Racetrack Memories: Optimizations and co-design for in-memory computing

With the rise of computationally expensive application domains such as machine learning, genomics, and fluids simulation, the quest for performance and energy-efficient computing has gained unprecedented momentum. The significant increase in computing and memory devices in modern systems has resulted in an unsustainable surge in energy consumption, a substantial portion of which is attributed to the memory system. The scaling of conventional memory technologies and their suitability for the next-generation system is also questionable. This has led to the emergence and rise of various nonvolatile memory (NVM) technologies. Racetrack memory (RTM) is one such nonvolatile memory technology that promises SRAM-comparable latency, reduced energy consumption, and unprecedented density compared to other technologies. However, RTM is sequential in nature, i.e., data in an RTM cell needs to be shifted to an access port before it can be accessed. These shift operations incur performance and energy penalties. In this talk, I will present a set of techniques, including optimal, near-optimal, and evolutionary algorithms for shifts minimization in RTMs. In addition, I will discuss the RTM potential in non-Von-Neumann in-memory computing paradigms, exploiting the device attributes to implement logic and arithmetic operations.

Speaker Bio

Asif Ali Khan Asif Ali Khan is a post-doctoral researcher at the Chair for Compiler Construction in the Computer Science Department of the TU Dresden, Germany. His research interests include computer architecture, heterogeneous memories, and compiler optimizations for the memory subsystem. He has published his findings in the most important conferences and journals in the domain, including DATE, DAC, LCTES, ISLPED, IEEE CAL, IEEE TCAD, IEEE TETC, IEEE TC, Proc. of the IEEE, ACM TECS and ACM TACO. Mr. Khan is actively collaborating with academic and industrial partners, including joint work with ETH, Tampere Univ., Pittsburgh Univ., TU Eindhoven, TU Dortmund, IST Islamabad, and MPI Halle.