

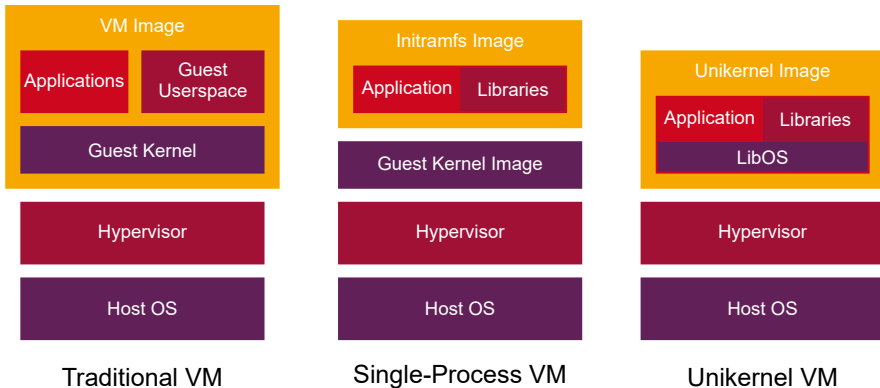
Dissecting the Performance Impact of System Calls

<https://doi.org/10.1145/3831586.3838146>

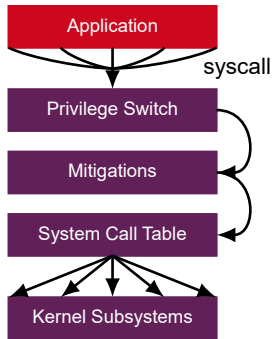
Martin Kröning	Vincent Feinendegen	Stefan Lankes
Sarah Simon	Jonathan Klimt	Antonello Monti

Workshop on Programming Languages and Operating Systems (PLOS '26)
September 29, 2026

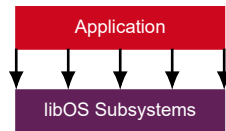
VM Flavors



System calls vs. libOS calls



Monolithic Kernel



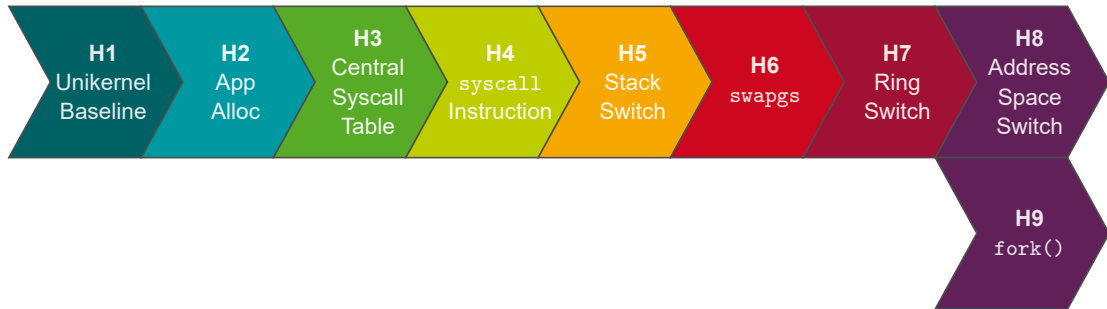
Unikernel

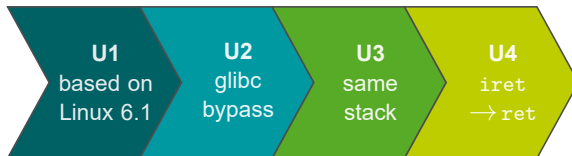
1. How costly are system calls?
2. How does system call overhead affect I/O performance?
3. What does this mean for unikernels?

Section 1

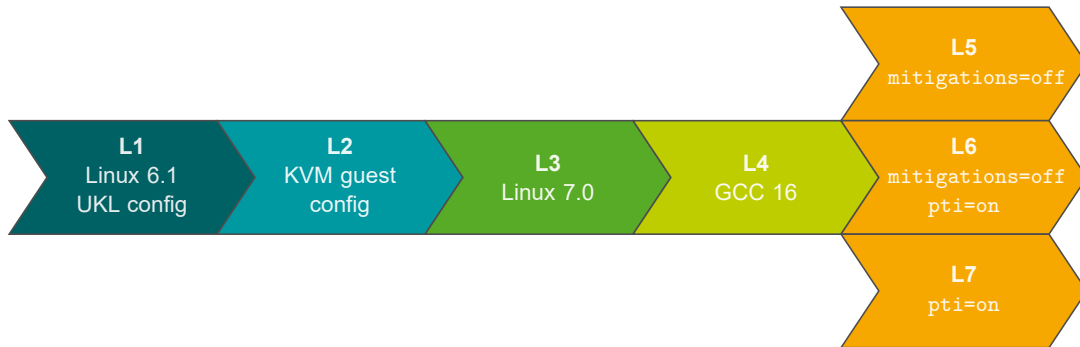
Approach

Anatomy of a System Call





Linux Targets



Section 2

Results

Latency Results

POIs: L5 (new kernel, no mitigations), H8 (synthetic overhead)

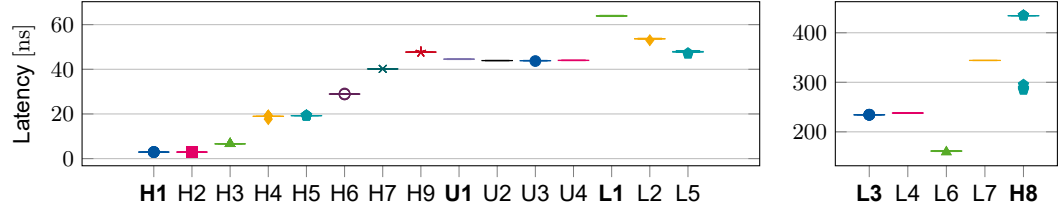


Figure: `getpid()` latency. Lower is better. Configurations grouped by latency range.

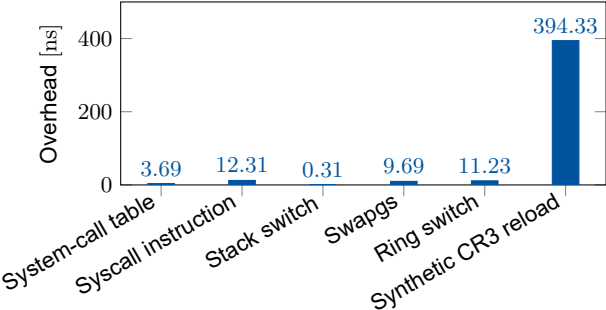


Figure: Overhead costs of traditional system calls.

TCP Receive Bandwidth

POIs: H8 (synthetic overhead), K1 (Unikraft, nolibc), L5 (new kernel, no mitigations)

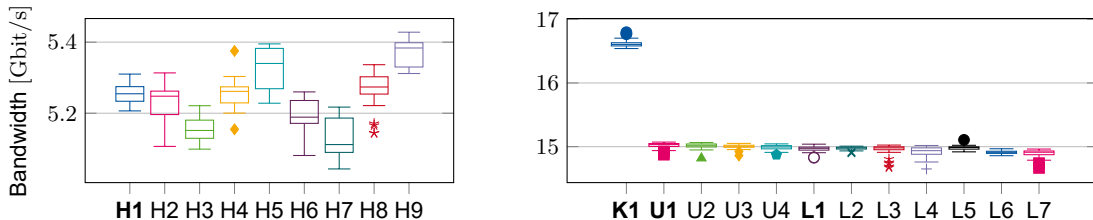


Figure: TCP receive bandwidth. Higher is better. Configurations grouped by bandwidth range.

HTTP Request Duration

POIs: H8 (synthetic overhead), K1 (Unikraft, nolibc), L5 (new kernel, no mitigations)

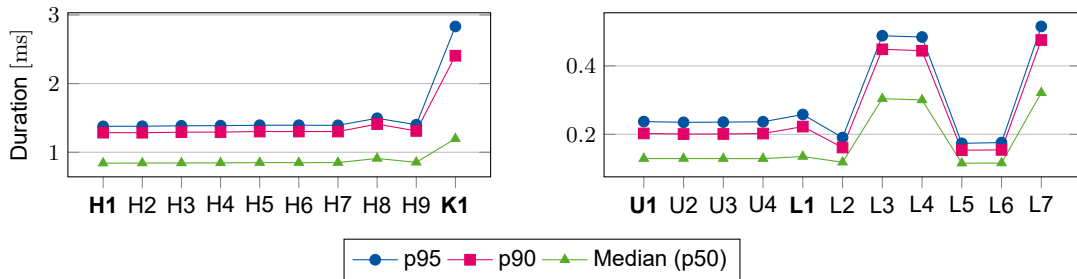


Figure: HTTP request duration. Lower is better. Configurations grouped by duration range.

1. How costly are system calls?

- ~ 40 ns unmitigated, hundreds of ns mitigated

2. How does system call overhead affect I/O performance?

- For I/O, unmitigated system calls are cheap.
- CPU vulnerability mitigations are expensive.
- I/O stack and driver maturity are most relevant.

3. What does this mean for unikernels?

- LibOS function calls are only a very small structural advantage.
- Unikernels might have the edge on image size and boot time.
- Unikernels with specialized applications can benefit from high integration.

Thank you for your attention

Questions?

H9 fork() source

<https://github.com/hermit-os/boot-image>

Martin Kröning

martin.kroening@eonerc.rwth-aachen.de

Institute for Automation of Complex Power Systems

RWTH Aachen University

Mathieustr. 10, 52074 Aachen, GERMANY

www.acs.eonerc.rwth-aachen.de



**Funded by
the European Union**

Funded by the European Union via the Horizon Europe projects CyberNEMO (101168182) and InterSCADA (101173007). Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the granting authority can be held responsible for them.

Image	Size [MiB]	Uncompressed [MiB]
Ubuntu cloud image	n/a	598.8
UKL U4 initramfs	8.3	16.9
UKL U4 unikernel	13.6	390.2
Hermit H1 unikernel	n/a	12.5
Linux L1 kernel	12.0	373.1
Linux L4 kernel	5.8	24.5
Linux initramfs	0.4	0.9
Unikraft K1 unikernel	n/a	0.5

Table: Image sizes relevant to the HTTP server.

Latency Results (2)

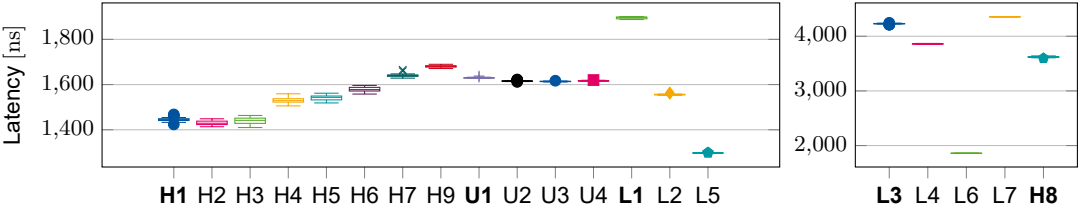


Figure: open() + write() + lseek() + read() + close() latency. Lower is better. Configurations grouped by latency range.

TCP Send Bandwidth

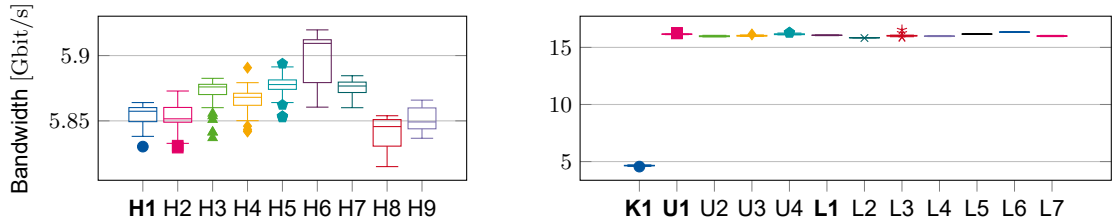


Figure: TCP send bandwidth. Higher is better. Configurations grouped by bandwidth range.