

## Bachelor's / Master's / Semester Project

### Hardware-Software-OS Cooperative Techniques for Efficient and Secure Computing

Co-designing software, hardware, and the operating system is a promising approach towards (i) accelerating a wide spectrum of modern applications like graph analytics, generative AI, and recommender systems, (ii) designing intelligent and efficient OS policies like memory management, storage management, container spawning, and (ii) hardening system and processor security.

We are searching for students who are interested in any of these hardware-software-OS co-design research topics:

1. Hardware/OS co-design to enable efficient and secure memory and compute resources
  - a. New out-of-the-box virtual memory designs with a focus on new memory trends like CXL memory pooling, processing-near-memory, processing-using memory, and in-storage processing
  - b. Establishing new protection schemes against microarchitectural attacks that leverage the OS to introduce new vulnerabilities
  - c. Design of specialized hardware to enable fast inter-process operations (e.g., context switching, spawning containers)
  - d. Simulation and FPGA-based infrastructures to enable hardware/OS co-design studies
2. Designing software and hardware solutions to harden the security of emerging paradigms like processing-in-memory and in-storage processing

#### Requirements:

- Strong coding (mainly C/C++) skills
- Strong computer architecture and operating systems background
- Strong work ethic

#### Suggested readings:

- [1] Konstantinos Kanellopoulos et al. "[Victima: Drastically Increasing Address Translation Reach by Leveraging Underutilized Cache Resources](#)" MICRO 2023
- [2] Konstantinos Kanellopoulos et al. "[Utopia: Fast and Efficient Address Translation via Hybrid Restrictive & Flexible Virtual-to-Physical Address Mappings](#)" MICRO 2023
- [3] Vijaykumar et al. "[A Case for Richer Cross-layer Abstractions: Bridging the Semantic Gap with Expressive Memory](#)" ISCA 2018
- [4] Hajinazar et al. "[The Virtual Block Interface: A Flexible Alternative to the Conventional Virtual Memory Framework](#)" ISCA 2020
- [5] Kanellopoulos et al. "[SMASH: Co-designing Software Compression and Hardware-Accelerated Indexing for Efficient Sparse Matrix Operations](#)" MICRO 2019
- [6] Onur Mutlu, "[Intelligent Architectures for Intelligent Machines](#)" Invited paper in DATE 2021

If you are interested, please email:

Professor Onur Mutlu, [omutlu@gmail.com](mailto:omutlu@gmail.com), <https://people.inf.ethz.ch/omutlu/>  
Konstantinos Kanellopoulos, [konkanello@gmail.com](mailto:konkanello@gmail.com)

Also, apply online:

<https://safari.ethz.ch/work-with-us/projects>