Waveform Design for mm-wave RAT

<u>Objective</u>: Design and investigate waveform(s) for mm-wave radio access technologies

<u>Background</u>: Mobile communication systems operating in higher frequencies than those currently allocated to 4G networks are being considered by industry as a very promising approach to significantly boost capacity. Such a system can potentially utilize the much larger spectrum available in high frequencies. Moreover, in order to support user data rates of Gbps and above, contiguous bandwidths larger than 100 MHz (being the widest bandwidth currently defined for 4G) are required. Depending on the realization of the 5G system, bandwidths in the order of several GHz may be needed for efficient high capacity data delivery.Such wide contiguous blocks of bandwidth are not available below 6 GHz, where the spectrum is highly fragmented, but can be found in higher frequencies above 6 GHz, and in particular in the millimetre-wave (mm-wave) frequency bands. A millimetre-wave air-interface, operating in frequencies beyond 30 GHz, can serve extreme demands on capacity, throughput, latency, mobility, and reliability, by making use of the large available bandwidths. A mm-wave radio access technology (RAT) is therefore envisioned to be an integral part of the 5G multi-RAT system.

The foundation of a successful mm-wave radio access technology is based on the waveform design. The currently used waveform in 4G systems is OFDM. However, the propagation characteristics for the frequencies in mm-wave bands are relatively unfavourable compared to the frequencies below 6 GHz. Furthermore, the signals transmitted and received at very high frequencies are subject to severe RF impairments. However, the small wavelength also brings benefits, allowing for a much larger number of antenna elements to be integrated into the devices. An efficient *<u>waveform design</u>* has to overcome the *<u>mm-wave specific (propagation and RF impairment related) challenges</u>*, while harnessing the benefits of *<u>large available channel bandwidth</u>* and *<u>massive number of antennas</u>*.

<u>Project Description</u>:

The project will investigate single-carrier and multi-carrier waveforms such as OFDM, FBMC, UW-OFDM, UF-OFDM, FQAM-OFDM, zero-tail OFDM, and possibly their variants/hybrids for mm-wave communication. These candidate waveforms (and possibly new waveforms) will be evaluated for the following key performance indicators:

- Robustness against RF impairments
- Spectral efficiency
- Compatibility with multi-antenna technologies
- Robustness against Doppler effect
- Low Peak-to-Average-Power-Ratio (PAPR)

Required Skills: The applicant for this master thesis will be assessed based on the following merits:

- Desire to work on challenging research project and produce timely results
- Strong background in Signal Processing, Digital Communications, and Matrix Algebra
- Proficiency in MATLAB and C++ Programming
- Prior experience or a good understanding of OFDM and single carrier transmission schemes