



**Offer #2024-07423**

## **PhD Position F/M Data capture and collection by energy-free sensors and ultra-low power transmission in hostile environments**

**Contract type** : Fixed-term contract

**Level of qualifications required** : Graduate degree or equivalent

**Fonction** : PhD Position

**Level of experience** : Recently graduated

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

The Inria University of Lille centre, created in 2008, employs 360 people including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria University of Lille centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region. For more than 10 years, the Inria University of Lille centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

### **Context**

In recent years, the deterioration of our pavements and bridges has accelerated as a result of ageing structures, climate change and the increase in the authorised load of heavy goods vehicles. A number of initiatives are being put in place to better measure this deterioration and anticipate the need for road infrastructure maintenance.

Through their joint ROAD-AI project, Inria and Cerema are jointly studying digital tools for modelling these phenomena using structural instrumentation. This initiative is complemented and reinforced by the SIRCAPASS project coordinated by SilMach, which aims to use a new passive sensor technology for this instrumentation.

It is within the framework of these projects that the subject of this thesis falls, the aim of which is to design wireless communication protocols that will enable efficient data collection with minimal energy consumption.

In order to put all the assets in place around this complex problem, the thesis will be hosted by Inria (at the Lille or Sophia centre) and monitored by CEREMA for the business and operational aspects. The PhD student will also be required to interact regularly with the other partners of the project, in particular SilMach, who is in charge of hardware development.

### **Assignment**

Data collection is at the heart of the integrated management of road infrastructures and engineering structures. However, by definition, this data is collected in highly restrictive environments (e.g. reduced accessibility, absence of electrical and communication networks, etc.), or even hostile environments (e.g. weather conditions, luminosity, humidity, etc.). The sensors are all different in nature, with potentially heterogeneous dimensions, sensitivity and means of communication, providing data that is heterogeneous in size, type and frequency of acquisition.

The aim will be to design a communication protocol that meets the needs of data collection by the sensors and command feedback, regardless of the area in which they are deployed, while consuming as little energy as possible. This protocol will have to take into account the application constraints of physical deployment (accessibility, radio environment, possibility of power supply or recovery of ambient energy) and adapt dynamically to the type of data (scalar, image, etc.) and its operational needs (alert vs. monitoring).

The energy consumption associated with data transmission is impacted by the choice of radio technology used, the quantity of data transmitted and the transmission power (and therefore the

distances over which the data is transmitted). The communication protocol studied will focus on layers 2 (access to the medium) and 3 (routing) and will adapt these different parameters dynamically to meet application requirements (in terms of latency, delay, throughput, etc.) which vary from one type of data to another, with minimum energy consumption.

Particular attention will be paid to quantifying the energy efficiency of the data capture, collection, transmission and processing methodologies in relation to the targeted operational objectives.

## Main activities

M1-M6: Study of different data collection scenarios. For each scenario, the aim will be to define the architecture envisaged (star or multi-hop network), its feasibility and to characterise the various data to be collected or downlinked (type, volume, frequency, QoS requirements, etc), highlighting the advantages and disadvantages or technical difficulties of each.

M6-M12: Comparisons of several strategies, evaluated by simulation and emulation (including field data and traces in the simulations).

M6-M12: The doctoral student will study the literature on communication protocols with an agility similar to that required in the SIRCAPASS scenarios.

At the end of the first year, one or more scenarios will be selected, guiding the studies to be carried out on the design of communication protocols. Students will be familiarised with the business and technical constraints.

M12-M18: Design of a first version of the SIRCAPASS communication protocol.

M18-M20: Implementation of the solution and initial laboratory evaluations. Revision of the protocol according to the results of the evaluation.

M20-M32: Implementation and experimentation in the field. Continuous revision of the protocol according to the results of the evaluation.

M32-M36: Finalising and writing the thesis report.

## Skills

- Knowledge in wireless networks and edge computing
- English speaking
- Autonomy
- Open minded
- Team working
- Capacity to write English reports and papers
- Sense of organization, autonomy, rigor

## Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## General Information

- **Theme/Domain** : Networks and Telecommunications System & Networks (BAP E)
- **Town/city** : Villeneuve d'Ascq ou Sophia Antipolis
- **Inria Center** : [Centre Inria de l'Université de Lille](#)
- **Starting date** : 2024-10-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2024-06-30

## Contacts

- **Inria Team** : [FUN](#)
- **PhD Supervisor** :  
Mitton Nathalie / [Nathalie.Mitton@inria.fr](mailto:Nathalie.Mitton@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.

## The keys to success

We are looking for candidate that owns a Master in computer science who is creative in proposing solutions and capable of critical analysis of results. We demand the student:

- 1) to be curious and interested in new technologies
- 2) to have a strong background in mobile networks and forwarding protocols;
- 3) to have a strong background in optimisation models;
- 4) to be fluent in spoken and written English with strong communication and presentation skills;
- 5) experience with mobility modeling, resource management for wireless networks are considered a plus.
- 6) to have excellent skills in scripting and programming (e.g., python, C/C++, Java, ROS) as well as previous experience with simulation tools;

**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

Please send us your CV and cover letter.

### **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.