Sujet de Thèse/PhD Proposal, 2020

Laboratory/Laboratoire : LISITE
Topic/Thématique : Digital Communications/Communications Numériques

"Advanced Spatial Multiplexing Schemes for Ultra-high Rate in Beyond 5G System"/ "Multiplexage Spatial Avancé pour des Systèmes Au-delà de la 5G à Débit Ultra-Elevé "

5G networks are expected to be deployed in 2020 and are considered as a global game changer from a technological, economic, societal and environmental perspective, introducing very aggressive performance requirements in terms of latency, energy efficiency (EE) and wireless broadband capacity. With future wireless networks being expected to support a very broad variety of services characterized by conflicting and even more demanding requirements [1] [2], many experts state that the evolution defining the 6th Generation (6G) of cellular networks will be the virtualization of network resources such as to support user and service requirements by dynamically adjusting system parameters in order to adapt to network/wireless environment/service conditions. From a PHY layer perspective such an effort for virtualizing resources can only be enabled by means of smart networking interfaces with configurable radios. While environmental aware virtualization will contribute towards meeting these targets, the definition of new PHY layer designs is also required [2]. More specifically, processing high bandwidth signals or high constellation modulation schemes is challenging for Radio Frequency front ends and poses the need for proposing record-high SE signal shaping.

Achieving enhanced performance in bit rates will require the use of very high constellation order. However, these high order constellations are sensitive (among other) to non-linearity, phase noise, and antenna switching impacts in the transmission medium. For modulation schemes such as high-order Quadrature Amplitude Modulation (QAM), signal shaping may not be able to overcome some of these challenges. Therefore, it is vital to develop new signal shaping techniques that exploit additional signal dimensions for information bearing purposes. In that sense, spatial modulation (SM) and index modulations (IM) ([3] [4]) using novel dimensions for indexation could allow for achieving record-high bits/s/Hz/polarization in B5G wireless communication systems without blowing up the system power [3][5].

Main targets of this PhD proposal

This PhD proposal is an explorative research proposal challenging the **evaluation and the development of efficient modulations and spatial multiplexing schemes in below 6GHz band targeting the beyond 5G (6G) ultra-high bit rates communications for future services.** Therefore, main researches targeted in this PhD are:

i) The design of new modulation and detection schemes achieving ultra-high rate and reliability.
ii) Increased spectral efficiency and transmission rate: Towards this direction, the research questions that need to be addressed include the definition of novel generalized/enhanced SM schemes with higher SE, lower transceiver complexity, and better SNR performance.
iii) Investigate the capability of Machine Learning in the design of new receiver architectures considering slow time-varying channels and power amplifier nonlinearities

References:

[1] Matti Latva-aho, Kari Leppänen, 6G Research Visions 1Key Drivers and Research Challenges for 6G Ubiquitous Wireless Intelligence, 6G Summit, Oulu, Finland, September 2019

[2] Faouzi Bader and Jacques Palicot, "Thinking Points- Where Next? Spectrum Management Beyond 5G", at Spectrum for 5G –Fuelling Europe's 5G Vision, EU Commission, December 2016.

[3] DOCOMO, "5G Radio Access: Requirements, Concepts and Technologies," 5G White Paper, July 2014.
[4] E. Basar et al., “Index modulation techniques for next-generation wireless networks”, IEEE Access, vol. 5, no.1, pp. 16693-16746, Sep. 2017
[5] Saud Althunibat, Raed Mesleh, and Talha Faizur Rahman “A Novel Uplink Multiple Access Technique Based on Index-Modulation Concept “, IEEE Trans. on Communications, Vol. 67, Issue: 7, pp. 4848-4855. July 2019.

This PhD. thesis will start approximately in October 2020 and will be supervised by Prof. C. F. BADER and Dr. Yahia MEDJAHDI at ISEP (France) /Thèse débutera approximativement en octobre 2020, elle sera co-encadrée par le Prof. C. F. BADER (HDR), et le Dr. Yahia MEDJAHDI et se déroulera dans les locaux de l’ISEP à Issy les Moulineaux, France.

Covered Areas /Domaines abordés :

MIMO schemes, Digital communications, Beyond 5G, Signal processing, / MIMO, Communications numériques, au-delà de la 5G, traitement du Signal.

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