



**Offre n°2025-08858**

## **Post-Doctoral Research Visit F/M Tiny Digital Twins: MLops, Embedded Neural Networks and Wireless Communication Compression**

**Type de contrat :** Fixed-term contract

**Contrat renouvelable :** Oui

**Niveau de diplôme exigé :** PhD or equivalent

**Fonction :** Post-Doctoral Research Visit

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

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris**.

The centre has 40 [project teams](#), 27 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

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

This position is part of the postdoctoral program offered by Inria's International Relations Department. The recruited postdoc is expected to spend one part of their time at Inria (on the Paris-Saclay University campus), and another part at Freie Universität Berlin (within the Inria Berlin initiative, see <https://berlin.inria.fr/>), working between two teams that have a strong collaboration in the field of

embedded AI (see below).

## Mission confiée

### Topics

The postdoc focuses on novel and advanced embedded AI, combining two complementary aspects. On the one hand, *efficient data communication using AI* [2,3] with neural network models that can summarize and compress data from one or more sensors to a server. On the other hand, *TinyML and TinyMLops* [1] which focus on the implementation of AI directly on constrained microcontrollers.

**TinyML aspect:** The goal is to implement efficient AI model execution (TinyML) on microcontrollers, and manage AI models (MLOps: remote updates, performance monitoring – here secure TinyMLOps) on hardware such as Nordic nRF52, STM32, ESP32, or RISC-V. Networking will use IoT technologies such as BLE, 802.15.4, or LTE-M.

On top of this hardware, prototypes will be developed in conjunction with an open-source operating system written in embedded Rust (Ariel OS [4]) or embedded C (RIOT [5]).

These prototypes will be co-developed and tested with Freie Universität Berlin. This project follows up on RIOT-ML (see below [6]), also linked to concrete industrial use cases for efficient sensor-to-server communication (Digital Twins).

**Communication aspect:** Neural models will be used to both preprocess and compress data [2]. The objective is to maintain an up-to-date view of distant systems and objects on servers, using data from sensors (e.g., position, vibration, images, etc.). Ideally, all sensor data would be sent in real-time, but energy and network constraints prohibit this. Instead of classic compression (e.g., Lempel-Ziv, ZIP), neural networks can be used to extract and transmit “essential information,” reconstructing it server-side [3] (a concept also generalized as “semantic communications” [7]). Some open questions are how to best select, design, train such models, and for which tasks, and further, how to synchronize data between the real world and the server.

The overall goal is to propose novel solutions, to design and implement such an innovative system, that optimizes the entire chain: sensors – communication – cloud. It will combine embedded systems and AI aspects.

[1] Capogrosso, L., Cunico, F., Cheng, D.S., Fummi, F. and Cristani, M., 2024. "A machine learning-oriented survey on tiny machine learning". *IEEE Access*, 12, pp.23406-23426.

[2] Bernard, A., Dridi, A., Marot, M., Afifi, H., & Balakrichenan, S. (2021, September). "Embedding ML algorithms onto LPWAN sensors for compressed communications." In *2021 IEEE 32nd Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)* (pp. 1539-1545). IEEE.

- [3] Zhang, M., Zhang, H., Fang, Y., & Yuan, D. (2022). Learning-based data transmissions for future 6G enabled industrial IoT: A data compression perspective. *IEEE Network*, 36(5), 180-187.
- [4] Ariel OS: <https://ariel-os.org>
- [5] RIOT: <https://riot-os.org>
- [6] Huang, Z., Zandberg, K., Schleiser, K., & Baccelli, E. (2025). RIOT-ML: toolkit for over-the-air secure updates and performance evaluation of TinyML models. *Annals of Telecommunications*, 80(3), 283-297.
- [7] Chaccour, C., Saad, W., Debbah, M., Han, Z., & Poor, H. V. (2024). Less data, more knowledge: Building next generation semantic communication networks. *IEEE Communications Surveys & Tutorials*.

## **Responsibilities**

The researcher will be responsible for the design and development of the conceptual parts (AI, model, protocols) and for an implementation with an application to digital twins, including both a backend and a low-power microcontroller component. This task would typically includes dataset generation and using this dataset – along with other existing ones – applied to an use case of a digital twin optimizing wireless communication between a fleet of small IoT devices (microcontrollers) and a backend system (implementing the digital twins).

## **Coordination/Management**

The recruited person will be the main point of contact between Inria, Freie Universität Berlin, the maintainers of Ariel OS and/or RIOT, including software engineers we collaborate with at Campus Cyber, and last but not least, the involved industrial partners deploying the use case.

## **Principales activités**

### **Main activities :**

- Interaction with experts in machine learning and secure low-power IoT networking protocols;
- Implementation and testing of software prototypes involving / running on low-power hardware;
- Dataset generation;
- Using datasets to design/train/fine-tune models deployed on microcontroller;
- Interaction with industry partners for real-world deployment;
- Experimental evaluation, and theoretical evaluation (where applicable);
- Research paper writing & publication.

### **Complementary activities:**

- *Upstreaming of open source code (e.g. in the Ariel OS or the RIOT ecosystems);*

- *Contributions to standardization (e.g. IETF).*

## Compétences

### Technical Skills and Level Required:

- Machine Learning (theory and practice) and MLOps;
- Embedded Rust, and/or C;
- Knowledge of low-level software optimization techniques;
- RTOS or bare-metal experience on 32-bit microcontrollers (ARM Cortex-M, RISC-V, ESP32);
- Knowledge of network protocol stacks (BLE, NB-IoT, TCP/IP, TLS, 6LoWPAN...);
- Open-source software workflows;
- Git.

### Languages & Interpersonal skills :

- Good command of scientific English (written, spoken, reading);
- Working in distributed teams.

## 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 (after 6 months of employment) 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

## Rémunération

Monthly gross salary : 2.788 euros

## Informations générales

- **Thème/Domaine** : Distributed programming and Software engineering  
Software Experimental platforms (BAP E)
- **Ville** : Palaiseau
- **Centre Inria** : [Centre Inria de Saclay](#)
- **Date de prise de fonction souhaitée** : 2025-10-01
- **Durée de contrat** : 2 years
- **Date limite pour postuler** : 2025-09-30

## Contacts

- **Équipe Inria** : [TRIBE](#)
- **Recruteur** :  
Bacelli Emmanuel / [Emmanuel.Bacelli@inria.fr](mailto:Emmanuel.Bacelli@inria.fr)

## 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

- Be passionate about experimental research;
- Be comfortable with community-based open source software development;
- Know how to take initiatives and lead an action in this context.

**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

**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.