"Angle-of-Arrival estimation at millimeter-wave frequencies: theory and experiments"

Keywords: Wireless Communications, Propagation Channel Modeling, Angle-of-Arrival estimation

A master internship position is offered at Sorbonne University (GeePs laboratory), in Paris (duration of 4 to 6 months, depending on candidate availability) to work in a new project in collaboration with Polytech'Nantes (IETR laboratory), with a possibility to pursue a PhD afterwards.

About the context of the internship

The technological breakthrough brought by the first phase of 5G development is the use of massive MIMO systems in the sub-6 GHz band. Large antenna arrays associated to powerful coding schemes will enable high data rate and better spectrum efficiency. The second phase of 5G deployment should introduce the wide spread of millimeter-waves, with frequencies like 28 GHz, 40 GHz, and even beyond 60 GHz. At those frequencies, the free space attenuation is very large and high-gain antennas are required to improve link budget in order to reach a sufficient SNR to communicate (see figure 1). High-gain antennas are typically achieved by using large arrays (hundreds or thousands of radiating elements) and exhibit directional properties. They formed a radiating beam that needs to be oriented toward the Line-Of-Sight (LOS) path between the base station and the user equipment or toward a strong Non-LOS path (i.e., multipath component). This alignment procedure is known as beam-training. The issue is that when the user is mobile, a misalignment of the beam occurs, and the base station needs to find again a strong path. When the mobility is too fast, the beam-training procedure fails, which jeopardizes the actual data transmission. To realistically assess improved beam-training techniques in mobile scenarios, there is a need to estimate the Angle-of-Arrival (AoA) of the different multipath components existing between a base station and a mobile user in real time, the goal being to develop time-varying power-angular-spectrum channel models.

About the internship work

To develop a channel model that statistically describes the time-varying behavior of the power angular spectrum, on need to estimate AoA fast enough with respect to the user mobility. Consequently, the internship consists in implementing an AoA technique using a full-digital architecture of phased array at 28 GHz. The goal is to develop the required signal processing and to build a 28 GHz measurement setup using radiofrequency equipment (e.g., sources, filters, mixers, antennas) and software-defined radio units (see Figure 2).

The internship specific tasks include:

- State-of-the-art of AoA estimation techniques and time-varying power-angular-spectrum channel models

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- Implementation in simulation of the chosen AoA estimation able to work with coherent sources
- Practical AoA experiments in anechoic chamber at sub-6 GHz
- Practical AoA experiments in anechoic chamber at 28 GHz
- Practical AoA experiments in indoor environments at 28 GHz

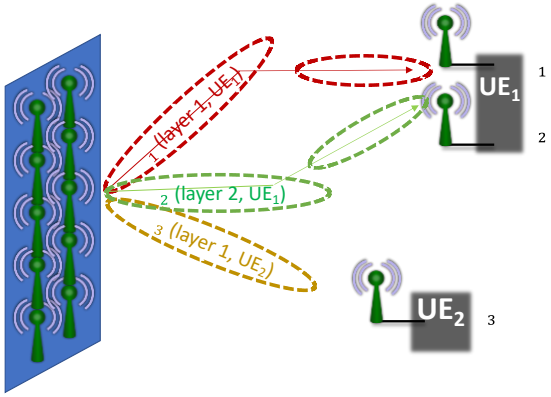

Figure 1 - MU-MIMO mm-wave multibeam operation

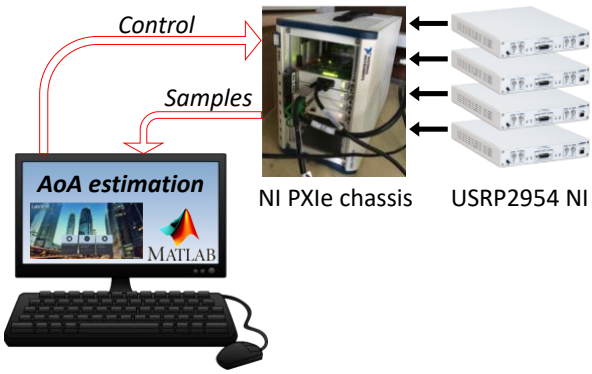

Figure 2 – Software-defined radio solutions for MIMO applications (from National Instrument)

About the environment

Sorbonne Université is in the center of Paris and offers an attractive working environment for students from all over the world. The candidate will benefit from all necessary equipment for design, fabrication, and experiments.

A scholarship of about 600€ per month will be provided as well as guidance in finding an accommodation.

This work is part of an ANR project, BeSensiCom, starting in November er 2022 for 4 years, in cooperation with the university of Nantes and is also carried out in the frame of a European network, the INTERACT COST action, where results are regularly presented.

Qualification and requirements

The candidate should be highly motivated, autonomous, and willing to pursue her/his career with a PhD. She/he should be enrolled in a master program with a strong background in radiofrequency, wireless systems, and signal processing.

Starting date

Anytime between January and April 2023
(The potential PhD should start afterwards, between September and November 2023)

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