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Extending LPWAN Architectures with Heterogeneous Mesh Networks. The Challenge.

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Extending LPWAN Architectures with Heterogeneous Mesh Networks. The Challenge.

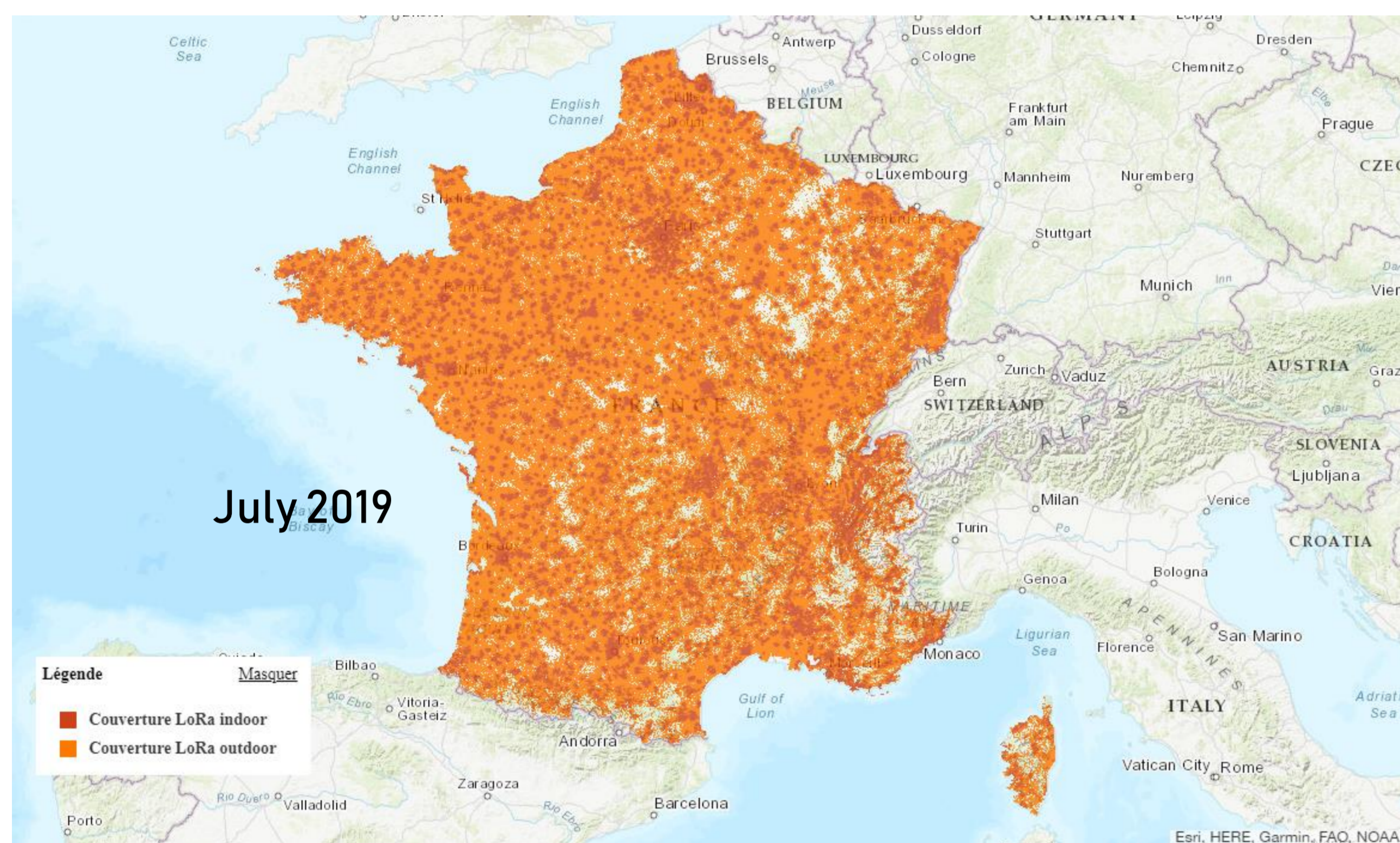
Mina Rady (Orange Labs). Supervised by Dominique Barthel, Quentin Lampin (Orange Labs), and Thomas Watteyne (INRIA Paris).

The Context

- One of the challenges faced by LPWANs today is hard to reach areas, for example:
 - Smart Meters (with the CE M/441 mandate)
 - Parking lot sensors
- Current network architecture is closer to Aloha style protocols via Gateways used to create hotspots with high-throughput back-haul such Ethernet, WiFi, or 3GPP. Such scheme faces three challenges:

I. Towards Extreme Coverage

- Orange has an infrastructure for LoRaWAN coverage across France.
- In **urban** scenarios, deep indoor nodes such as smart meters or parking sensors are difficult to reach, despite existing coverage from outdoor gateways.
- In **suburban** or agricultural scenarios, some land spaces outside of the cities are out of coverage.
- First sub-conclusion:** more pervasive coverage is needed.



Orange LoRa coverage in France.

<https://www.orange-business.com/fr/reseau-iot>



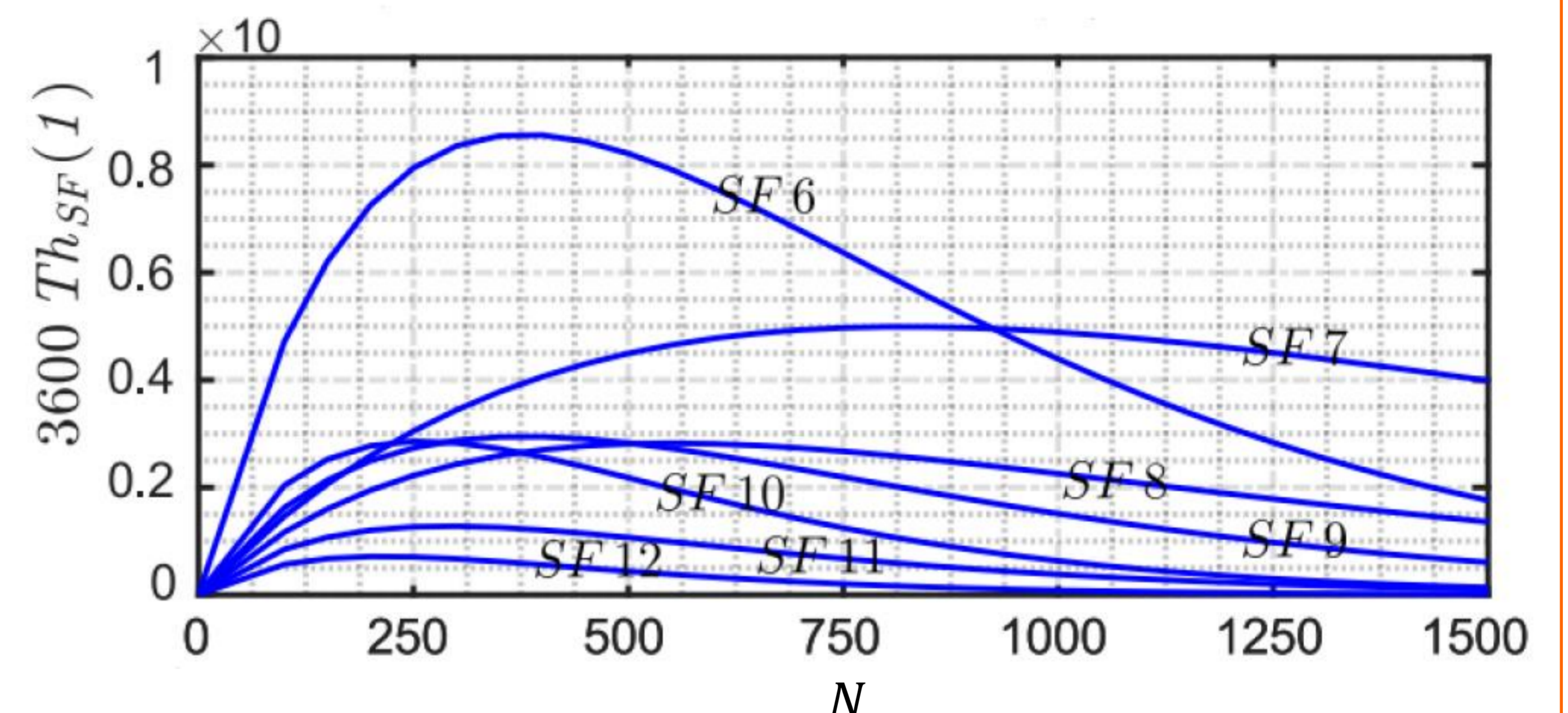
Example of concrete structure environments of underground parking sensors parking in Orange Labs Meylan

II. Economic Efficiency

- In the current network architecture, coverage can be extended by adding more GWs.
- Some out of coverage devices are so isolated that the financial outcome from their subscription is too small to justify the CapEx and OpEx costs of a new GW:
 - CapEx:** A typical LoRaWAN station costs around 1000 euros CapEx. A fixed power source (at least) needs to be secured.
 - OpEx:** Recurring fees per GW by third parties and for roof rental contracts.
- Second sub-conclusion:** cheaper coverage devices are needed with minimized installation and recurring costs.

III. Coverage and ISM Band Capacity Limitations

- Another way to extend coverage is using more robust modulations at higher Tx powers.
 - Such modulations consume significant time on air, thus draining the ISM band, leading to overall lower capacity.
- ISM band is a limited resource that is shared among non-cooperating players (i.e. with diverse owners). This makes the above challenges even worse due to collateral influence to/from all players.



Average effective throughput in one hour of LoRaWAN with different spread factors with one repetition.

(Quentin Lampin, Zhuocheng Li, Nadège Favre, Orange Labs)

- A better solution could be to split the link in two or more links where robust modulations are used only where necessary to optimize ISM band tenancy, data rate, and network capacity.
- An allocation-based approach is beneficial to minimize contention at network bottlenecks.
- Third sub-conclusion:** A multi-hop, multi-radio, allocation based paradigm is required.

The Proposal: An Agile Mesh Architecture

We propose a mesh architecture that allows heterogeneous Radio Access Technologies and physical layer modulations within the same system for an agile and adaptive network.

- Some modulations are robust and long range but long air time with low data rate.
- Others are less robust but with less air time such as 15.4g (2.4 GHz or 868 MHz) or LoRa at SF6.

Related Implementations

- A Smart Extender for LoRaWAN has been implemented by Orange Labs. It offers a cheaper and portable alternative for extending coverage.
- OpenWSN TSCH based mesh network technology based on 802.15.4e and 802.15.4g has been intensively researched and tested. It offers a reliable framework for agile mesh development.



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