“Leaky-Wave Antenna design for Angle-Of-Arrival Estimation”

Keywords: Leaky-wave antenna, millimeter-waves, aperture field analysis

A master internship position is offered at Sorbonne University, in Paris (duration of 4 to 6 months, depending on candidate availability), with a possibility to pursue a PhD afterwards.

The context

The second phase of 5G deployment will introduce millimeter-wave communications. At those frequencies, free space attenuation is large and high-gain antennas are required to improve link budget and enable communications. High-gain antennas are typically achieved by using large arrays and exhibit 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 strong Non-LOS paths (i.e., multipath component). This alignment procedure is known as beam-training (see Figure 1). 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 fails, which jeopardizes the actual data transmission. The estimation of the Angle-of-Arrival (AoA) of the incoming waves (i.e., LOS and NLOS components) in real time at the base station is therefore a key feature to speed-up beam-training, such as illustrated in Figure 2. For this scheme to be attractive and relevant, the sensing unit that estimates in real-time AoA should be low-power-consumption and low-cost.

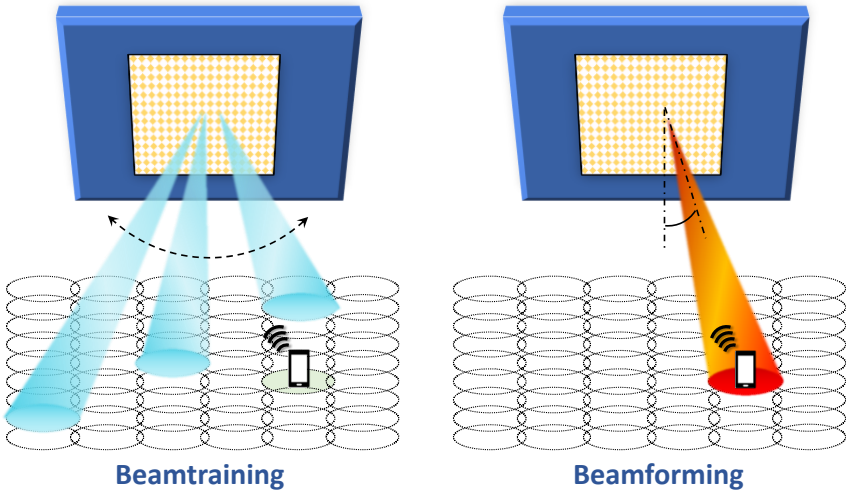

Figure 1 - Beam alignment procedure between a base station and a user equipment

The work

We have started investigating AoA estimation using a specific type of directional antennas: the leaky-wave antennas (LWA). LWAs are a class of traveling wave antennas that can efficiently replace antenna arrays, which are typically costly, power-consuming, and exhibit calibration issues, especially at millimeter-waves, to estimate AoA. LWAs exhibit directional properties (i.e., narrow beams) with a simple feeding structure (see figure 3). An interesting feature is that LWAs naturally exhibit beam scanning properties with frequency and can be therefore used to dynamically estimate AoA of different sources and multipath components (MPC). We have proved the concept using a frequency-domain MUSIC algorithm to achieve a low-complexity system able to estimate AoA in real time. However, the main bottleneck is to be able to scan a wide angular range with a limited frequency

GEEPS – Group of Electrical Engineering of Paris
Sorbonne University (ex - University of Pierre & Marie Curie)
Department of Engineering
4, place Jussieu – 75005 PARIS, FRANCE

bandwidth. We recently showed that multibeam LWAs can overcome this issue. The task of the internship candidate is therefore to study, design, fabricate LWAs that radiate multiple beams thanks to the efficient excitation of several visible space harmonics. To do so, a careful analysis of the antenna aperture field will be carried out to compare and propose antenna designs wherein higher-order spatial harmonics excitation is efficient.

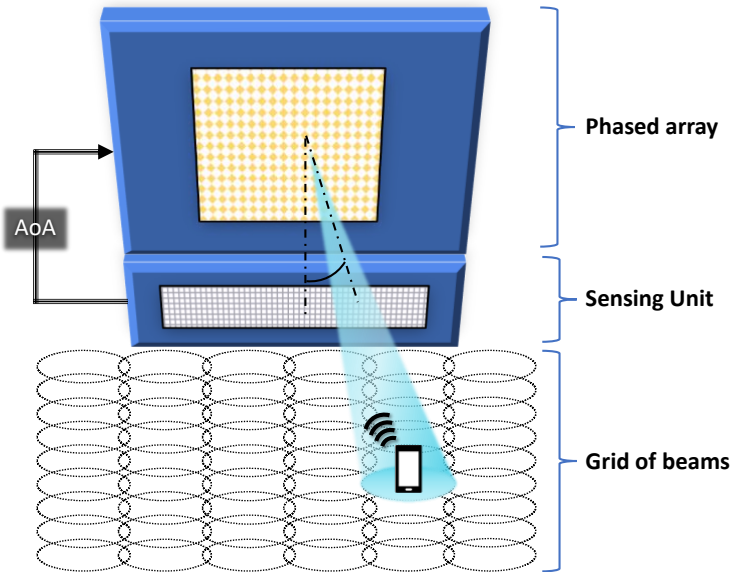

Figure 2 – Real time beam training thanks to low-complexity sensing unit

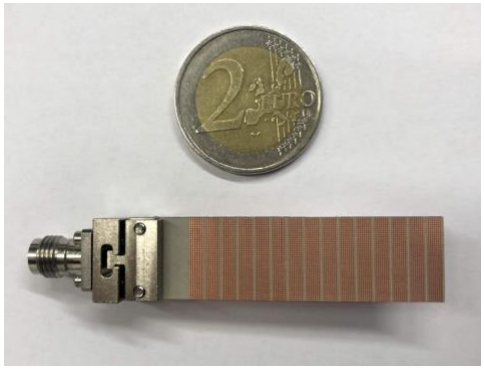

Figure 3 - Metasurface-based Leaky-Wave Antenna @ 60 GHz

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 electromagnetic devices.

Starting date

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

Contacts

Julien Sarrazin, julien.sarrazin@sorbonne-universite.fr

GEEPS – Group of Electrical Engineering of Paris
Sorbonne University (ex - University of Pierre & Marie Curie)
Department of Engineering
4, place Jussieu – 75005 PARIS, FRANCE