Environment Mapping with 5G 28 GHz mm-wave beamsteering arrays

Motivation

The 5G standard dedicated several gigahertz of bandwidth around 28 GHz for high-rate, low-range communications. To overcome the large path loss at millimeter-wave frequencies, large antenna arrays are required. We developed a pair of 28 GHz software-defined radios (SDRs), using conventional SDRs for generating the baseband signals, and a 16-antenna array for beamsteering. With our setup, signals with bandwidths up to 100 MHz can be generated, and the transmitter and receiver beams can be steered in azimuthal and elevation space through a digital control link.
Since the transceiver's beams are quite narrow, it is possible to identify individual multipath components in the environment, and eventually to recreate a map of the obstacles in the environment by steering the Tx and Rx beam in all directions to "scan" the environment.

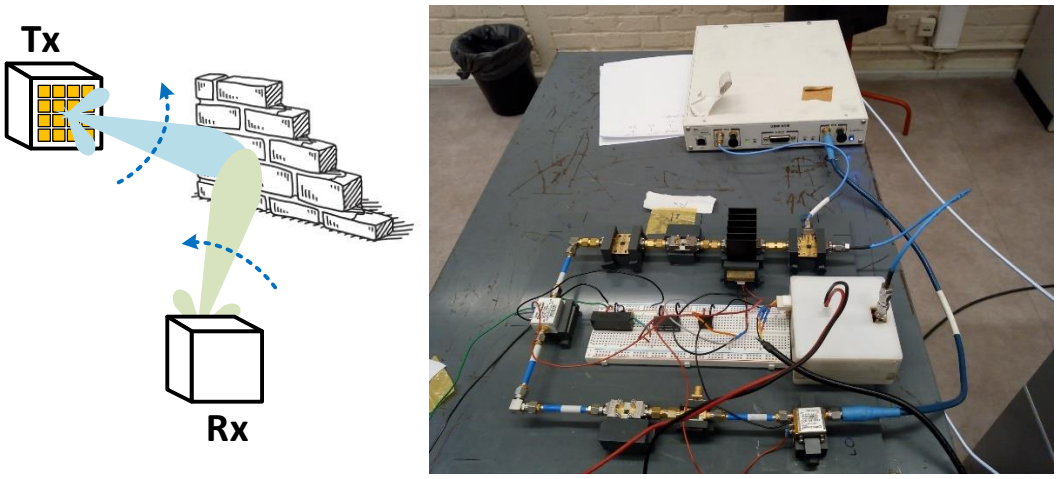

Figure: Concept of environment mapping through beamsteering and picture of our 28 GHz SDR

Objective

This Master's thesis will investigate the ability of a 28 GHz beamsteering system to resolve multipath components and eventually reconstruct an image of the environment surrounding our transceivers. The first step will be to adapt the SDR software to allow for transmitting and receiving signals up to 100 MHz of bandwidth. Next, the student will need to design and implement super-resolution algorithms, such as the expectation-maximization algorithm, to resolve individual multipath contributions in the received signal. Such high-complexity mathematical algorithms have been successfully leveraged for multipath identification in channel sounding scenarios, but must be adapted to account for the process of beamsteering in the proposed system. The student will have to perform measurement in synthetic and non-synthetic scenarios, and validate the super-resolution algorithm on these measurements.

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