Dynamically Reconfiguring Hardware-Vulnerability Mitigations to Improve Energy Efficiency

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Fachgruppentreffen Betriebssysteme

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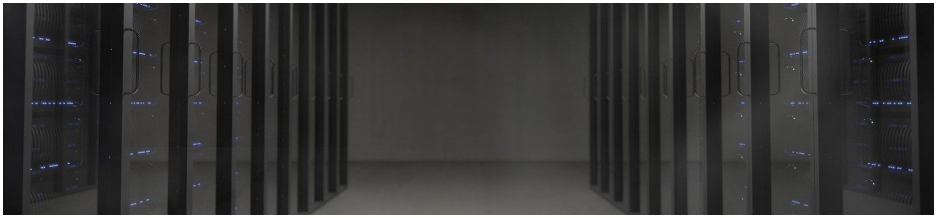
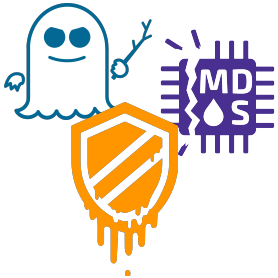
The Price of Hardware-Vulnerability Mitigations





Hardware Vulnerabilities & Mitigations

Spectre

- ⇒ leak of speculatively accessed data
- STOP restriction of speculation

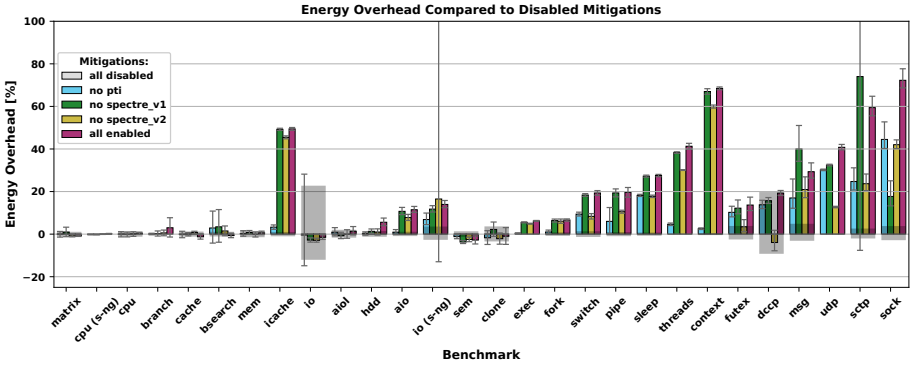
Meltdown

- ⇒ leak of speculatively accessed kernel data
- STOP Kernel Page Table Isolation (KPTI)

Microarchitectural Data Sampling (MDS)

- ⇒ sampling of data from shared on-core resources
- STOP disabling Simultaneous Multithreading (SMT), Core Scheduling

The Price of Spectre and Meltdown Mitigations

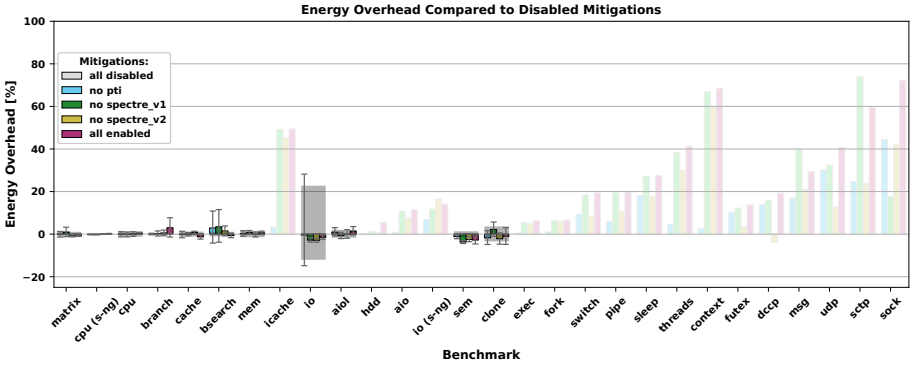


Benedict Herzog et al.

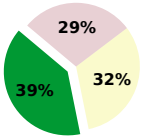
"The Price of Meltdown and Spectre: Energy Overhead of Mitigations at Operating System Level."

In: *Proceedings of the 14th European Workshop on Systems Security (EuroSec '21).*

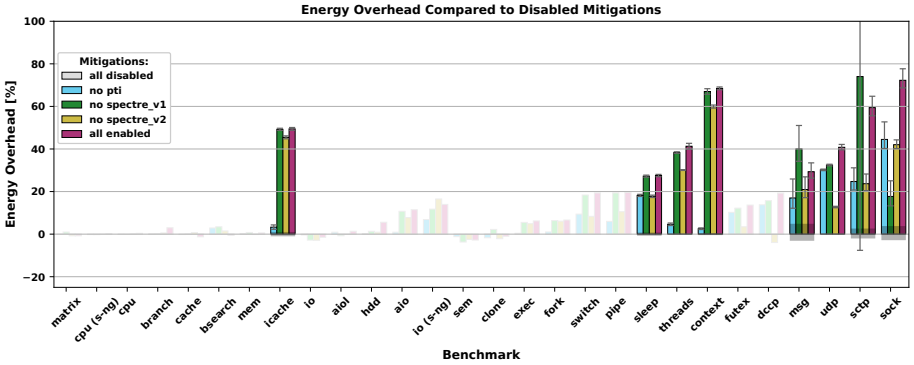
The Price of Spectre and Meltdown Mitigations



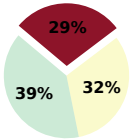
→ 11 out of 28 benchmarks have an overhead below 5 %



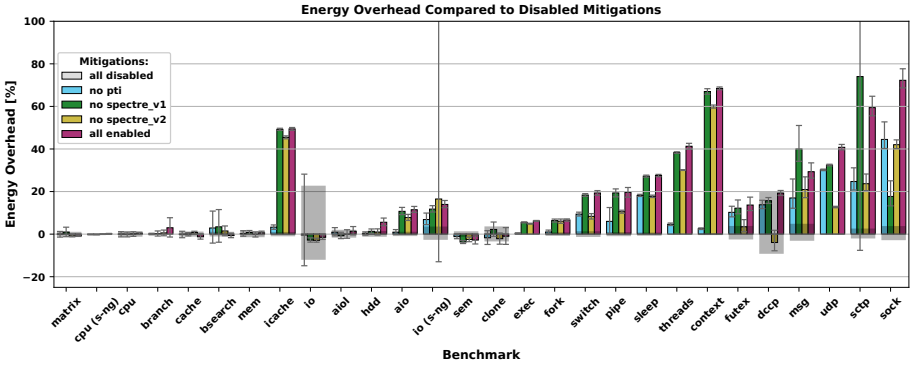
The Price of Spectre and Meltdown Mitigations



→ 8 out of 28 benchmarks have an overhead above 25 %

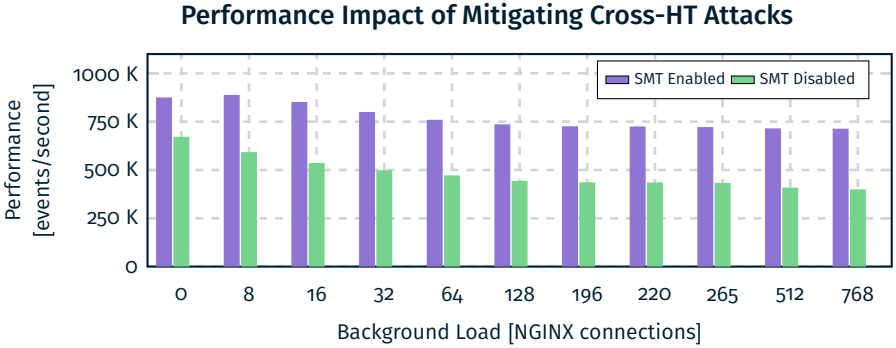


The Price of Spectre and Meltdown Mitigations



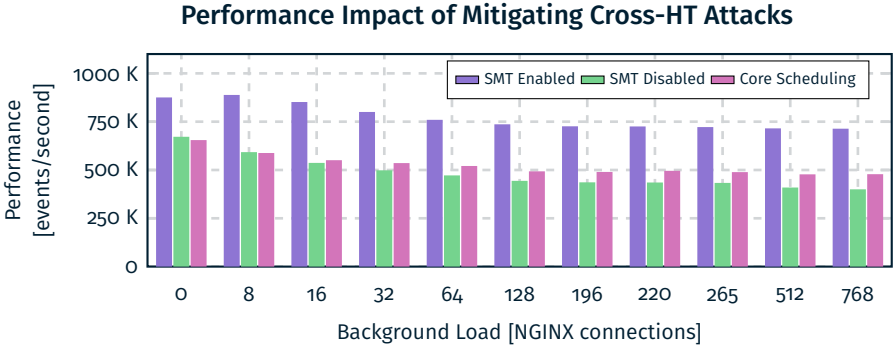
The overhead is highly application-dependent and ranges from ~0 % to 72 %.

The Price of Cross-HT Attack Mitigations



→ **disabling SMT incurs high performance penalties of up to 44 %**

The Price of Cross-HT Attack Mitigations



→ **Core Scheduling reduces performance penalties under high system load**

Potential of Customization and Reconfiguration

Customization

- adapt to application requirements
- adapt to current system state
- adapt to hardware

Reconfiguration

- adapt dynamically at run time
- avoid unnecessary overhead

optimize the system's energy efficiency &
utilize security features for improvements

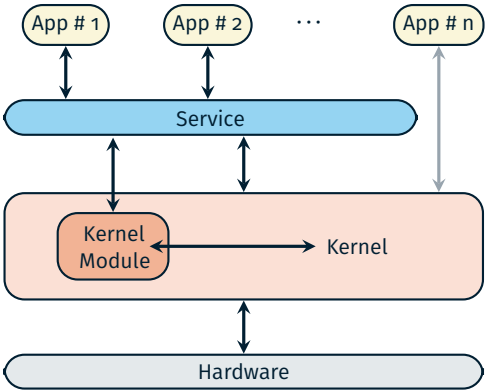
Dynamic Hardware-Vulnerability Mitigation Reconfigurations

Reconfiguration

- based on system state and application requirements
- update on any state changes

Kernel Reconfigurability

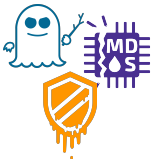
- information on vulnerabilities and available mitigations
- reconfiguration interface
- code-patching initiation

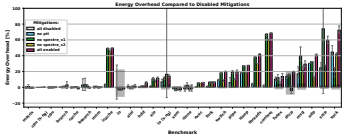


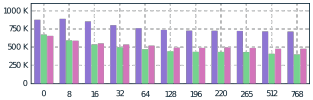
State of Work

First Results

- extensive evaluation of Spectre and Meltdown mitigations
- fully functional reconfiguration implementation
  → minimal performance overhead







Next Steps

- extensive evaluation of Core Scheduling
- continuously adapt system to current developments
- extension of system to include further mitigations

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