





# Meltdown exploits two properties of modern CPUs

- ▶ *Out of order execution* of OPs and  $\mu$ OPs
- ▶ Timing side channels for the cache

This allows an attacker to

- ▶ Read all memory mapped<sup>1</sup> in a process
- ▶ This often includes all other processes memory
- ▶ This does NOT allow reading "outside of a VM<sup>2</sup>"



**MELTDOWN**

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<sup>1</sup>Virtual vs. physical memory is another time <sup>2</sup> For fully virtualised VMs





SPECULATIVE  
EXECUTION

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**SPECTRE**



## MELTDOWN

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