Call for Applications for PhD in Electrical Communication Engineering: Advanced Interference Management Solutions for 5G systems with Multi-Radio Access Techniques

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CONTEXT

The tremendous success of mobile cellular services is leading to an ever increasing demand of ubiquitous high data rate. Recent forecasts have announced a 1000-fold increase in mobile data traffic by 2020. Currently, several technological drivers are investigated to support the requirements of future wireless networks. Amongst them, network densification through dense small cell deployment is the most promising option. Small cells are low power access nodes that can be integrated in classic mobile networks to create local hotspots, extend the network coverage, and enhance the end user performance by shortening the distance between mobile terminals and the access network.

Additionally, due to shortage of the available licensed spectrum, the wireless research community is studying architectures and radio access technologies (RATs) to efficiently exploit further available frequency resources [1,2]. According to this vision, the 5th generation (5G) of wireless network will be
a complex heterogeneous system, where operators will deploy in the same geographical area different type of access nodes, to satisfy user requirements, system constraints, and costs.

In this context, new interference management solutions are required for enabling efficient and robust operations of the different RATs used in the 5G. Current solutions such the (enhanced) inter-cell interference coordination schemes [3, 4] standardized by the 3GPP lack of flexibility and are not designed to enable operations on unlicensed bands. In contrast, the methods proposed in the framework of the cognitive radio mainly focus on ad-hoc networks [5].

An additional challenge will be to reliably model and assess the future 5G communication systems while taking into account the increasing heterogeneity of networks, devices, user conditions, environments, and services. Classical deterministic approaches used in system level simulators are characterized by limited scalability and high complexity, and can hardly characterize super dense heterogeneous networks. Recently, stochastic geometry techniques have been proposed to obtain tractable evaluations and easy-to-understand expressions for optimizing heterogeneous wireless networks [6].

**PHD OBJECTIVES**

The objective of this thesis is to design, develop, and assess interference mitigation solutions for 5G networks operating in unlicensed spectrum. To identify challenging scenarios and relevant optimization parameters, a preliminary analysis can be carried out by using stochastic geometry. This tool has gained popularity in the last years and recently has been used for modelling coverage and rate in mmW systems [7, 8] as well as in Multi-RAT heterogeneous networks [9, 10]. However, most of the studies presented in the literature focuses on modelling coverage and shannon capacity and lacks of accurately capturing system parameters and queuing dynamics [6].

The PhD student will have to propose cross layer solutions that take into account the specific PHY/MAC characteristics of the Multi-RAT under investigation, i.e., WiFi, milli-metric Wave (mmW) communication systems, and future evolutions of LTE. For instance, current WiFi standards are characterized by a MAC scheme that backs off transmissions when the measured interference level is above a given threshold [11]; therefore, concurrent LTE and WiFi operations in the same frequency resources may rapidly saturate the throughput of WiFi networks. To enable opportunistic use of spectrum, mobile systems beyond LTE can take advantage of novel flexible waveforms that are characterized by spectrum agility and interference mit-
igation features [12]. Moreover, in the mmW communication systems, the specific propagation characteristics and antenna directivity strongly affect the cell coverage and the perceived interference [13].

The optimal control of transmission parameters in wireless networks can be modelled and solved through (Partially Observable) Markov Decision Process (see for instance [14,15]). Additionally, learning tools based on simplified models, such as Fuzzy Q-learning [16], can be used to reliably characterize and optimize more complex systems. The organization of the work during the PhD can proceed as follows: 1) State-of-the-art on interference management techniques and stochastic geometry; 2) Based on this overview, develop a mathematical framework to characterize Multi-RAT heterogeneous networks; 3) Propose cross layer solutions for interference management in unlicensed spectrum; 4) Refine the investigated stochastic models to capture the benefits of the proposed interference management schemes; 5) Final evaluation in relevant 5G scenarios.

REQUIRED SKILLS

The ideal candidate for this position has a strong background on wireless networks and expertise in mathematics. Also, good communication skills, both oral and written English, are required; french knowledge is not mandatory. Some backgrounds in simulations and scientific language can be a plus. We expect also the candidate to have notions of research techniques (documenting and reporting, work organization, independent working, creativity).

PRACTICAL INFORMATION

The PhD student will join the Wireless Communication System Studies laboratory within CEA-Leti, Grenoble, and will be inscribed to Telecom ParisTech (Ecole Doctorale de l’Université Paris Saclay). The duration of the PhD is 3 years, and it is expected to start during the last trimester of 2015.

HOW TO APPLY

Potential candidates should send a resume and a motivation letter in PDF along with 2 references to the email addresses: antonio.de-domenico@cea.fr and marceau.coupechoux@telecom-paristech.fr.
References


