Preface

As silicon technology advances, field programmable gate arrays appear to gain ground against the traditional ASIC project starts, reaching out to form the mainstream implementation basis. Their predefined structures result in an essential inefficiency, or performance gap at all relevant axes, i.e. clock frequency, power and area. Thus, highly optimised system realisations become more and more important to use this technology at its best. Microarchitectures and their adaptation to the FPGA hardware, combined with an optimal matching of model structures and FPGA structures, are two points of action where engineers can try to get optimally balanced solutions for their designs, thus fighting the performance gap towards the ASIC reference.

While microarchitecture design based on the knowledge of FPGA structures is located in the domain of traditional hardware engineering, the mapping and matching is based on EDA algorithms and thus strongly related to computer science. Algorithms and the related sophisticated tools are permanently in short supply for leading edge optimisation needs.

Martin's dissertation deals with the algorithmic optimisation of circuits for the multiplication of a variable with constants in different flavours. As this type of operations is elementary in all areas of digital signal processing and also usually on the critical path, his approaches and results are of high relevance not only by themselves but also as a direction for further research. His direct contributions are the advancement of algorithmic treatment of pipeline-based multiplier circuits using heuristics and exact optimisation algorithms, the adaptation of several algorithms to the specific conditions of field programmable gate arrays, specifically lookup-table based multipliers, ternary adders and embedded multipliers with fixed word length, and the transfer of his findings to a floating-point multiplier architecture for multiple constants.

Along with all the accompanying details, this is a large range of topics Martin presents here. It is an impressive and comprehensive achievement, convincing by its depth of discussion as well as its contributions in each of the areas.

Martin was one of my first PhD candidates. Thrown into the cultural conflict between computer science and electrical engineering he soon developed a sense for the symbiosis of both disciplines. The approach and results are symptomatical for this developing interdisciplinary area, where systems and their optimisation algorithms are developed corporately.

I found Martin's text exciting to read, as it is a comprehensive work within the ongoing discussion of algorithmic hardware optimisation. His work is supported by a long list of successful publications. It is surely a contribution worth reading.

Kassel, 22. of April, 2016 *Prof. Dr.-Ing. Peter Zipf*

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