



**Offer #2024-08253**

## **M2 Internship on Testbed Design for Emulating Dense LoRaWAN Networks**

**Contract type :** Internship

**Level of qualifications required :** Master's or equivalent

**Fonction :** Internship Research

### **About the research centre or Inria department**

This internship is an INSA internship, within an Inria Research Team.

The Inria research centre in Lyon is the 9th Inria research centre, formally created in January 2022. It brings together approximately 300 people in 17 research teams and research support services.

Its staff are distributed in Villeurbanne, Lyon Gerland, and Saint-Etienne.

The Lyon centre is active in the fields of software, distributed and high-performance computing, embedded systems, quantum computing and privacy in the digital world, but also in digital health and computational biology.

### **Context**

This work will take place in the Inria Agora research team in Lyon, in conjunction with the ANR DOLL national research project. The goal of the DOLL project is to improve LoRaWAN for an increased network capacity in the presence of downlink traffic, while not hindering the reliability of uplink communication. The internship student will be supervised by Dr. Oana Iova (Inria Agora, INSA Lyon) and will work closely with Carlos Fernandez Hernandez (PhD student in Inria Agora, INSA Lyon) and Prof. Fabrice Valois (Inria Agora, INSA Lyon).

### **Assignment**

LoRaWAN [1] has established itself as one of the most popular Low Power Wide Area Network (LPWAN) technologies for communicating Internet of Things (IoT) devices. Although it has been thoroughly studied, most research and applications have focused on uplink traffic (from end device to network server), while downlink traffic (from network server to end device) is not prioritised [2], as it can have a negative impact on network performance [3, 4]. Nevertheless, downlink traffic is essential for several LoRaWAN mechanisms (e.g., end device activation) and key to exploiting applications that require the bidirectional capabilities of LoRaWAN (e.g., for reliability). Since the network server is in charge of determining when and from which gateway the downlink should be transmitted, this process has to be more thoroughly studied.

The problematic to explore during the internship is focused on the communication between the end devices, the gateways, and the network server, specifically how the gateway forwarder software handles the downlink traffic [5].

### **References**

- [1] L. A. T. Committee, "Lorawan 1.1 specification," <https://resources.lora-alliance.org/technical-specifications/lorawan-specification-v1-1>, 2018, 2023-04-
- [2] J. M. Marais, A. M. Abu-Mahfouz, and G. P. Hancke, "A survey on the viability of confirmed traffic in a LoRaWAN," vol. 8, pp. 9296–9311. [Online]. Available: <https://ieeexplore.ieee.org/document/8952708/>
- [3] A.-I. Pop, U. Raza, P. Kulkarni, and M. Sooriyabandara, "Does bidirectional traffic do more harm than good in LoRaWAN based LPWA networks?" in GLOBECOM 2017 - 2017 IEEE Global Communications Conference. IEEE, pp. 1–6. [Online]. Available: <http://ieeexplore.ieee.org/document/8254509/>
- [4] F. Van den Abeele, J. Haxhibeqiri, I. Moerman, and J. Hoebeke, "Scalability analysis of large-scale LoRaWAN networks in ns-3," vol. 4, no. 6, pp. 2186–2198. [Online]. Available: <http://ieeexplore.ieee.org/document/8090518/>
- [5] J. Wang and P.-G. Fan, "Research and implement of just-in-time dual buffer-queues in LoRaWAN gateways," in 2020 IEEE 8th International Conference on Information, Communication and Networks (ICICN). IEEE, pp. 63–68. [Online]. Available: <https://ieeexplore.ieee.org/document/9205105>

### **Main activities**

The intern student will design and setup a testbed consisting in a Raspberry-Pi running an instance of a network server (e.g., Chirpstack or The Things Stack) and two LoRaWAN gateways where the scheduling

process will be studied from both perspectives. The intern student will also have to design a mechanism to inject uplink traffic to the network server that will allow to generate downlink traffic as well as a system that allows to collect data for analysis. A scientific report explaining the testbed and the resulted data is expected.

## Skills

Applicants studying for a Computer Science or Telecommunication Engineering degree are encouraged to apply and should have the following skills:

- A good background in systems and computer networks;
- Practical skills with programming languages (mainly C/C++ and Python).

French language is not mandatory but welcomed. We look for empathic proactive and self-driven students.

## Benefits package

- Subsidized meals at INSA university restaurants
- Partial reimbursement of public transport costs
- Social, cultural and sports events and activities
- Social security coverage

## Remuneration

Salary apx. 600€ per month (4.35 euros/hour)

This internship will be remunerated by INSA

## General Information

- **Theme/Domain** : Networks and Telecommunications System & Networks (BAP E)
- **Town/city** : Villeurbanne
- **Inria Center** : [Centre Inria de Lyon](#)
- **Starting date** : 2025-02-03
- **Duration of contract** : 6 months
- **Deadline to apply** : 2024-11-28

## Contacts

- **Inria Team** : [AGORA](#)
- **Recruiter** :  
Iova Oana-teodora / [oana.iova@inria.fr](mailto:oana.iova@inria.fr)

## About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

**Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

## Instruction to apply

### Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

### Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.