

Bachelor/Master Thesis

Energy Optimization for NVM Accesses

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 08.11.2022

As an alternative to traditional DRAM, non-volatile main memories (NVMs) are being addressed by a wide focus in the research community but are also market ready available. Such NVMs feature new technologies, which come usually with some benefits and drawbacks. While, for instance, the integration density can be high and therefore the capacity can be large at a low cost, NVMs are sometimes slower than DRAM, have a limited lifetime and can consume more energy for accesses. Hence, it is of crucial interest to optimize software in a way that optimizes the energy consumption and lifetime, but keeps the retention, i.e. the time before a value is lost in the memory, long enough. That can be achieved by a precise analysis of software and instrumentation means, which alter memory accesses, even after the program has been written.

their access properties. In order to simulate various types of NVMs, simulation tools exist in the research group, which the students should get familiar with. Additionally, in order to analyze the memory accesses of a program and to modify these accesses during compilation, an LLVM based setup also exists in the research group. After getting familiar with these tools, students shall decide in which direction they prefer to pursue their thesis, i.e. rather focusing on the simulations or on the program analysis. Students should subsequently define the scope of their thesis together with the supervisor.

The thesis generally can be carried out with different focuses. I.e. the focus can be on memory analysis on the application level, or it could be on altering the memory accesses of the application. Furthermore, the focus could be on changes in the NVM simulation itself or in the operating system in order to alter the memory usage of the operating system.

Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.

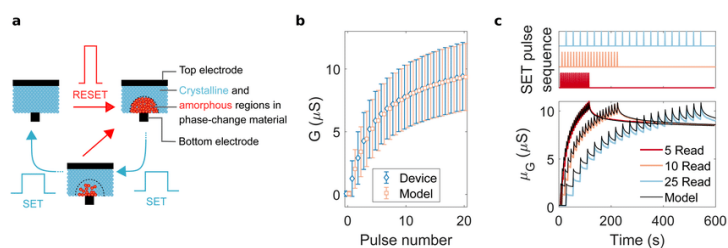


Figure 1: Write process of a phase change memory (PCM)¹

Figure 1 illustrates the process of writing a value to a specific NVM technology, namely phase change memory (PCM). It can be seen that write accesses are an incremental process, which programs the memory cell to a certain value. Depending on how long that write pulse endures, the energy consumption, but also retention and lifetime can be tuned.

In this thesis, students should first get familiar with the topic of non-volatile memory and

Required Skills:

- Knowledgeable of C and C++ programming
- Willing to program low-level (i.e. machine-close code / LLVM)

Acquired Skills after the thesis:

- Knowledge about modern memory technologies and memory access properties.
- Knowledge about memory simulation and analysis.

¹<https://www.researchgate.net/publication/341407365/figure/fig1/AS:89145116459417601589549928808/Phase-change-memory-characteristics-a-Phase-change-memory-devices-have-a-phase-change.ppm>