyzed, looking for correlations with environmental factors (temperature, relative humidity, rain, ...)

References

[1] “TheThingsNetwork fair access policy.” [Online]. Available: https://forum.thethingsnetwork.org/t/limitations-data-rate-packet-size-30-seconds-day-fair-access-policy-nodes-per-gateway/1300.
[2] Arjan, “LoRaWAN 1.0.x airtime calculator,” 2019. [Online]. Available: https://avbentem.github.io/lorawan-airtime-ui/ttn/eu868/5.
[3] A. Augustin, J. Yi, T. Clausen, and W. M. Townsley, “A study of Lora: Long range & low power networks for the internet of things,” *Sensors (Switzerland)*, vol. 16, no. 9, pp. 1–18, 2016.
[4] J. Gaelens, P. Van Torre, J. Verhaevert, and H. Rogier, “Lora mobile-to-base-station channel characterization in the antarctic,” *Sensors (Switzerland)*, vol. 17, no. 8, 2017.

Acknowledgments

The mobile device packaging was designed and printed at FabLab Mons.

Fab-IoT-Lab is supported by the European Regional Development Fund and the Wallonia in the framework of the DigiSTORM project.

University of Mons
francois.roland@umons.ac.be
+32 65 375059