TECHNISCHE UNIVERSITÄT DRESDEN

**Faculty of Electrical and Computer Engineering** Vodafone Chair Mobile Communications Systems

# Timing Estimation with 1-bit Quantization and Oversampling at the Receiver

Master/Diploma Thesis

**Problem Statement**

The design of communications systems to achieve data rates beyond 100 Gb/s necessitates the use of large bandwidths at high carrier frequencies, which in turn requires the receiver to be equipped with very fast analog-to-digital converters (ADCs). At these high sampling rates, high-resolution ADCs have been identified as a bottleneck regarding the power consumption of the system. Using ADCs with 1-bit of resolution for these systems is considered beneficial, as 1-bit ADCs can operate very energy-efficient and the loss in achievable rate due to the low resolution can be partially compensated by higher signaling and sampling rates, i.e., oversampling w.r.t. the Nyquist rate.

Typically, in communications systems, the receiver performs synchronized detection, i.e., the received signal is downconverted and sampled before detection is performed at symbol rate. However, the propagation channel between transmitter and receiver can cause several disturbances (such as phase and timing offsets), which need to be resolved (synchronized) before detection can be performed. To be able to perform synchronization, the disturbances need to be estimated in the first place, which is why channel estimation is a vital part of every receiver.

In this regard, the aim of the diploma thesis is to investigate suitable estimation algorithms for timing offsets in communications systems with 1-bit quantization and temporal oversampling at the receiver. Off-the-shelf estimation algorithms, known for standard receivers, cannot be applied due to the nonlinear nature of the 1-bit quantization. Both, the adaptation of already known timing estimation algorithms as well as the derivation of new algorithms are possible. The creation of a simulation environment for the verification of the algorithms as well as the verification itself are also part of the task.

**Tasks**

- Literature research of suitable estimation approaches
- Derivation of timing estimation algorithms
- Implementation of the algorithms
- Verification of the estimation algorithms in a suitable simulation environment

**Expected Skills**

- Experience with Matlab/Python

**Contact Person**

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