



**Offre n°2025-08828**

## **Post-Doctoral Research Visit F/M Downlink Optimization for Robust Direct-to-Satellite LoRaWAN**

*Le descriptif de l'offre ci-dessous est en Anglais*

**Type de contrat :** CDD

**Niveau de diplôme exigé :** Thèse ou équivalent

**Fonction :** Post-Doctorant

**Niveau d'expérience souhaité :** De 3 à 5 ans

### **A propos du centre ou de la direction fonctionnelle**

The Inria research centre in Lyon is the 9th Inria research centre, formally created in January 2022. It brings together approximately 320 people in 19 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.

### **Contexte et atouts du poste**

#### **About the centre**

The postdoctoral position at Inria's AGORA research group, located at the La Doua Campus in Lyon, offers a unique opportunity to collaborate with esteemed experts

such as Dr. Juan Fraire, Dr. Oana Iova, and Prof. Hervé Rivano. The appointee will use advanced software tools like FloRaSat, an Omnet++-based DtS-IoT simulator, enhancing their expertise in space communication systems and wireless sensor networks. This role is enriched by AGORA's strong international and academic-industrial collaborations. This position is a gateway to cutting-edge research and professional growth in IoT, space networking, and Internet technologies in general.

### **Context**

Every year, Inria's International Relations Department (DRI) has a few postdoctoral positions to support Inria's international collaborations. The postdoctoral contract will have a duration of 12 to 24 months. The default start date is November 1st, 2025, and not later than January 1st, 2026. One of the Inria Centres in France will recruit the postdoctoral fellow. Still, it is recommended that the time be shared between France and the partner country, in this case, the Universidade Federal de Santa Catarina in Brazil. Please note that the postdoctoral fellow has to start his/her contract in France and that the visits must respect Inria rules for missions.

### **Eligibility Conditions**

Candidates for postdoctoral positions are recruited after the end of their Ph.D. or after a first post-doctoral period: for the candidates who obtained their PhD in the Northern hemisphere, the date of the Ph.D. defense shall be later than September 1, 2022; in the Southern hemisphere, later than April 1, 2022. To encourage mobility, the postdoctoral position must occur in a scientific environment that is genuinely different from the Ph.D. (and, if applicable, from the position held since the Ph.D.); particular attention is thus paid to French or international candidates who obtained their doctorate abroad.

## **Mission confiée**

### **Context**

The emerging paradigm of Direct-to-Satellite Internet of Things (DtS-IoT) represents a significant advancement in linking terrestrial Low-Power Wide Area Network (LPWAN) technologies with Low-Earth Orbit (LEO) satellites. Through this new paradigm, IoT devices communicate using well-established terrestrial technologies such as LoRaWAN to transmit data directly to satellites, even without ground infrastructure. DtS-IoT enables efficient and seamless connectivity for global-scale applications such as international asset tracking, cross-border environmental monitoring, and global data collection and distribution. DtS-IoT also facilitates the development of applications in remote regions that would otherwise be challenging to cover with low-cost terrestrial IoT connectivity, like oceanic monitoring and remote agriculture.

While LPWAN technologies such as LoRaWAN suit DtS-IoT connectivity, existing prototypes and validations have predominantly emphasized data uplink communication (from end devices to satellites); however, downlink communication (from satellites to end devices) is of the utmost importance for ensuring robust data communication and user access to all the deployed end devices. This includes acknowledging successfully received uplink data. Data flows from the Internet to ground devices through the LEO satellite network in these cases. Additionally, the downlink channel enables the LoRaWAN network and application servers to utilize a control channel to remotely configure end devices and operate actuators via the DtS-IoT network. This postdoc is focused on proposing and testing efficient downlink techniques within the DtS-IoT landscape, utilizing LEO satellite networks, and addressing the constraints of IoT communications in space.

## **Assignment**

In the DtS-IoT context, the unique challenges associated with LoRaWAN's downlink are multi-faceted. On the one hand, they involve the challenging selection of suitable downlinking gateways (situated onboard the LEO satellites) that minimize the number of transmissions to end devices with overlapping reception windows and coverage. On the other hand, once a LEO satellite is selected, intricate scheduling follows for each downlink packet to be forwarded across high-latency, low data rate, cross-linked, and multi-hop LEO networks to multiple LoRaWAN devices.

Addressing these challenges requires developing specialized and customized solutions across several layers of the DtS-IoT network stack, physical layer models, MAC algorithms, network optimization, and satellite scheduling methods. The proposed solutions could be based on offline and online optimization and machine learning approaches to schedule downlink messages to prevent overlap, assure optimal channel conditions, and ensure seamless, reliable, and efficient communication between remote IoT devices and the space core network connected to the Internet.

## **Collaboration**

Dr. Juan Fraire and Dr. Oana Iova actively collaborate with Prof. Richard Demo Souza from Universidade Federal de Santa Catarina (UFSC) in Brazil on the topic of Direct-to-Satellite Internet of Things convergence, also supported by a STIC AmSud project recently acquired by Inria and UFSC.

## **References**

- Fraire, Juan A., Oana Iova, and Fabrice Valois. "Space-terrestrial integrated Internet of Things: Challenges and opportunities." *IEEE Communications Magazine* 60, no. 12 (2022): 64-70.
- Fraire, Juan A., Pablo Madoery, Mehdi Ait Mesbah, Oana Iova, and Fabrice Valois. "Simulating lora-based direct-to-satellite IoT networks with FloraSat." In *2022 IEEE 23rd International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)*, pp. 464-470. IEEE, 2022.
- Tondo, Felipe Augusto, Jean Michel de Souza Sant'Ana, Samuel Montejó-Sánchez, Onel Luis Alcaraz López, Sandra Céspedes, and Richard Demo

- Souza. "Non-Orthogonal Multiple-Access Strategies for Direct-to-Satellite IoT Networks." arXiv preprint arXiv:2409.02748 (2024).
- Ron, Dara, Chan-Jae Lee, Kisong Lee, Hyun-Ho Choi, and Jung-Ryun Lee. "Performance analysis and optimization of downlink transmission in LoRaWAN class B mode." IEEE Internet of Things Journal 7, no. 8 (2020): 7836-7847.
  - Abboud, Samira, Nancy El Rachkidy, Alexandre Guitton, and Haidar Safa. "Gateway selection for downlink communication in LoRaWAN." In 2019 IEEE Wireless Communications and Networking Conference (WCNC), pp. 1-6. IEEE, 2019.

## Principales activités

### 1. Comprehensive Literature Review

- Survey state-of-the-art techniques in DtS-IoT, LoRaWAN downlink mechanisms, satellite scheduling, and network optimization methods.
- Identify current limitations and research gaps specific to downlink performance and scalability.

### 2. Model Development

- Explore energy-aware, latency-constrained, and multi-hop-aware strategies for robust downlink delivery.
- Design and implement simulation, analytical, optimization (exact or heuristic), and/or machine learning models to address gateway selection and downlink scheduling in DtS-IoT systems.

### 3. Definition of Performance Metrics and Tooling

- Define relevant performance indicators (e.g., delivery ratio, delay, energy consumption, fairness) for downlink communication in realistic satellite scenarios.
- Develop and implement the software tools to evaluate these metrics through simulation or analytical frameworks.

### 4. Simulation Campaigns and Data Analysis

- Execute large-scale simulation campaigns using realistic satellite constellation configurations.
- Collect, organize, and analyze the resulting data to evaluate the proposed downlink strategies under diverse traffic and coverage conditions.

### 5. Dissemination of Results

- Write detailed technical reports and documentation describing the developed methods, tools, and findings.

- Prepare and submit high-quality papers to international conferences and journals in satellite communications, IoT, and networking (e.g., IEEE ICC, GLOBECOM, TCOM, CN, IoTJ).

## Compétences

The ideal candidate for this postdoctoral position holds a PhD in Computer Science, Electrical or Telecommunications Engineering, or a related field, with a solid foundation in wireless networking, satellite communications, or LPWAN technologies such as LoRaWAN. Proficiency in programming—particularly in Python and C++—is expected, along with experience in simulation environments (e.g., OMNeT++, NS-3) or in developing optimization and machine learning models. A firm grasp of mathematical modeling, performance evaluation, and network protocol design is highly desirable. Fluency in English is essential for effective collaboration and dissemination, while knowledge of French or Portuguese is advantageous but not required. The candidate should demonstrate a proactive, self-driven attitude and the ability to work independently and as part of an international, interdisciplinary team.

## Avantages

- 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 (90 days / year) and flexible organization of working hours
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage under conditions

## Rémunération

2788 € gross salary / month

## Informations générales

- **Thème/Domaine :** Réseaux et télécommunications  
Système & réseaux (BAP E)
- **Ville :** Villeurbanne

- **Centre Inria :** [Centre Inria de Lyon](#)
- **Date de prise de fonction souhaitée :** 2025-11-01
- **Durée de contrat :** 2 ans
- **Date limite pour postuler :** 2025-05-18

## Contacts

- **Équipe Inria :** [AGORA](#)
- **Recruteur :**  
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## A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

## L'essentiel pour réussir

We seek a highly motivated and technically skilled postdoctoral researcher with a strong interest in emerging paradigms at the intersection of satellite communications and the Internet of Things (IoT). The ideal candidate will demonstrate intellectual curiosity, creativity, and a drive to tackle complex, multi-layered challenges in space-based networking. A solid foundation in wireless communications or computer networks, combined with hands-on experience in programming and performance evaluation, is essential. The candidate should be comfortable working in interdisciplinary and international teams and show strong initiative, adaptability, and scientific rigor. Excellent written and oral communication skills are essential for engaging collaborators and disseminating results.

**Attention:** Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

## Consignes pour postuler

Applications must be submitted online via the Inria website. Processing of applications submitted via other channels is not guaranteed.

**Sécurité défense :**

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

**Politique de recrutement :**

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.