Osiris: Automated Discovery of Microarchitectural Side Channels

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CISPA Helmholtz Center for Information Security

Motivation

Microarchitectural timing side channels, e.g., Flush+Reload or Prime+Probe, can be exploited in different scenarios:

- Attack implementations of cryptographic protocols

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Finding side channels is a **labour-intensive** and **time-consuming** process

We **improve** this process **by fuzzing** for side channels!

Flush+Reload

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int* probe_memory = malloc(4096);
_mm_clflush(probe_memory)



// potentially executed victim code
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before = time();
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plot(after-before);
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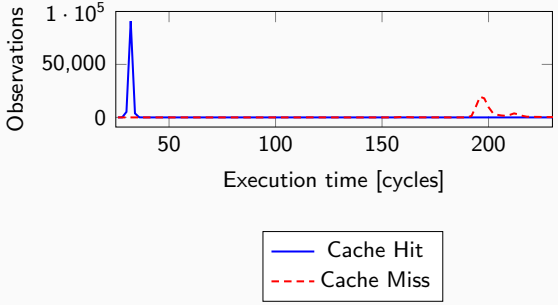

Flush+Reload – Sequence Triple

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Sequence Triples

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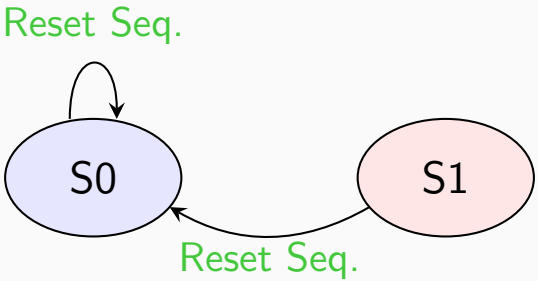

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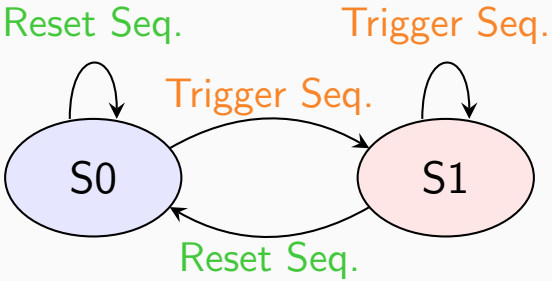

Testing A Sequence Triple

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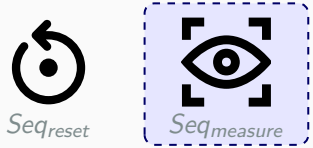


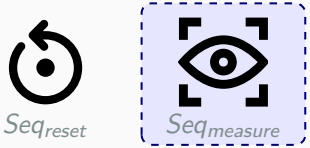
Testing A Sequence Triple

Seq_{reset}

$Seq_{measure}$

Cold path S0

Testing A Sequence Triple



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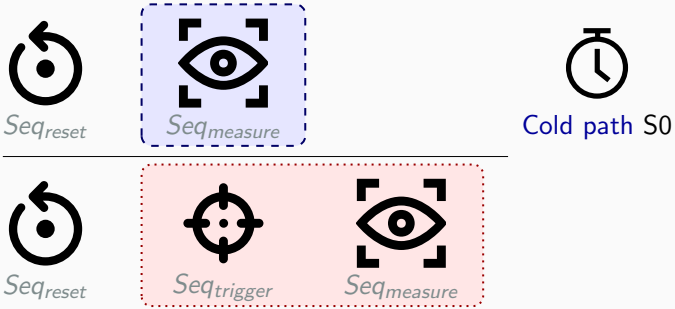

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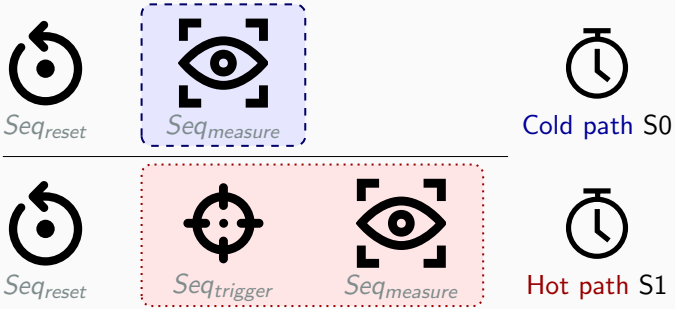

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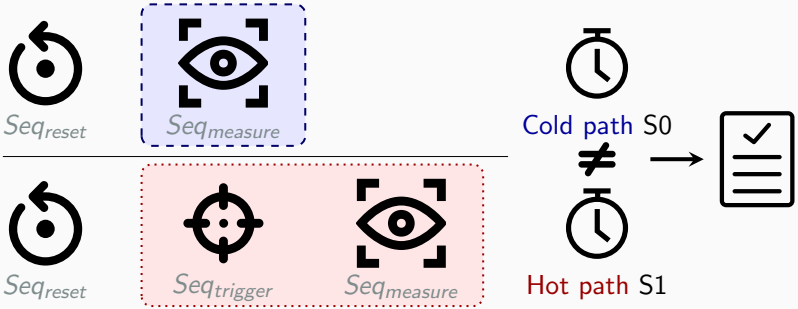

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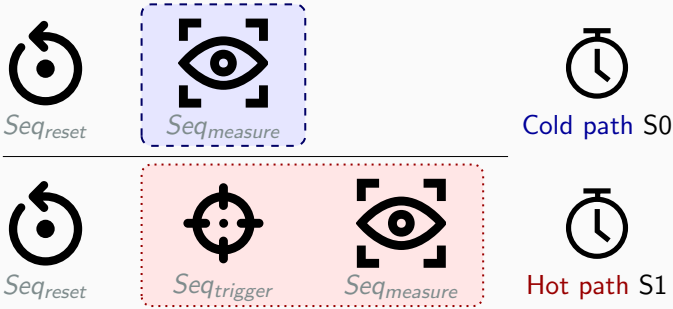

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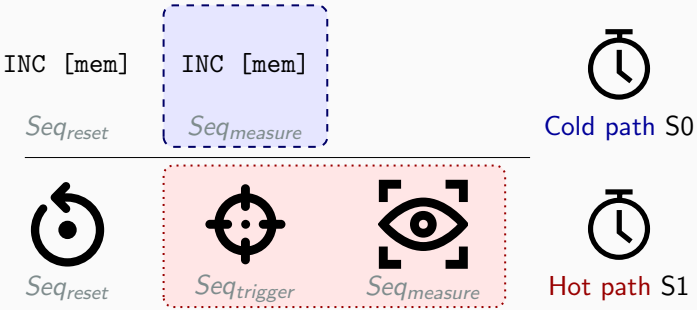

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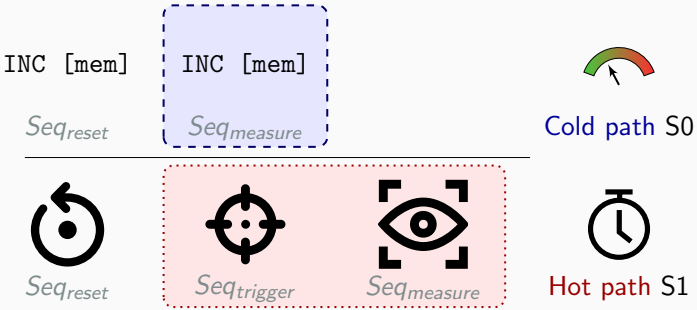

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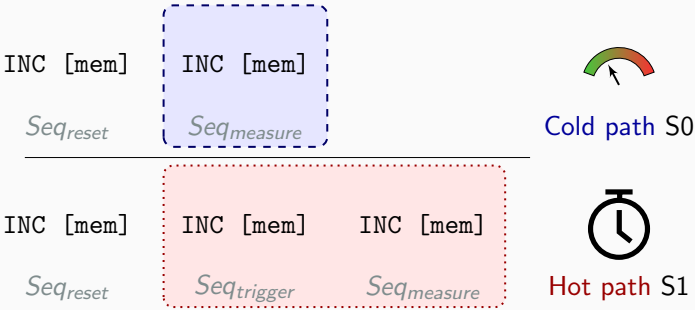

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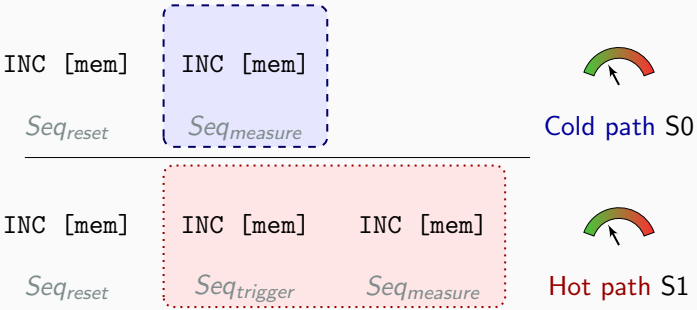

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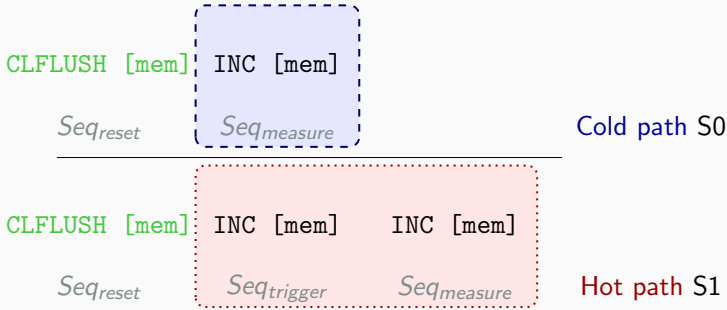

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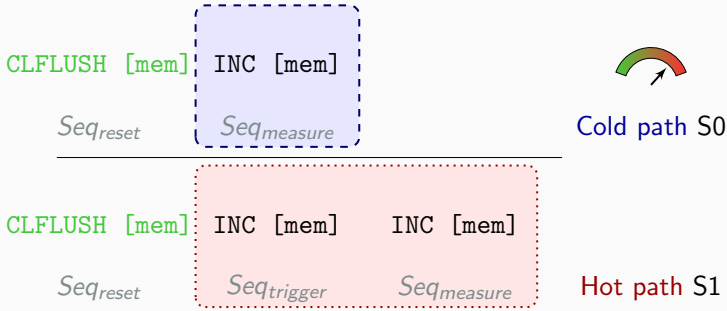

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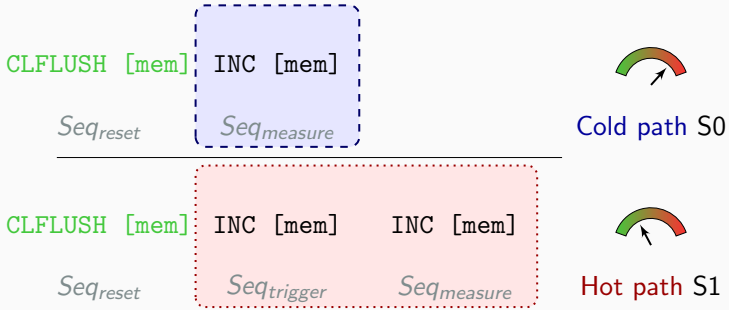

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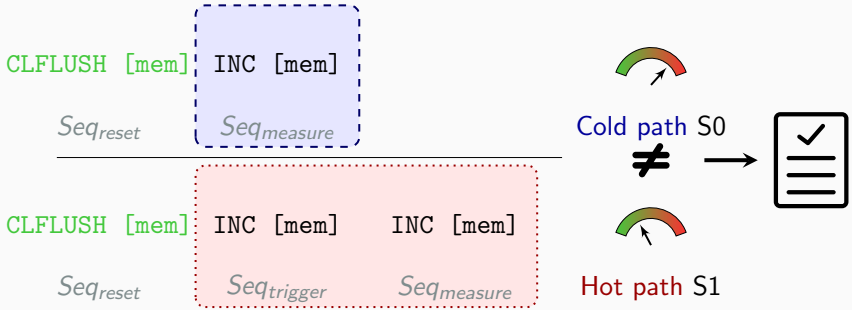
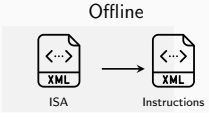


Osiris – Fuzzing x86 CPUs for Side Channels



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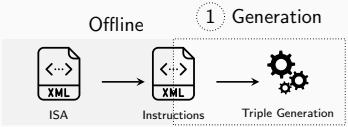

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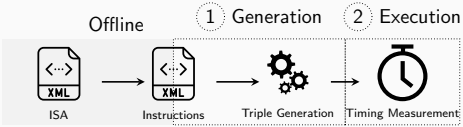

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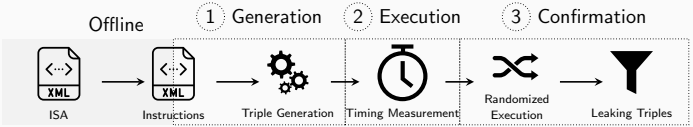

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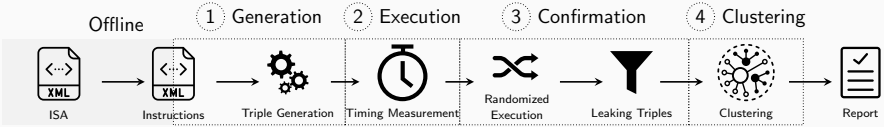

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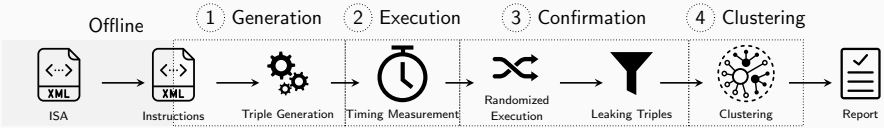

We tested Osiris on **5 different CPUs** (AMD and Intel)

Fuzzing Results

- Runtime of up to $\sim$ 4 days per CPU

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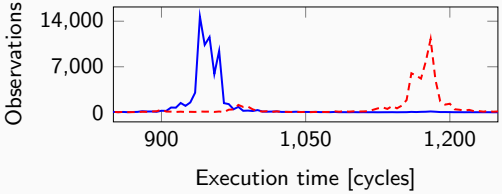
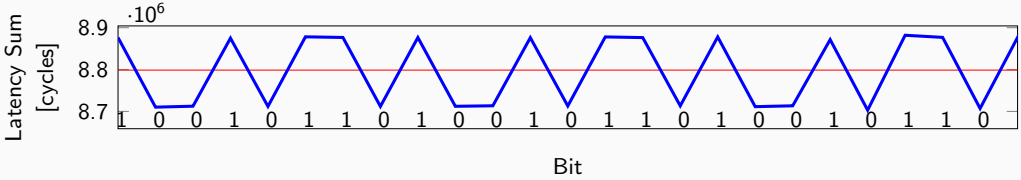


RDRAND-Based Side channel

Case Studies – RDRAND Covert Channel



RDRAND Covert Channel Transmission on Ice-Lake

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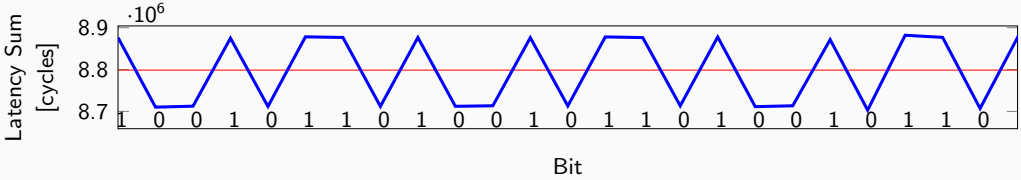

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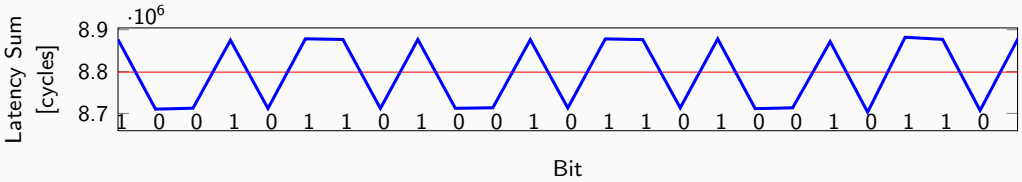

RDRAND Covert Channel Transmission on Ice-Lake

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Few requirements: no shared memory, no shared cache

Stealthy: no related performance counters

Improving Transient-Execution Attacks

- **Mounted Spectre and Meltdown** attacks using the novel side channels

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Case Studies – Improving Attacks and KASLR break

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- Works **on new Intel CPUs** (Ice Lake and Comet Lake)

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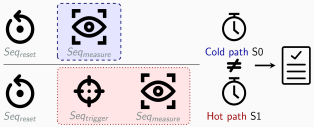
- We denote **side channels as sequence triples**



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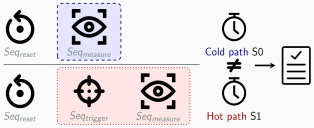

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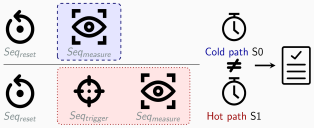

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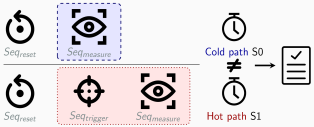

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- We **open-sourced Osiris** on `https://github.com/cispa/osiris`