

PhD position

Title: Wireless Sensing for Smarter Networks

PhD location: LIX, Ecole Polytechnique

Starting date: October 2025, for a 3-years contract

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Description

Wireless networks are more and more pervasive and ubiquitous in our society where they enable a large variety of applications for our daily lives. At the same time, if they are primarily designed for communication, their spectrum of services is increasingly expanding to include related uses to which they are particularly well suited. Ongoing research around *wireless sensing* has shown that these networks can be used, among other things, to track the position of users [1], monitor their health (heart rate, breathing rate, sleep quality, etc.) [2], authenticate them in a biometric way (recognize their walking, breathing, etc.) [3], or to recognize what they are doing (gesture and activity recognition [4]). The list is far from being exhaustive and this is already under standardization [5] and adoption by the market [6, 7].

As an emerging research field, *wireless sensing* takes advantage of physical properties of electromagnetic waves when they encounter or travel through obstacles (reflection, absorption, diffraction, etc.) and builds on top of knowledge from different scientific fields – including Networking, Machine Learning/Artificial Intelligence and Signal Processing – to enable a wide variety of applications – and therefore speed up the entrance in a smarter world.

However, while these *wireless sensing* techniques are currently undergoing rapid development, they do not yet allow networks to push their limits in fulfilling their primary function: communication. These networks continue to face significant challenges in terms of throughput, latency, quality of service, and resource sharing between nodes. This PhD aims at leveraging these advances to achieve two complementary objectives. The first is to contribute to the effort of providing performant *wireless sensing* based services capable of improving the lives of end users. The second objective is to exploit, for the first time, this detailed knowledge of the environment provided by these techniques to improve network operation and iterate endlessly. This, however, faces a number of key challenges stemming from the complexity of signals to analyze as well as the rigidity of existing network protocols.

The aim of this research project is to tackle these challenges and advance the field by combining knowledge from Networking and Machine/Deep Learning. Practical tasks during the PhD will include:

- Performing collection and analysis on data obtained on available wireless testbeds
- Designing innovative *wireless sensing* powered systems, protocols, methodologies and tools by combining knowledge from AI and Networking
- Implementing prototypes of these systems by implementing on real hardware and evaluating them under realistic usage conditions; and comparing them with state of the art systems
- Preparing scientific papers to publish results in top tier conferences and journals in the domain such as IEEE INFOCOM, IEEE PerCom, ACM MobiCom, ACM SenSys, ACM MobiSys, ACM IMWUT, IEEE TMC, etc.

Ideal candidate profile:

- Holding a Master's degree or an engineering degree in Computer Science, Machine Learning or Telecommunications, or in the process of getting it soon
- Hands-on experience and strong skills in Machine and Deep Learning. Knowledge of modern learning schemes such as Multi-task Learning, Autoencoders, GANs, Transformers and Transfer Learning would be appreciated.

- Knowledge of network protocols functioning
- Strong programming skills in any common language such as C++, Python, Java, etc.
- Being motivated to learn quickly while trying new solutions and work on challenging research problems

How to apply: Send your CV and university transcripts by mail to the advisors (e-mail addresses above) before June 1st, 2025. Motivation and recommendation letters are welcome but optional.

References

- [1] J. Wang, X. Zhang, et al., “Device-free wireless localization and activity recognition: A deep learning approach,” *IEEE Transactions on Vehicular Technology*, vol. 66, no. 7, pp. 6258–6267, 2017. doi: 10.1109/TVT.2016.2635161.
- [2] S. Yue, H. He, et al. “Extracting multi-person respiration from entangled rf signals,” *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, vol. 2, no. 2, pp. 1–22, Jul. 2018. doi: 10.1145/3214289.
- [3] F. Lin, C. Song, et al., “Cardiac scan: A non-contact and continuous heart-based user authentication system,” in *International Conference on Mobile Computing and Networking (MobiCom)*, ACM, 2017, pp. 315–328. doi: 10.1145/3117811.3117839.
- [4] E. Kim, S. Helal, et al., “Human activity recognition and pattern discovery,” *IEEE Pervasive Computing*, vol. 9, no. 1, pp. 48–53, 2010. doi: 10.1109/MPRV.2010.7.
- [5] Rui Du, Haocheng Hua, et al. « An overview on IEEE 802.11 bf : WLAN sensing ». In : arXiv preprint arXiv :2310.17661 (2023).
- [6] Origin Wireless AI, “WiFi can do more. Make Your Home Smarter, Safer, and More Secure with AI Sensing”, Available at <https://www.originwirelessai.com/>
- [7] Eric le Bourlot, “Wi-Fi Sensing : l’astucieuse technologie d’Orange pour sécuriser votre maison avec une simple Livebox”, Available at <https://www.01net.com/actualites/wi-fi-sensing-lastucieuse-technologie-dorange-pour-securiser-votre-maison-avec-une-simple-livebox.html>.