About the research centre or Inria department

Located at the heart of the main national research and higher education cluster, member of the Université Paris Saclay, a major actor in the French investments for the Future Programme (Idex, LabEx, IRT, EqipeX) and partner of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge, safety, security and reliability, modelling, simulation and optimisation (with priority given to energy).

The 450 researchers and engineers from Inria and its partners who work in the research centre's 31 teams, the 100 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Ile-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Context

You will work in the INFINE Team at Inria Saclay at Palaiseau.

INFINE team members have 20+ years of experience in research and development in wireless networks, sensor networks and recently IoT. We are also active participants and contributors to Internet standardization. INFINE is a major contributor (and actually a co-founder) to the open-source project RIOT, an operating system for the Internet of Things (in action: http://riot-os.org). We also maintain one of the sites of the open access testbed FIT IoT-LAB (saclay.cam.hre).

Assignment

This research engineer position on one of the two topics below:

- **topic A) Optimized Protocols for IoT Networks (Network Coding and Information Centric Networking)**
- **topic B) Machine Learning for Multiple Access in IoT**

Main activities

**Topic A) Optimized Protocols for IoT Networks (Network Coding and Information Centric Networking)**

Among other innovations, the Internet standardisation has started looking into two modern families of protocols: the first one is the family of the family of network coding protocols (in the NWCN group [A1]), and the second one is the family of information-centric network (ICN) protocols (in the ICNRG group [A2]). The goal of this line of work is to contribute to invent new protocols, to implement them and evaluate them - for one family of such protocols (or both [A3]). This will be in the context of IoT and Internet standardisation, and based from strong experience gained over the past years in the team [4k-A7].

Network coding, consists in “mixing packets together” (such as doing XOR of different packets), and is particularly useful for wireless communications: for instance, for wireless broadcast, it can improve throughput, or it can provide for efficient error correction on lossy links (as an improvement of QUIC). The design of broadcast protocols is of prime interest [A4], with the use case of software updates for IoT.

Information-Centric Networking is another idea: the idea that one does not need to send IP packets to a server (identified by an address which carries no semantics), but that one can refer to content through names such as “/building/sensor1/temperature” and send them directly in the network with the same means. ICN protocols have a number of appealing features: due to their design (and also as clean-slate protocols), they can offer opportunities to adapt the communication layers to the versatile requirements of IoT (4k-AB). One focus is on new efficient wireless multi-hop ICN protocols, that allow for communication with the edge/edge computing, for RIOT the friendly operating system for IoT.

**Topic B) Machine Learning for Multiple Access in IoT**

The next generation wireless networks, such as Internet-of-Things (IoT), poses a unique challenge to enable the autonomous operation of nodes, while simultaneously achieving the performance similar to network with a centralized operation. On the other hand, the machine learning and AI based techniques are increasingly being used to enhance the performance of wireless communication systems, e.g., for multiple access [81,82], power control [83], and even for end-to-end reconstruction of the data [84].

This goal in this work is to develop machine learning and AI based MAC layer techniques for next generation wireless networks, e.g., IoT networks, while simultaneously ensuring the uncoordinated operation of the nodes. The possible directions could include connectionless multiple access protocols, source reconstruction and enabling the energy harvesting based IoT networks. The proposed research problems could use the tools from deep learning, reinforcement learning, and learning over networks.
References:

[A2] IRTF ICNRG - Information-Centric Networking research group - https://irtf.org/icnrg
[A4] “Network Coding and Multihop Wireless Networks” presentation, IETF 100 ---- “Experiments with Broadcast with Network Coding”, presentation, IETF 89
[A7] L. Dauphin, E. Baccelli, C. Adjih, "RIOT-ROS2: Low-Cost Robots in IoT Controlled via Information-Centric Networking", PEMWN 2018 - https://hal.inria.fr/hal-01898889 - (slides)
[A8] Shang, W., Afanasyev, A. and Zhang, L., 2016, December. "The design and implementation of the NDN protocol stack for RIOT-OS". In Globecom Workshops (GC Wkshps), 2016 IEEE (pp. 1-6). IEEE.

Skills
We are looking for highly skilled developers:

- Excellent programming skills and experience in languages: C and Python
- Knowledge of development for embedded systems
- Good knowledge of project management tools (make, git, github)

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration

In regards to professional experience