### Beamforming strategies for Joint Communication and Sensing (JCAS) Services in 6G Networks

Theme:	Communication, Sensing
Application:	6G
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### Master Thesis Assignment / Student Assignment

### I. Introduction:

**Summary:** Currently, wireless communication and radar sensing are two separate worlds. This is partly because radar mainly works at high frequencies (such as mmWave radar at 77 GHz) due to the required resolution and wireless communication currently only takes place below 6 GHz. In 6G, the differences in frequency will disappear, meaning that the configurable software antennas used for communication can also be used for radar sensing. JCAS offers several new functions that are very important in 6G, both for the use of the network itself (such as precise location of the users) as well as for various applications, such as road safety and smart industries 4.0.

### II. Description

Through this internship/ graduation project you will develop the critical components and concepts for a new generation of base stations that will support JCAS. You will especially focus on Dual-scenario beamforming concepts. You are going to investigate what the limits are if we want to do both sensing and communication in future 6G networks. You will further investigate beamforming techniques that support JCAS. As a starting point we will use OFDM and OTFS modulation concepts and investigate other possibilities.

Key activities of the proposed graduation project contributing to beamforming strategies for JCAS includes:

- To conduct a comprehensive literature review on the beamforming concepts for JCAS in mobile networks, in order to establish a solid research foundation, aid in modelling and potentially further sharpen the problem formulation to ensure novelty.
- To define a limited set of challenging scenarios with gradually increasing complexity, which will form the basis for the solution development and assessment.
- To model relevant scenario aspects related to sensing and communication requirements.
- To develop one or more beamforming concept. Formulate one or more heuristic solutions that can be used as a baseline.
- To develop a simulator incorporating model and solution aspects.
- To utilise aforementioned simulator to conduct an extensive quantitative assessment of the proposed beamforming solutions across a range of relevant scenarios.
- To derive key insights and conclusions regarding the beamforming solutions (defining initial system level requirement for 6G JCAS system), achievable performance, the sensitivity to selected scenario aspects and complexity issues related to the algorithm execution itself and implementational feasibility.

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The MSc project will be conducted as part of the large nationally funded research programme 'Future Network Services', which brings together 50-60 partners for a targeted period of six years. The proposed MSc project / internship is envisioned to involve collaborations/regular interactions with FNS partners.

### III. Requirement courses, skills and supervision:

## Fundamental knowledge on radio systems and signals, antennas and radio propagation, signal processing, logical thinking and problem solving.

As a graduate student pursuing a Master's degree, preferably in Electrical Engineering or a related discipline, you should possess the following qualifications:

- affinity with signal processing and wireless communication: Demonstrated interest in these areas will be advantageous;
- programming experience: Proficiency in either Matlab or Python (or both) is essential;
- enterprising, flexible, and cooperative nature;
- effective communication skills;
- creativity and innovation;
- knowledge of radar and communication systems: Familiarity with these topics is a plus.

The duration of the graduation project is approximately nine months, although an internship option is also available.

You want an internship opportunity on the precursor of your career; an internship gives you an opportunity to take a good look at your prospective future employer. TNO goes a step further. It's not just looking that interests us; you and your knowledge are essential to our innovation. That's why we attach a great deal of value to your personal and professional development. You will, of course, be properly supervised during your work placement and be given the scope for you to get the best out of yourself. Furthermore, we provide:

- A highly professional, innovative internship environment, within a team of top experts.
- A suitable internship allowance (615 euro for wo-, hbo- and mbo-students, for a full-time internship).
- Possibility of eight hours of free leave per internship month (for a full-time internship).

• A free membership of Jong TNO, where you can meet other TNO professionals and join several activities, such as sports activities, (work-related) courses or the yearly ski-trip.

• Use of a laptop.

**Contact Information** 

• An allowance for travel expenses in case you don't receive an OV-card.

