CYBERUS TECHNOLOGY

Mitigating Processor Vulnerabilities by Restructuring the Kernel Address Space

Sebastian Eydam

About Me

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- Computer-Science student at BTU Cottbus since 2015
- Cyberus Technology intern since 2017
- Cyberus Technology employee since 2022

About Cyberus

CYBERUS TECHNOLOGY

- german cyber security software company
- founded in 2017
- focus on secure virtualization and automated software testing
- `https://www.cyberus-technology.de/blog.html`
- `https://github.com/cyberus-technology/hedron`

Motivation

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- existing mitigations introduce costly instructions into performance critical parts of the kernel
- investigate an alternative mitigation strategy on the kernel design level that ideally adds no runtime overhead and is CPU independent

Current Status

Proposed Mitigation

Case-Study: Hedron

Measurement

Efficacy

Conclusion

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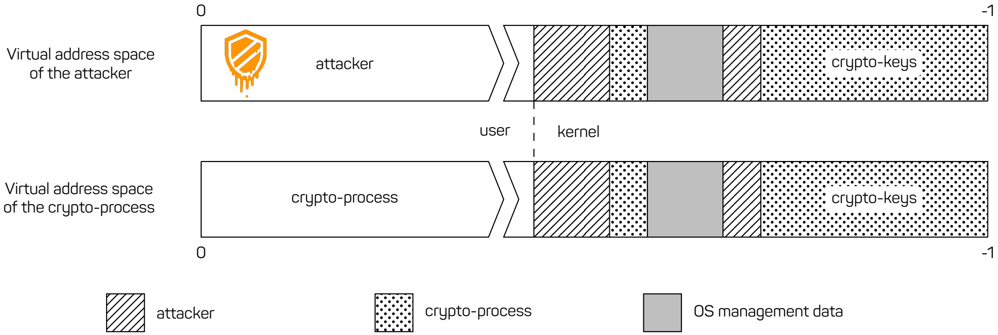

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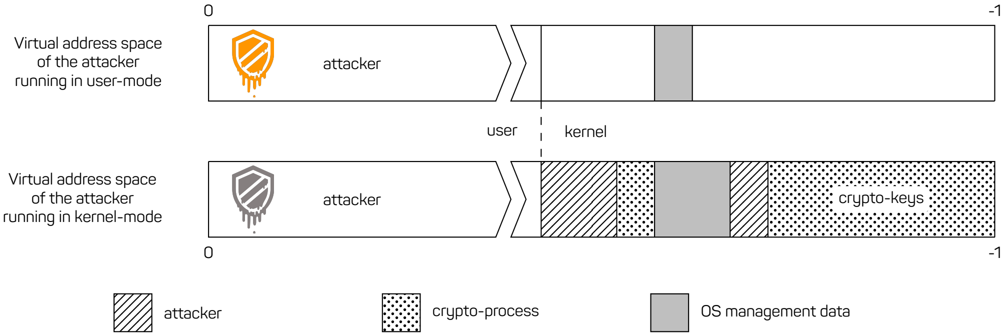

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Proposed Mitigation
General Idea

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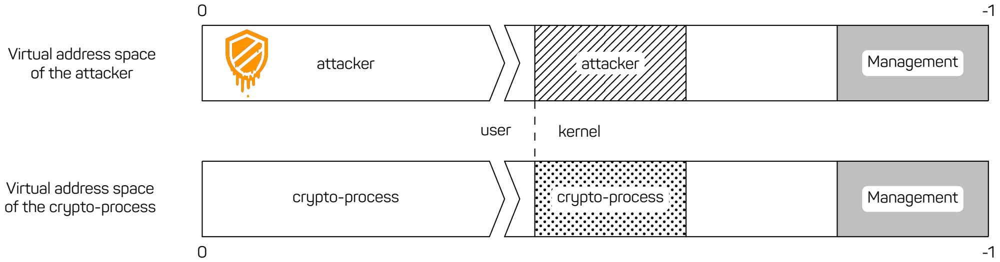

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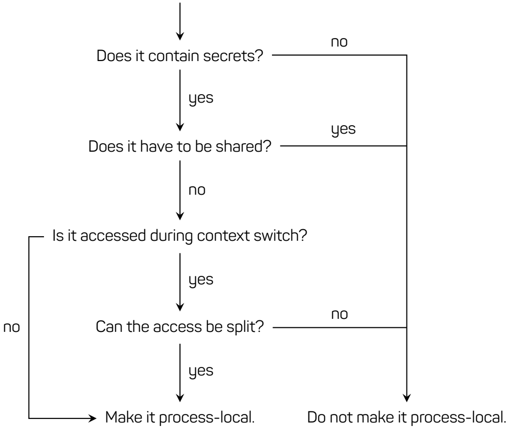


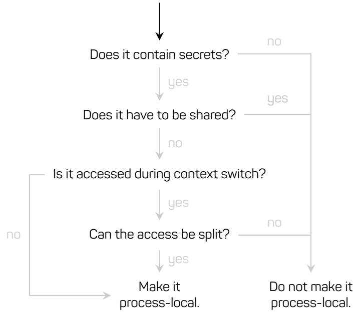
UTCB

Does it contain secrets?

Does it have to be shared?

Is it accessed during context switch?

Can the access be split?



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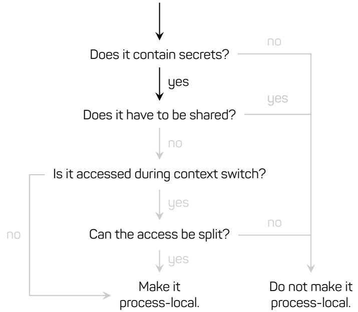

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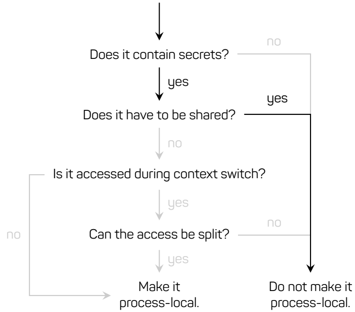

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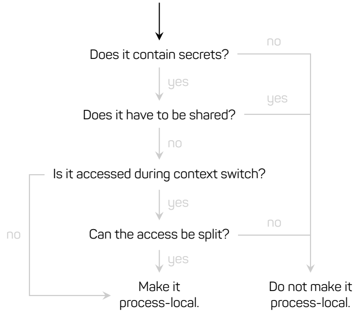

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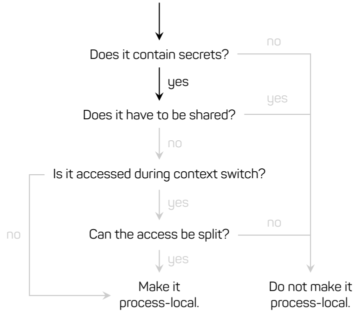

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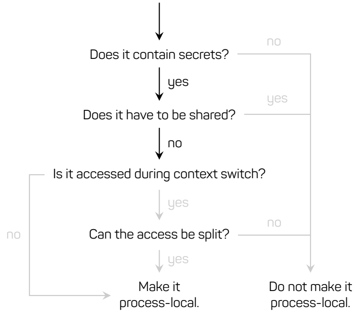

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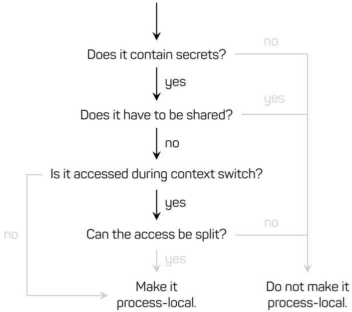

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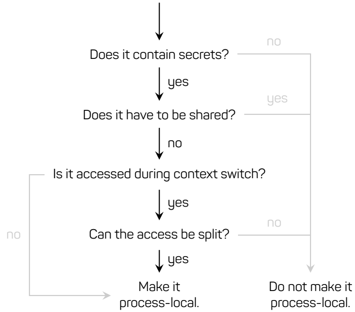

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- a memory allocator for process-local memory
- slight modifications of the context switch
- a mechanism to initialize process-local memory

Case-Study: Hedron

Initialization-Problem

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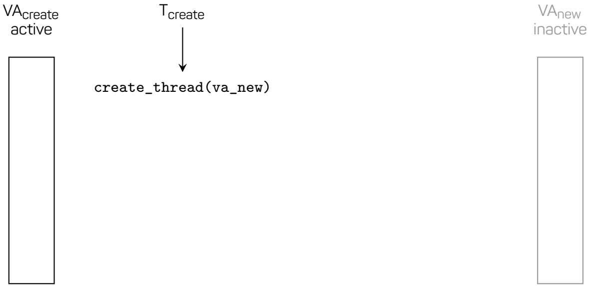
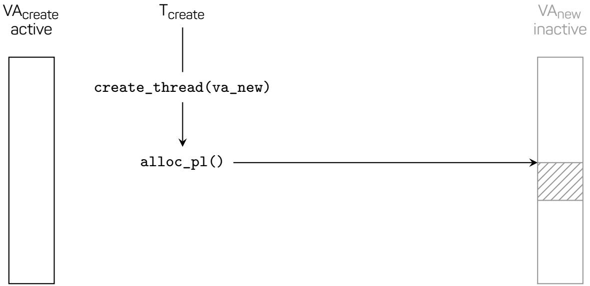
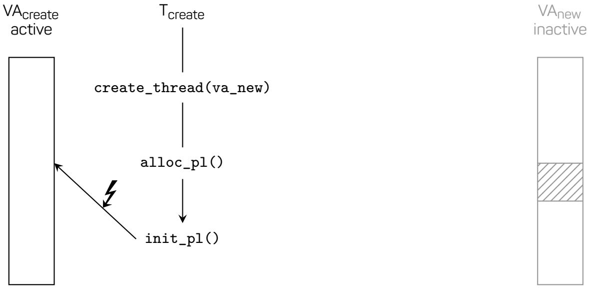




VAcreate
active
Tcreate
create_thread(va_new)
alloc_pl()
VAnew
inactive



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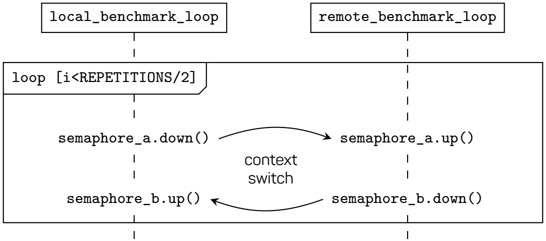

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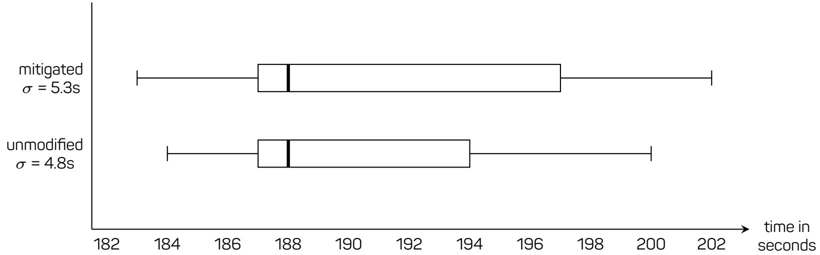
	Hedron (unmodified)	Hedron with mitigation
Cycles per context switch	2294	2315

Measurement

Linux kernel compile - Results



Measurement

Windows DiskSpd - Results (128K seq read, threads: 1, queue depth: 32)

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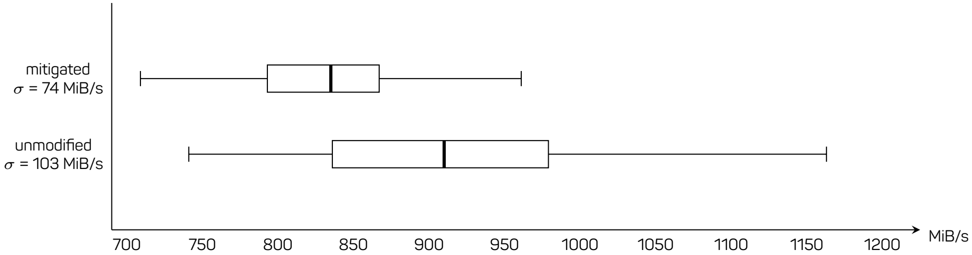
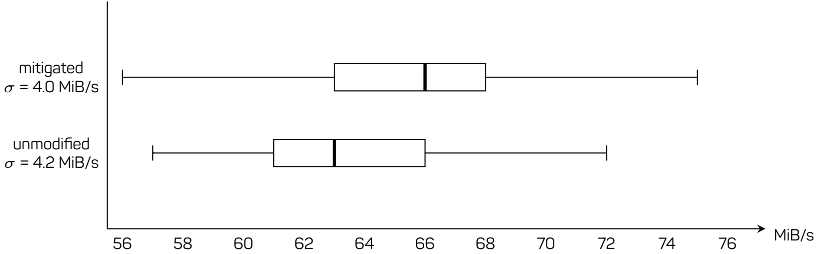


Measurement

Windows DiskSpd - Results (4k rnd read, threads: 16, queue depth: 32)



Efficacy of the Mitigation

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Mitigation	Meltdown	Spectre v1	Spectre v2	unknown	zero cost	CPU independent
Kernel Page Table Isolation						
Disabling speculative execution						
Speculative Load Hardening						
Retpolines						
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- `https://github.com/amphi/hedron/tree/new-mitigation-prototype`