SoK: In Search of Lost Time: A Review of JavaScript Timers in Browsers

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JavaScript-based timing attacks

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Exploit timing differences to infer secrets from the JavaScript sandbox.

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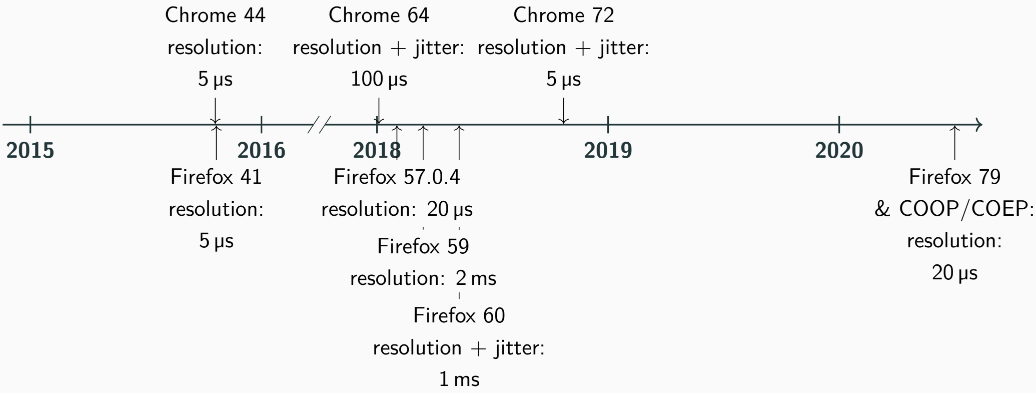
Resolution of 10 -100 ns

JS and timers: A complicated history



2015 2016 2018 2019 2020

Chrome 44
resolution:
5 µs

Firefox 41
resolution:
5 µs

Chrome 64
resolution + jitter:
100 µs

Firefox 57.0.4
resolution: 20 µs

Firefox 59
resolution: 2 ms

Firefox 60
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Firefox 79
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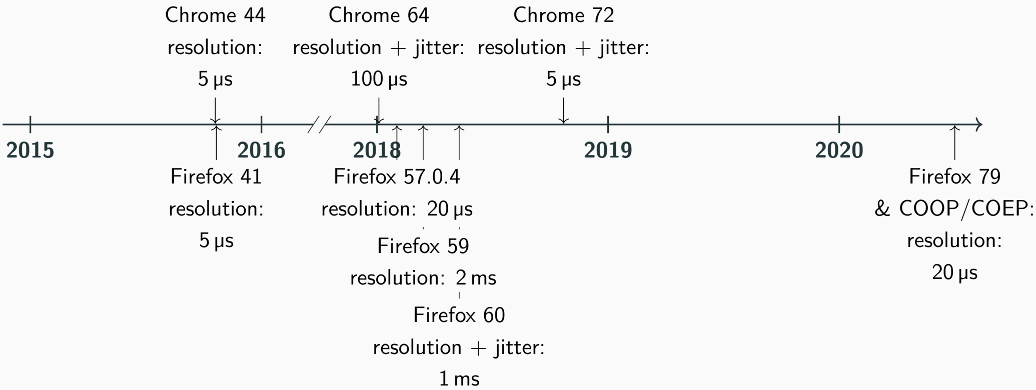

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What are the motivations and implications of changing the timers' resolution?

Classification of JavaScript timing attacks

- Hardware-contention-based attacks
- Transient execution attacks
- Attacks based on system resources
- Attacks based on browser resources

Classification of JavaScript timing attacks

- **Hardware-contention-based attacks**

  Principle: The attacker infers secrets from timing differences caused by hardware state

  Prerequisites: High resolution timers & Shared hardware resources

  Examples: JavaScript Prime+Probe, Rowhammer.js
- Transient execution attacks
- Attacks based on system resources
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Classification of JavaScript timing attacks

- Hardware-contention-based attacks
- **Transient execution attacks**

  Principle: The attacker infers secrets from traces of transient execution on the hardware.

  Prerequisites: Transient execution, high resolution timers & shared hardware resources

  Examples: Spectre, RIDL

- Attacks based on system resources
- Attacks based on browser resources

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  Examples: Keystroke attacks, memory deduplication attacks.
- Attacks based on browser resources

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  Examples: History sniffing, fingerprinting.

JavaScript Timers

Built-in timers have a resolution ranging from 5-100 µs.

We have to create our own auxiliary timers:

- by interpolating the low resolution timers
- by exploiting multithreading to build a clock thread

Find out more about these timers and ther properties in the paper!

Michael Schwarz et al. "Fantastic timers and where to find them: High-resolution microarchitectural attacks in javascript". In: International Conference on Financial Cryptography and Data Security. 2017

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Disable certain multithreading features.

Security vs Practicality

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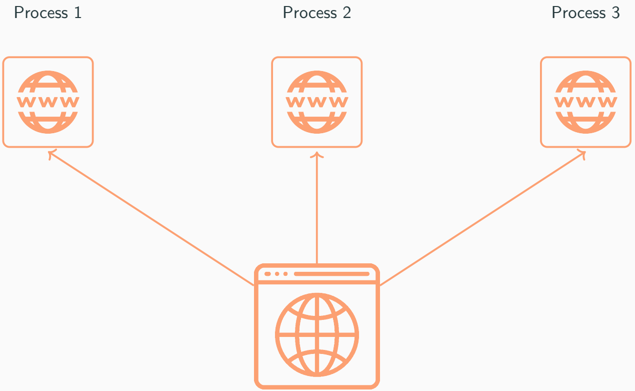
Isolation-based countermeasures

Site isolation



Charles Reis, Alexander Moshchuk, and Nasko Oskov. “Site Isolation: Process Separation for Web Sites within the Browser”. In: USENIX Security Symposium. 2019

Goals of isolation

Different processes means:

- Different address spaces

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What site isolation does not prevent:

- Hardware contention timing attacks.
- Cross address space (transient execution) attacks[1].

[1] For instance https://leaky.page/ was published a few days after our paper

A change in defense paradigm

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Timing-based countermeasures are obsolete:

- Grant higher resolution and lower jitter to built-in timers
- Reallow multi-threading tools

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Our goal is that this analysis can be helpful not only at this point in time, but also in the future.

You can find more detailed technical explanations in the paper!

The code is available here: https://github.com/thomasrokicki/in-search-of-lost-time

How to evaluate the efficiency of a timer

Resolution: Smallest operation a timer can measure.

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Resolution: Smallest operation a timer can measure.

Measurement overhead: Time it takes to make the measurement.

You can find more in-depth details of the experiments and results in the full paper.

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Timers are more of a threat than two years ago.

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- Isolation-based countermeasures only apply to Spectre v1 and some system resource attacks.
- Browsers are potentially vulnerable to many hardware or transient execution attacks.
- More viable countermeasures must be found, but it is not particularly suited for browsers.

Thank you for your attention

Contact me here: `thomas.rokicki@irisa.fr`

Feel free to read the paper for more technical details!

Find the code here:

`https://github.com/thomasrokicki/in-search-of-lost-time`