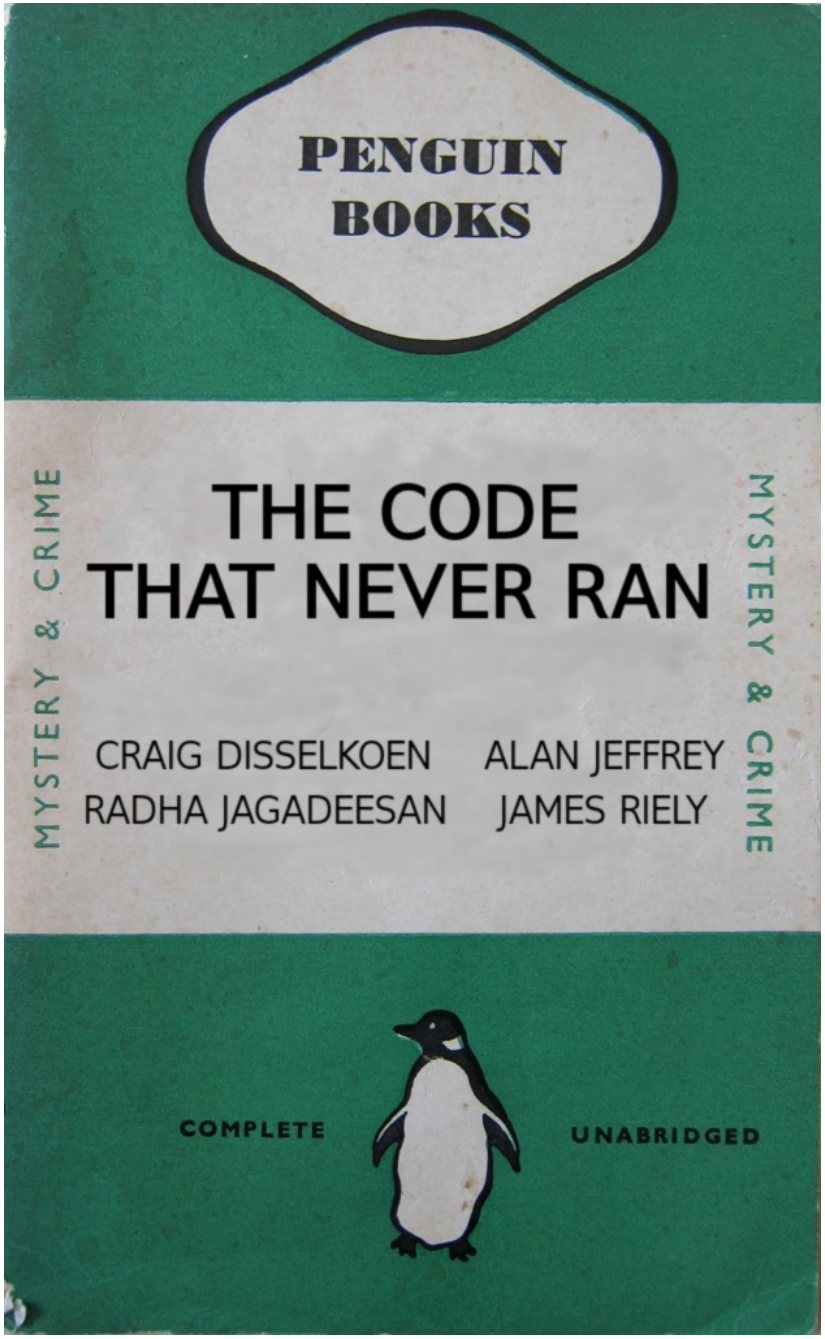


A classic locked-room mystery.
Eve was in the false branch of a conditional the whole time,
how could she do it?

Mozilla Research | DePaul University | U. California San Diego

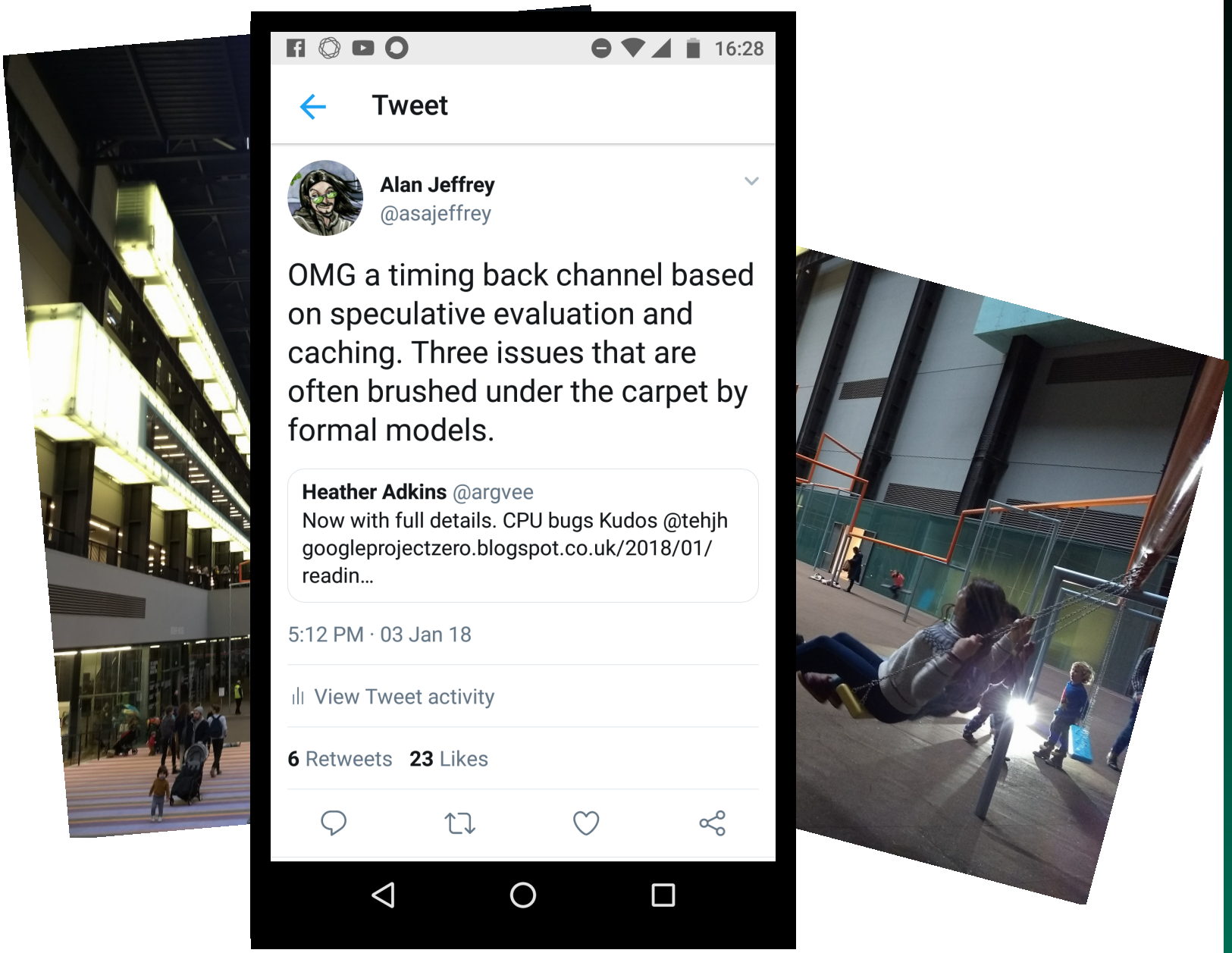
3 January 2018

Had a day out at the Tate Modern

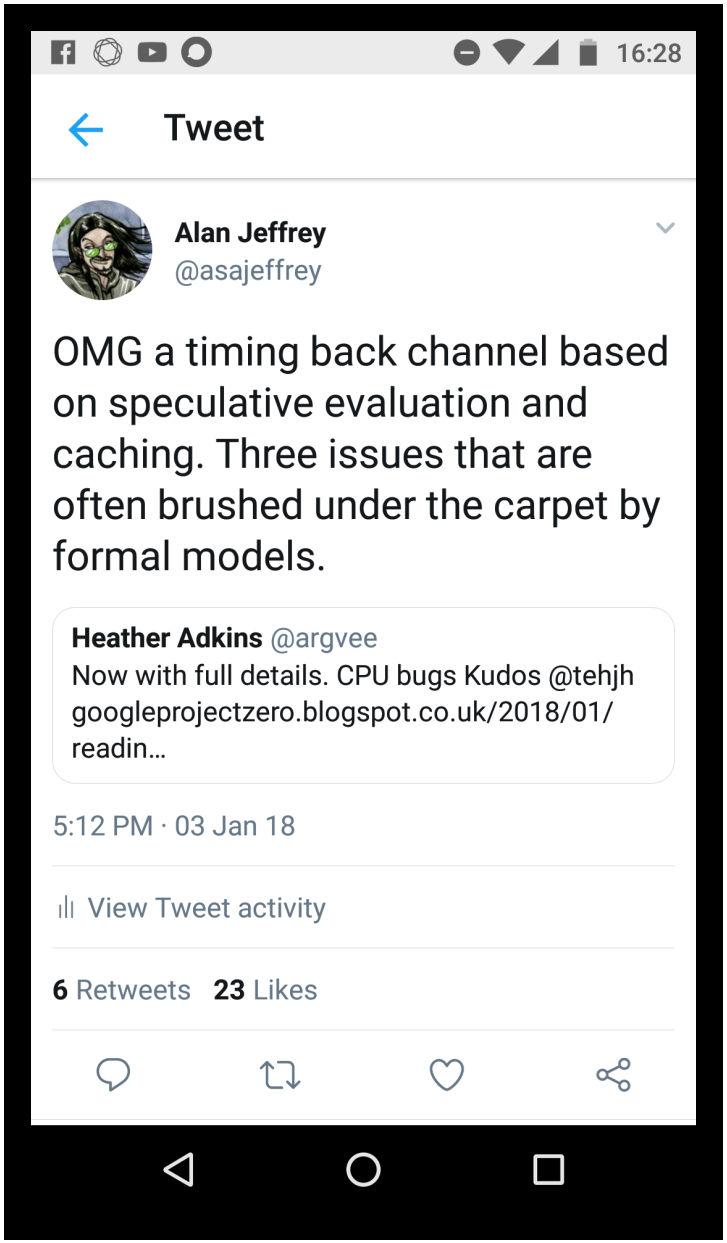
3 January 2018

3 January 2018

3 January 2018



Spectre



Attacks bypass run-time security checks.

Can bypass array bounds checks, and read whole process memory.

Can be exploited from JS, so evil.ad.com can read your bank.com data.

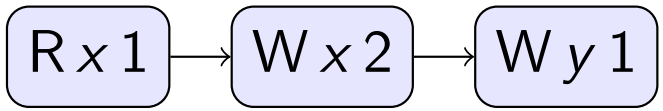
Attacks *speculative evaluation* hardware optimization.

Optimizations in hardware

A lie we tell programmers:
"computers execute instructions one after the other."

$$x := x + 1;\ y := 1$$

has execution:



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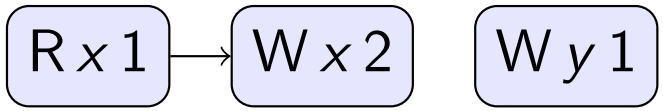

The W y 1 might happen first.

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Another lie we tell programmers:
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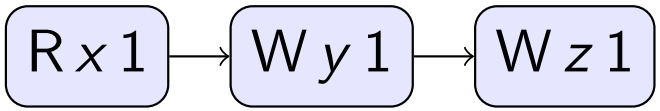
$$\texttt{if}\,(x)\,\{\,y\texttt{:=}1\texttt{;}\;z\texttt{:=}1\,\}\,\texttt{else}\,\{\,y\texttt{:=}2\texttt{;}\;z\texttt{:=}1\,\}$$

has execution:



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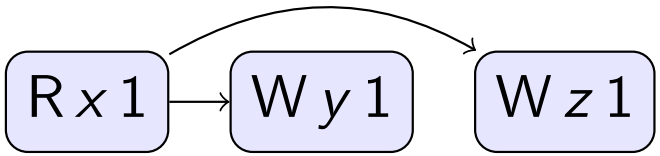

W z 1 might happen before W y 1.

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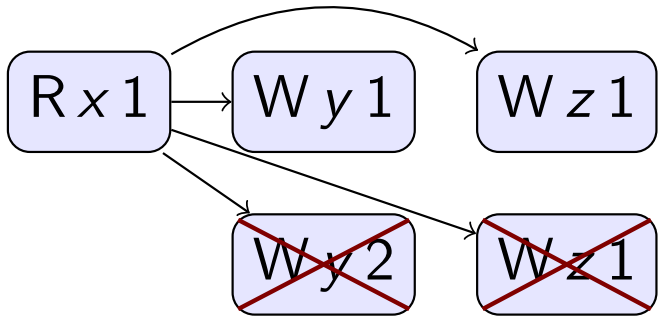

W y 2 might happen, then get rolled back.

Optimizations in hardware and compilers

Another lie we tell programmers:
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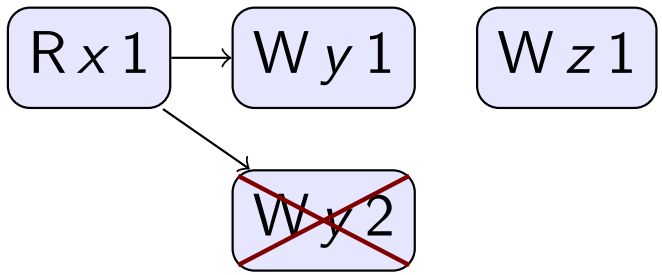

W z 1 might happen first.

Simplified Spectre

Imagine a `SECRET`, protected by a run-time security check:

$$\texttt{if canRead(SECRET)}\,\{\ldots\text{use }\texttt{SECRET}\ldots\}\,\texttt{else}\,\{\ldots\}$$

For attacker code `canRead(SECRET)` is always false

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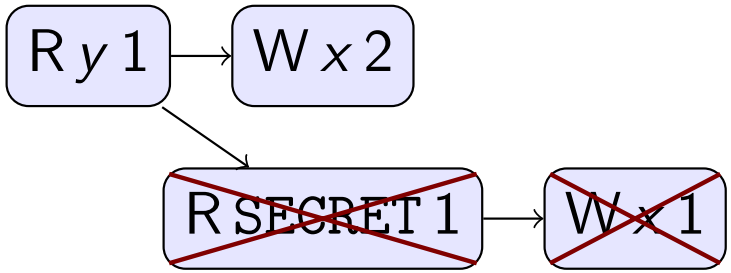

is an execution of
$\texttt{if}\ y\,\{\,\texttt{if canRead(SECRET)}\,\{\,x\texttt{:=SECRET}\,\}\,\texttt{else}\,\{\,x\texttt{:=2}\,\}\,\}$.

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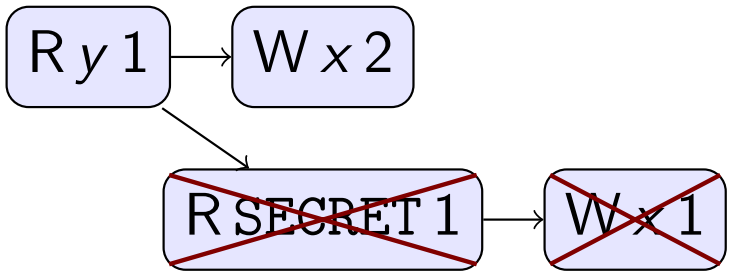

is an execution of
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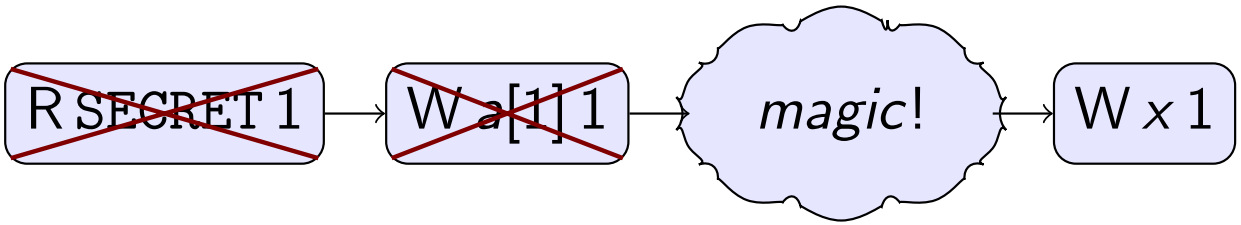
Attacker goal: learn if SECRET is 0 or 1.

Simplified Spectre

A very simplified Spectre attack:

$$\texttt{if canRead(SECRET)} \{ a[\texttt{SECRET}] := 1 \}$$
$$\texttt{else if touched} (a[0]) \{ x := 0 \}$$
$$\texttt{else if touched} (a[1]) \{ x := 1 \}$$

with execution



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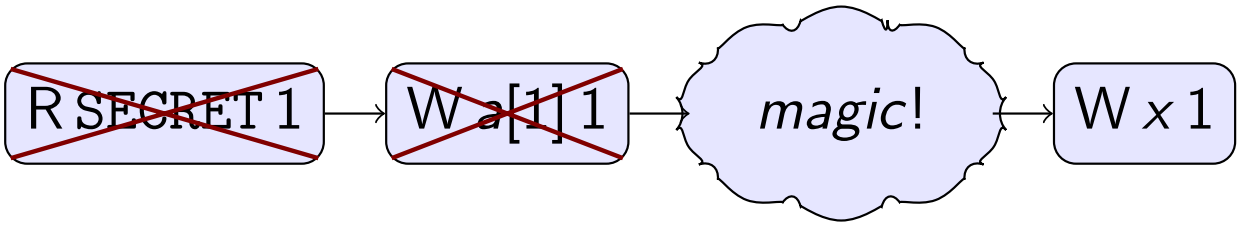

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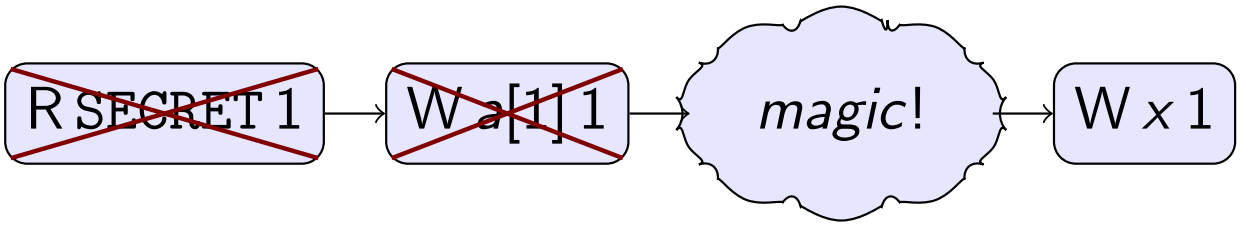

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if there's an implementation of "magic".

Narrator: there was one.

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Harden programs, compilers, etc.
(difficult because it's a large attack surface).