

# Hardware-based Virtual Memory for Analytical Database Query Processing on FPGAs

(Bachelorthesis) / Masterthesis

## Research field

In contrast to CPUs, FPGAs generally offer neither a fixed memory hierarchy nor virtual memory capabilities. Instead, realisation and use of memories, memory controllers, and bus systems is completely up to the designer. While this situation is advantageous for some applications for the increased optimisation potential, it hinders implementation and adoption of portable, more hardware-oblivious architectures. There is existing research into FPGA virtualisation and prototypes for allowing FPGA designs to access the host virtual memory, such as [1] and [2], as well as specialised memory access strategies for streaming applications [3].

## Research topic and working hypothesis

Adapting the aforementioned concepts and architectures for analytical database query processing on FPGAs requires work on several research and implementations tasks: Following comprehensive literature review, modelling these processes allows for effective design space exploration. Selected configurations are implemented in hardware and evaluated, validating the developed models against hardware implementations.

## Work plan

- Modelling of memory access methods for database operations on FPGAs.
- Design space exploration to determine viable implementation strategies and parameters.
- Implementing hardware components supporting virtual memory
- Evaluating performance and resource requirements

## Required skills

- Good knowledge of C++, ideally C++17.
- Knowledge of SystemC and Transaction-level Modelling (TLM) (cf. Lecture on Heterogeneous Computing).
- Good command of VHDL.

## Contact



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## References

- [1] K. Danne *Memory Management to Support Multitasking on FPGA Based Systems*. In Proceedings of the International Conference on Reconfigurable Computing and FPGAs (ReConFig), 2004.
- [2] H. Ng, Y. Choi, and H. K. So *Direct Virtual Memory Access from FPGA for High-Productivity Heterogeneous Computing*. In Proceedings of the International Conference on Field-Programmable Technology (FPT), 2013.
- [3] J. Park and P. C. Diniz *Synthesis of Pipelined Memory Access Controllers for Streamed Data Applications on FPGA-based Computing Engines*. In Proceedings of the International Symposium on System Synthesis (ISSS), 2001