Research Master 2 / engineer internship (+ PhD) proposal

Title: Multicell energy and spectrum collaboration in future wireless networks – System design in the presence of CSI uncertainty

Laboratory : Department : Signal et Communications
Team : SCEE
IETR – UMR/CNRS 6164 - Université de Rennes 1 and CentraleSupelec

Location : CentraleSupélec - Avenue du Général Leclerc, 35042 Rennes Cedex

Period: from 01/03/2019 ***Duration:*** from 4 to 6 months

Extension:
The training period will be followed by a 3 years PhD (if funded – answer given before the end of the internship)

Contact : **Internship (and PhD, if funded) will be co-advised by Georgios ROPOKIS and Christophe MOY**
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PhD project : ***(the internship is planned to be the beginning of a PhD work, if funded)***

With wireless and mobile communications applications playing an ever-increasing role in everyday life, meeting the connectivity and throughput demands that are foreseen for 5G and beyond 5G networks requires efficient spectrum sharing techniques. As a result, already considered aggressive frequency reuse multicell techniques, combined with new multicell Non-Orthogonal Multiple Access (NOMA) schemes [1], are expected to be in the spotlight of the wireless communications research community. Nevertheless, the use of NOMA techniques for such multicell, and interference limited scenarios requires the development of optimal physical layer (PHY) and Medium Access Control (MAC) decision making techniques, for better exploiting spectrum resources using the available information (Channel State Information - CSI).

At the same time, the pressing need for reducing carbon emissions, calls for new energy efficient/energy aware communications techniques. To meet this need, currently several solutions are investigated exploiting renewable energy resources and renewable energy sharing [2], and advanced Base Station (BS) on-off switching techniques as means towards achieving energy efficiency. However, the joint consideration of efficient spectrum and energy utilization requires changing our view of a communications network as an infrastructure for using, managing and sharing its spectrum resources towards the concept of a ***Network of Networks*** comprised of the communication network as it is traditionally defined (i.e. the communication infrastructure and the spectrum resources) and the *energy network* comprising of all energy resources (including renewable energy resources) that are accessible to the communication infrastructure.

This internship/thesis will take an important step towards the realization of this concept, by investigating efficient joint spectrum and energy management techniques. The focus will be on multicell communications systems and the introduction of novel, PHY/MAC based techniques jointly treating spectrum, and harvested energy as resources to be optimally exploited within the network, targeting at minimizing the network's power consumption while satisfying target Quality of Service (QoS) constraints. To that end, NOMA techniques, that can improve spectral efficiency, will also be investigated in challenging scenarios with CSI uncertainty. The

benefits that energy collaboration can bring in such scenarios will then be investigated as a mean for improving energy efficiency.

Benefits for the candidate

This internship offers the opportunity to work on timely open research issues currently investigated by the wireless research community, such as the problem of optimal MAC/PHY design for Multicell NOMA techniques. The PhD student will have the chance to work on key communications technologies that are expected to play key role in 5G systems and present novel algorithmic solutions targeting at tackling the ever increasing demand for energy efficient system designs. Through this research project, the PhD candidate will also have a unique opportunity to develop skills on **Advanced Optimization** techniques and **Artificial Intelligence/Machine Learning** with applications in wireless communications.

References:

[1] . Ding et al., "Application of Non-Orthogonal Multiple Access in LTE and 5G Networks," in *IEEE Communications Magazine*, vol. 55, no. 2, pp. 185-191, February 2017.
[2] J. Xu, L. Duan and R. Zhang, "Cost-aware green cellular networks with energy and communication cooperation," in *IEEE Communications Magazine*, vol. 53, no. 5, pp. 257-263, May 2015.