

Title: *Cooperation, optimization and artificial intelligence for future communications: interplay between model-based and data-driven approaches*

Official director: E. Veronica Belmega, ETIS, Cergy

Co-supervisor: Anne Savard, IMT Lille Douai, CERI Systèmes Numériques

Collaborator: Romain Negrel, ESIEE, Noisy le Grand

Location: Lille (approximately 1h away from Paris by TGV) and Cergy (Paris area)

Summary:

Future generations of wireless networks face great expectations regarding the increase in network capacity, system throughput, massive user density under a tight energy budget.

The goal of this PhD thesis is to design efficient resource allocation policies in cooperative networks composed of a cellular network and an opportunistic network of users. The latter can exploit several full-duplex operating relay nodes to communicate while ensuring a low impact, in terms of Shannon rates, on the cellular network performance; as well as energy harvesting in order to boost the opportunistic achievable rate. To the best of our knowledge, opportunistic rate maximization for a cognitive full-duplex relay aided multi-tier network, under a rate-based Quality of Service constraint has not been addressed in the literature. Furthermore, the simultaneous blend of full-duplexing, multi-tier networks, cooperative communications, enables us to optimize the global network while assessing the impact of each technique on the wireless network. This optimization problem will be tackled for several relaying schemes which will require various tools from multi-user information theory, to game theory, artificial intelligence and deep learning techniques.

Objectives:

This PhD proposal aims at deriving efficient and optimal resource allocation policies for networks that exploit jointly cognitive radio, full-duplex nodes, cooperative communications and energy harvesting. This simultaneous blend of cutting-edge technologies enables us to optimize the global network while assessing the impact of each technique. We assume that the communication takes place in two phases: one dedicated to power transfer and one dedicated to data transmission. The considered network is composed by several cellular user/destination pairs and several opportunistic user/destination pairs communicating with the help of some energy-harvesting FD relay nodes. The resulting network optimization problems are complex and non-convex and their solutions will require tools beyond classical optimization such as data-driven tools, deep networks and machine learning techniques, emerging as promising and necessary for the design of future 6G networks.

Within this PhD proposal, we intend to focus on the following objectives:

Objective 1: Design of a joint relay selection and power allocation policy when transmitters exploit energy harvesting to boost their communication.

Objective 2: Design of shared relay nodes capable of helping both the licensed and opportunistic transmissions.

Additional information

The successful candidate will be a member of both the wireless communications group of the research unit ETIS (website: <https://www-etis.ensea.fr/en/homepage.html>) and the Digital System group of IMT Lille Douai (website: <http://imt-lille-douai.fr/en/about-us/identity/>). ETIS Lab is located in Cergy-Pontoise, at 40 minutes by the RER suburban train from center Paris, and IMT Lille Douai is located in Villeneuve d'Ascq, at approximately 1h by TGV train from center Paris.

The successful candidate can start as early as September 2020.

Applications are sought from France, EU and international candidates with an outstanding academic background, especially in wireless communications, information theory, optimization theory, machine learning or related disciplines. Demonstrable mathematical skills will be essential and an interdisciplinary background (e.g. computer science, data science) will be an advantage. The candidate should be familiar with key engineering programming languages (Matlab, Python, ...)

Applicants must have an Msc degree (M2, engineer degree or equivalent in France). A good and working knowledge of the English Language is required.

How to apply:

Interested candidates have to send their detailed CV, academic records (from Bsc to Msc level), at least two academic referees and a short motivation letter via email to the contacts below. Applications will be received until the **15th of April 2020**.

Contacts:

E. Veronica Belmega

Email: belmega@ensea.fr

Webpage: <https://sites.google.com/site/evbelmega/home>

Anne Savard

Email: anne.savard@imt-lille-douai.fr

Webpage: <https://pro.univ-lille.fr/anne-savard/>

References:

A. Savard, and **E.V. Belmega**, "*A Cooperative D2D-Enabled Cellular Network under an Overall Power Constraint*", submitted to IEEE Trans. on Wireless Commun., Feb. 2020.

A. Savard, **E.V. Belmega**, "*Optimal Power Allocation in a Relay-aided Cognitive Network*", ACM ValueTools 2019, Palma de Mallorca, Spain, Mar. 2019.

P. Mertikopoulos, **E. V. Belmega**, **R. Negrel**, and L. Sanguinetti, "*Distributed stochastic optimization via matrix exponential learning*", IEEE Trans. on Signal Processing, vol. 65, no. 9, pp. 2277-2290, May 2017.

A. Savard, C. Weidmann, "*On the Gaussian multiway relay channel with intra-cluster links*", EURASIP Journal on Wireless Communications and Networking, SpringerOpen, 2016,52, pp. 1 - 17.

A. Savard, C. Weidmann, "*Lattice coding for the Gaussian one- and two-way relay channels with correlated noises*", IEEE ISIT, Hong-Kong, Jun. 2015