The Evolution of Transient-Execution Attacks

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Motivation

- Many different transient-execution attacks

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- Many different transient-execution attacks
- Previous work looked at differences of attacks
- What are the similarities?

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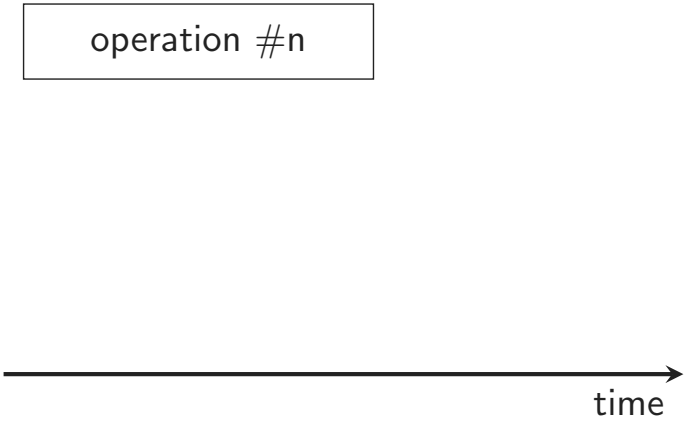
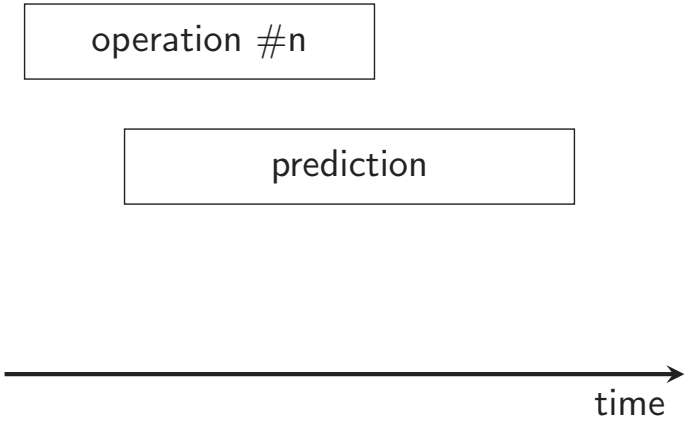
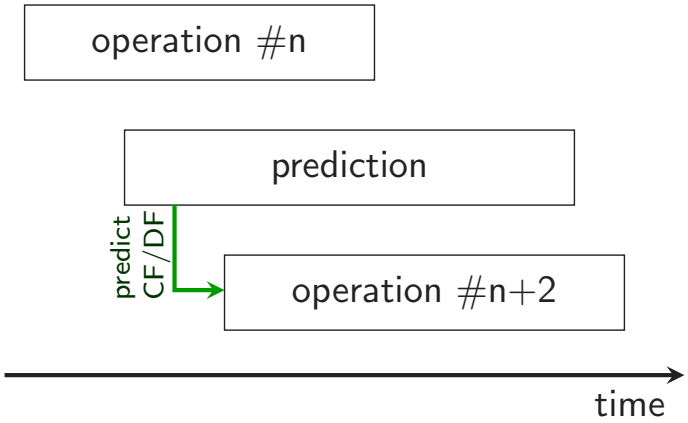
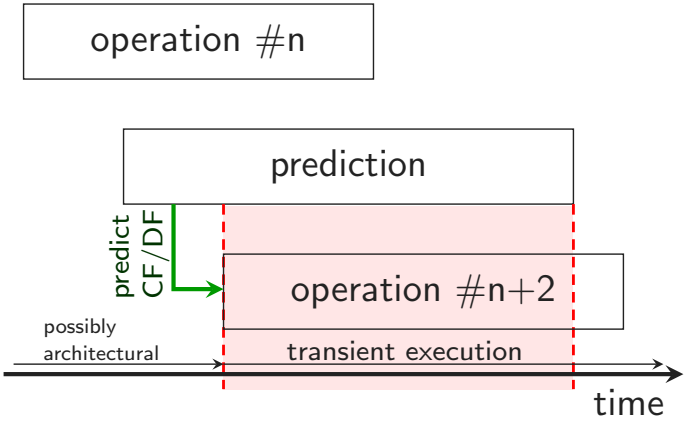
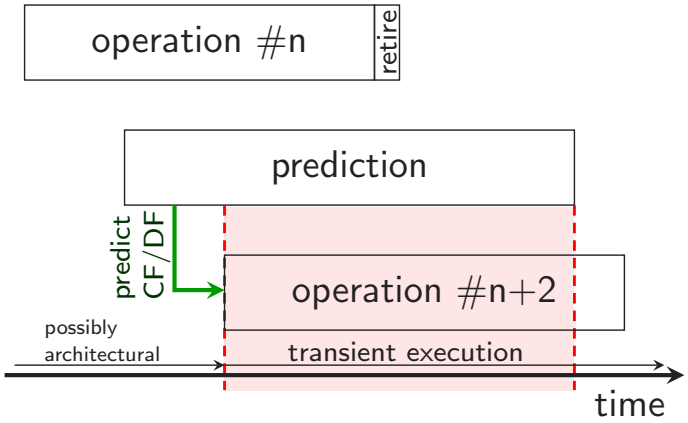
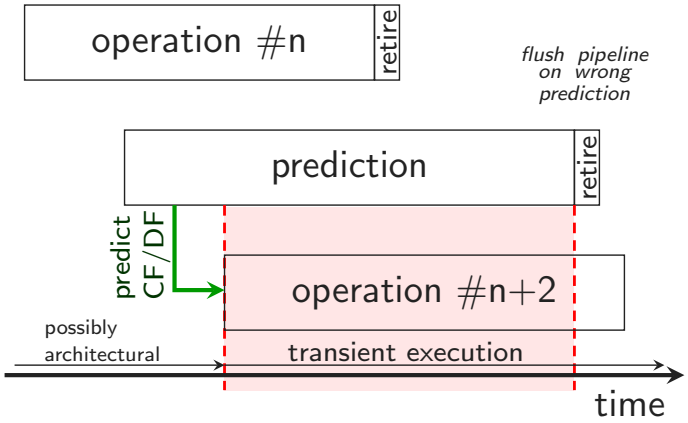

operation #n
time

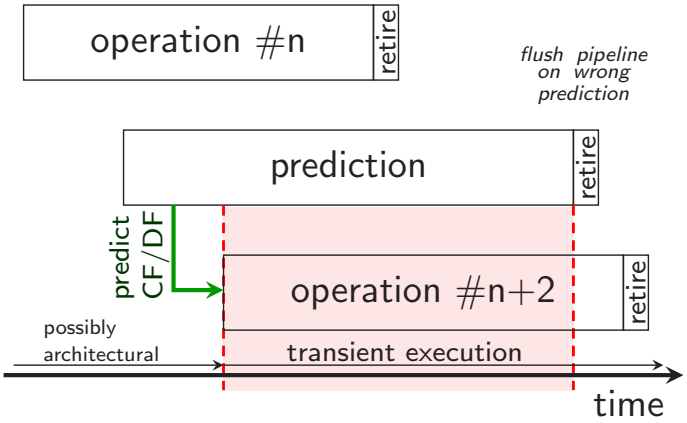

operation #n
prediction
time


operation #n
prediction
predict
CF/DF
operation #n+2
time


operation #n
prediction
predict CF/DF
operation #n+2
possibly architectural
transient execution
time


operation #n
retire
prediction
predict CF/DF
operation #n+2
possibly architectural
transient execution
time


operation #n
retire
flush pipeline on wrong prediction
prediction
retire
predict CF/DF
operation #n+2
possibly architectural
transient execution
time


operation #n
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flush pipeline on wrong prediction
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retire
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operation #n+2
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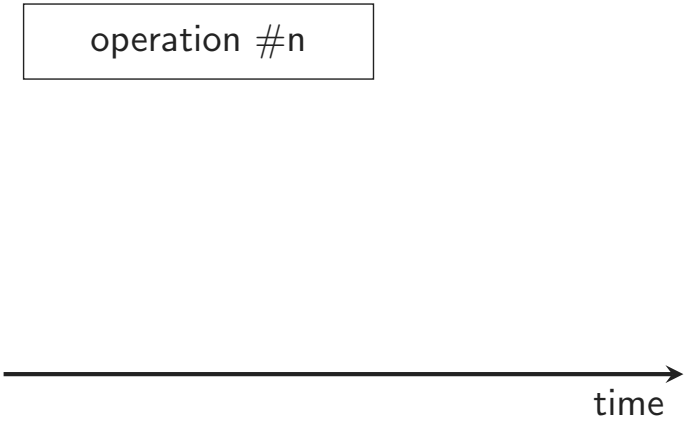
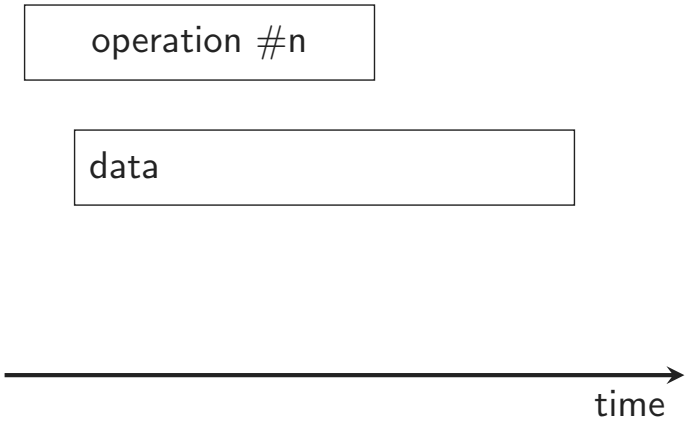
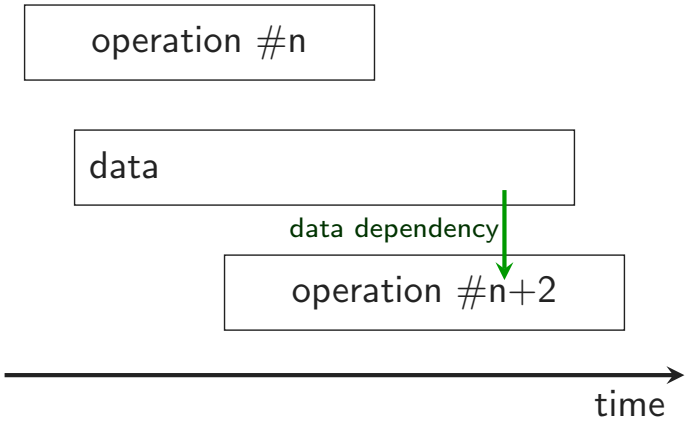
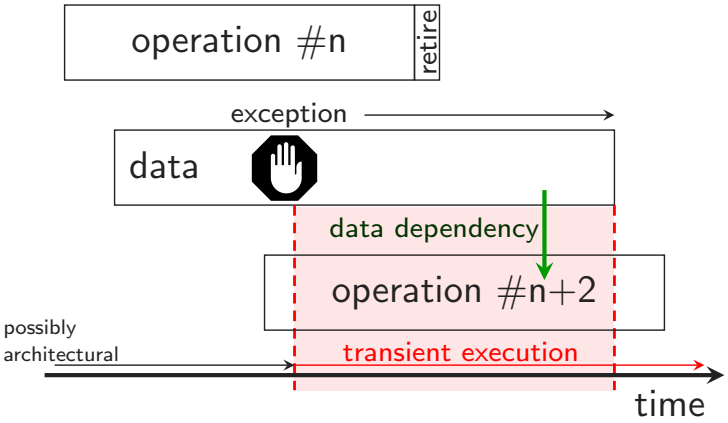
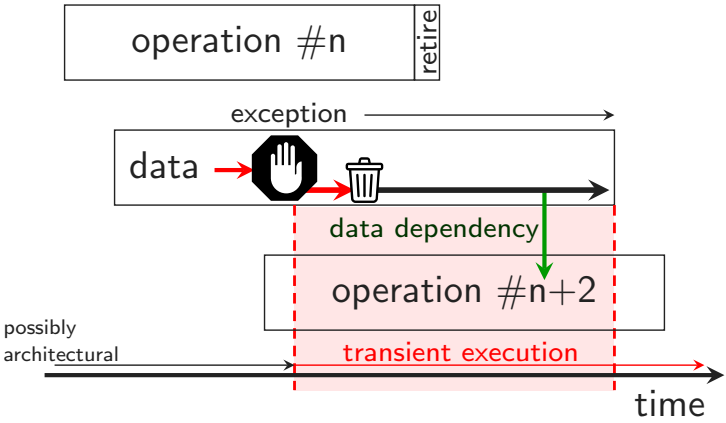

operation #n
time


operation #n
data
time


operation #n
data
data dependency
operation #n+2
time


operation #n
retire
exception
data
data dependency
operation #n+2
possibly
architectural
transient execution
time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retire
exception
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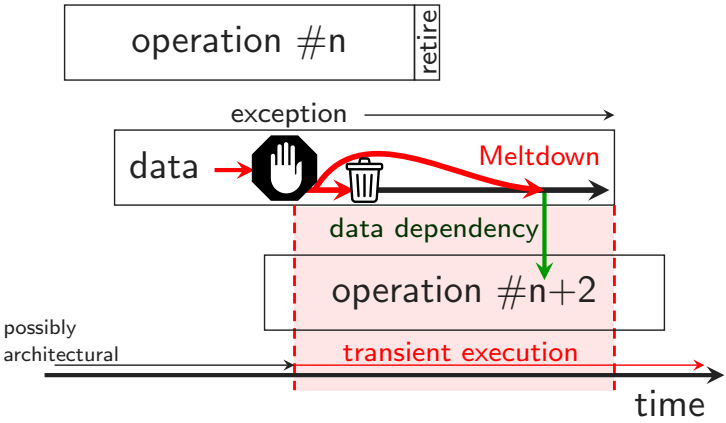
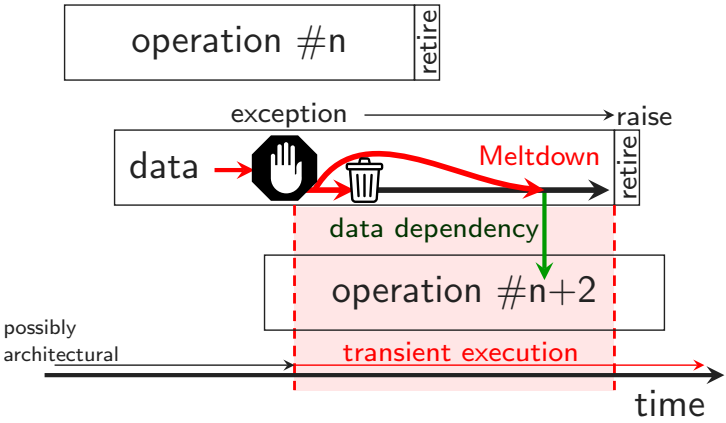
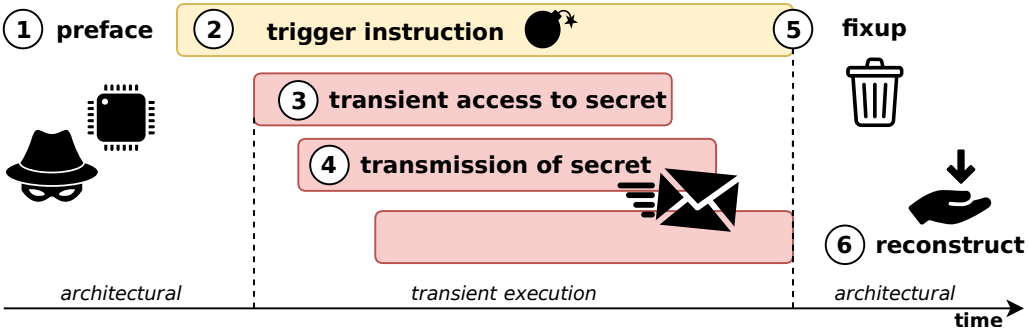

operation #n
retire
exception
data
Meltdown
data dependency
operation #n+2
possibly
architectural
transient execution
time


operation #n
retire
exception
raise
data
Meltdown
retire
data dependency
operation #n+2
possibly
architectural
transient execution
time

Transient-Execution Attack Phases



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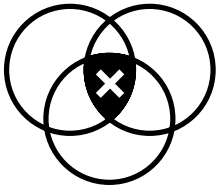
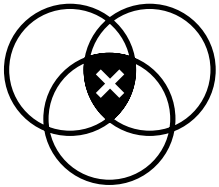
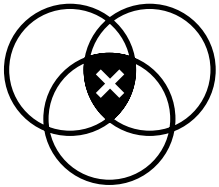


Similarities allows to group into 3 categories:



Similarities allows to group into 3 categories:

- Deferred permission check



Similarities allows to group into 3 categories:

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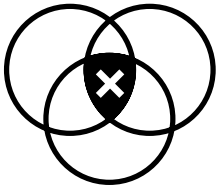
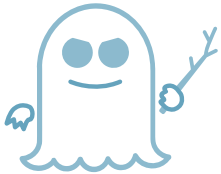
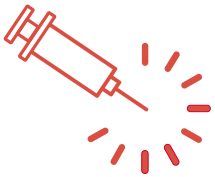


Similarities allows to group into 3 categories:

- Deferred permission check
- Incorrect use of intermediate values
- Use-after-free

Load Value Injection





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More details in the paper

- More details on the individual attacks
- Information on store-to-load forwarding
- ...

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The Evolution of Transient-Execution Attacks.

Recap

- Extended previous phases with an explicit transient access phase

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- Highlighted the similarities between Meltdown-type attacks

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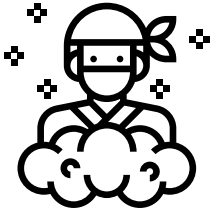
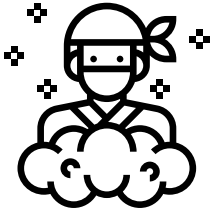
- Highlighted the similarities between Meltdown-type attacks
- Discussed the evolution of transient-execution attacks

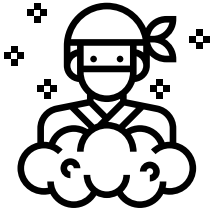


- Transient Execution Attacks are...



- Transient Execution Attacks are...
  - ...a novel class of attacks

Conclusion



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  - ...extremely powerful

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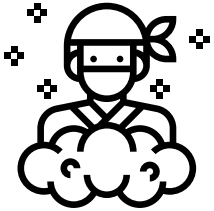

- Transient Execution Attacks are...
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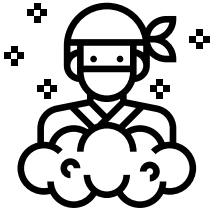
  - ...extremely powerful
  - ...only at the beginning



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  - ...a novel class of attacks
  - ...extremely powerful
  - ...only at the beginning
- Many optimizations introduce side channels $\rightarrow$ now exploitable

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Acknowledgments

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