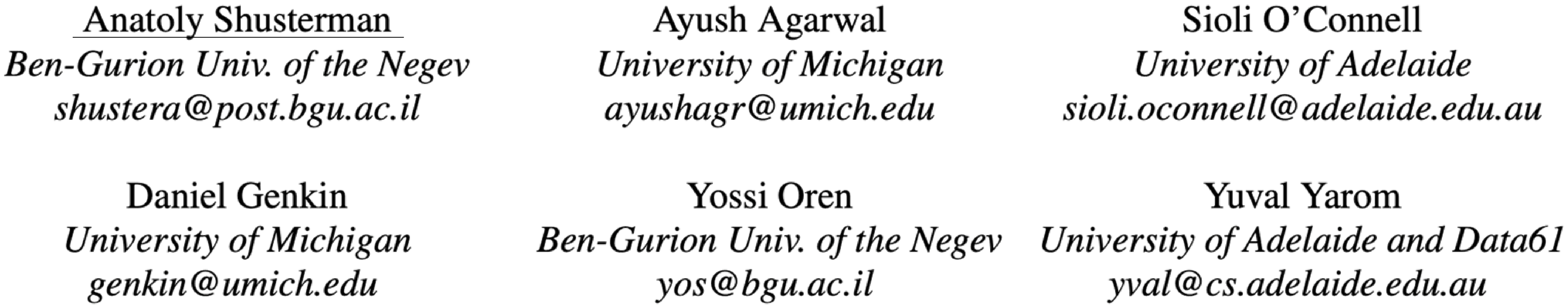
Prime+Probe 1 – JavaScript 0

Overcoming Browser-based Side-Channel Defenses



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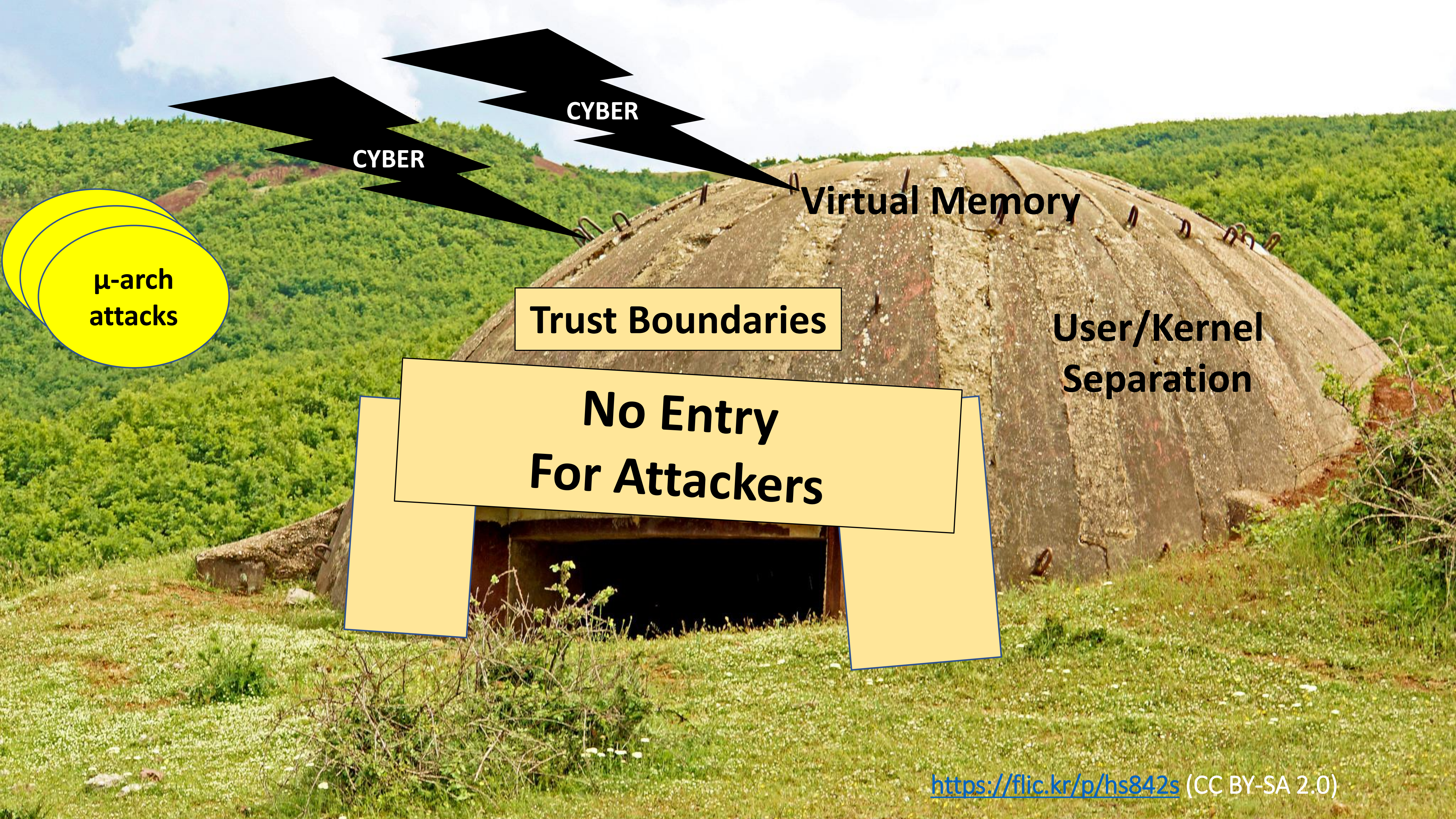

CYBER

CYBER

μ-arch
attacks

Virtual Memory

Trust Boundaries

User/Kernel
Separation

No Entry
For Attackers

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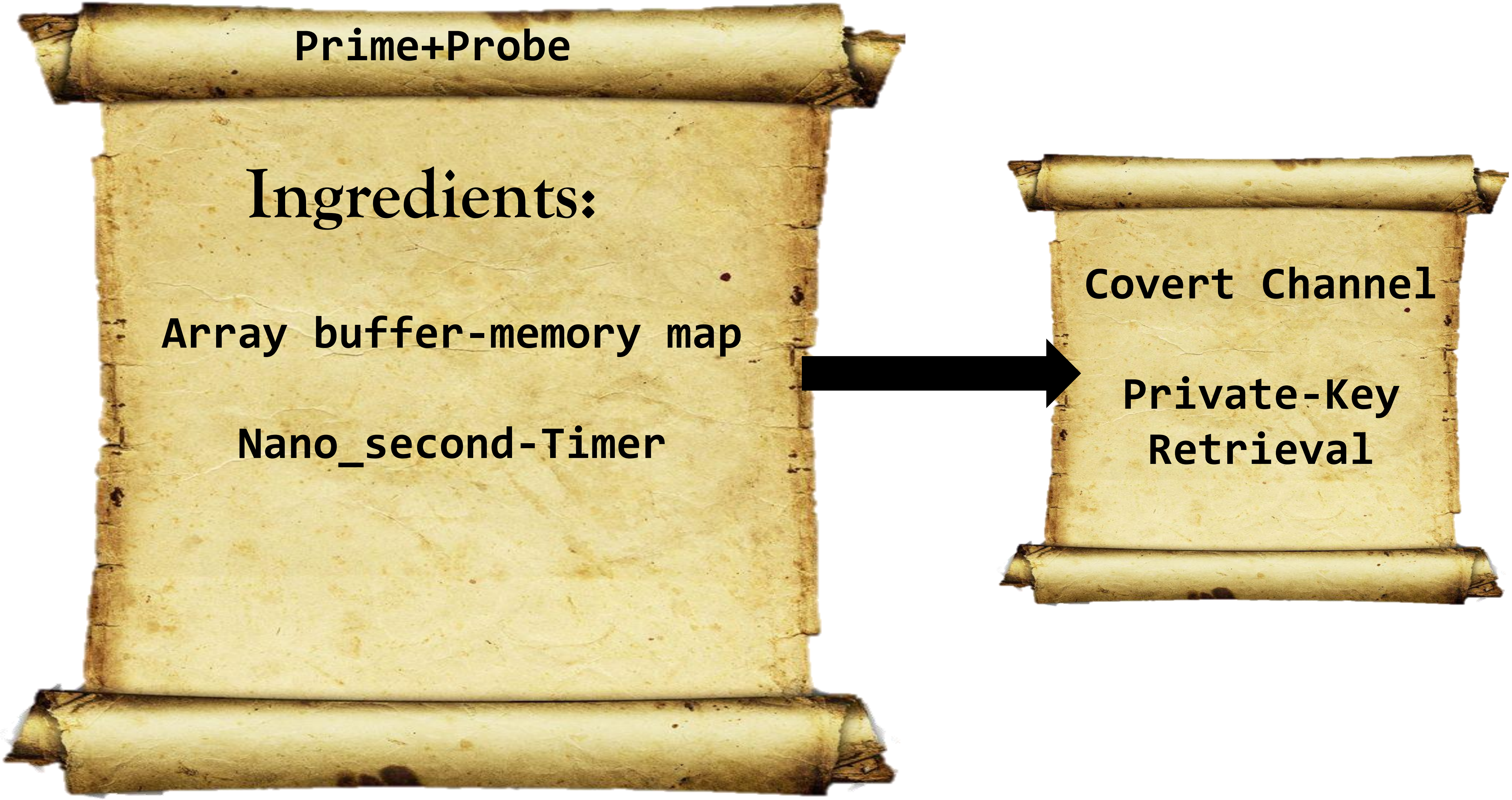


Prime+Probe

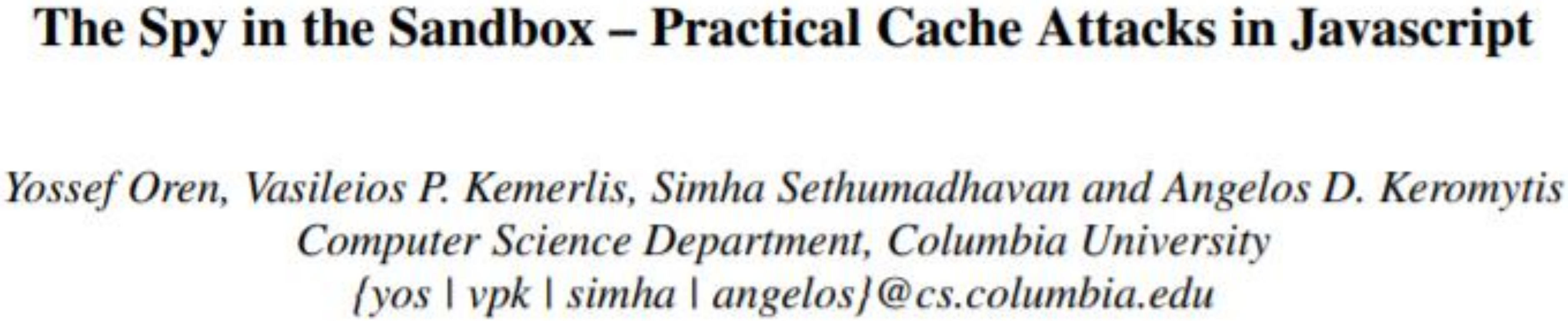
Ingredients:

Array buffer-memory map

Nano_second-Timer

Covert Channel

Private-Key Retrieval



The Spy in the Sandbox – Practical Cache Attacks in Javascript

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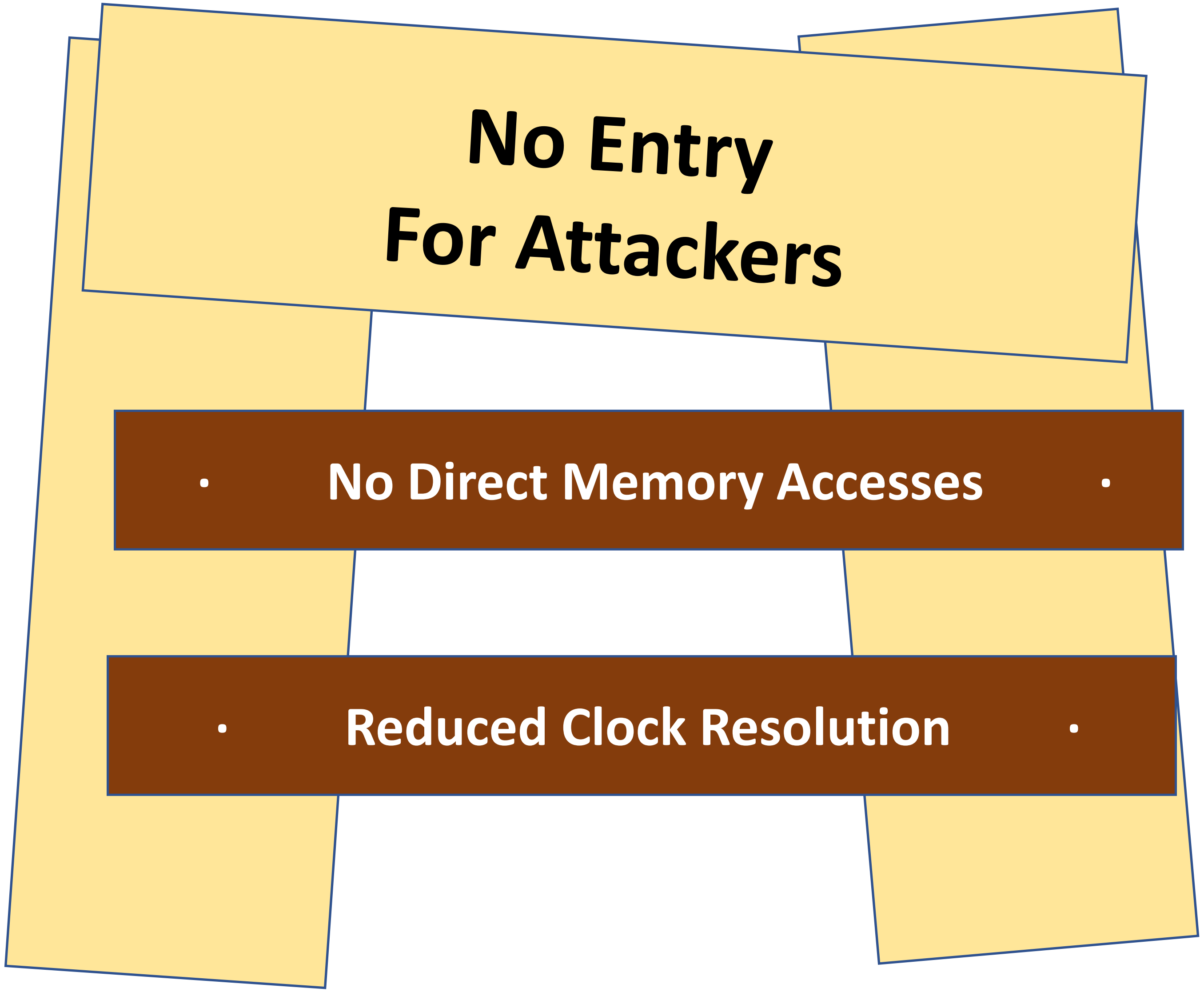
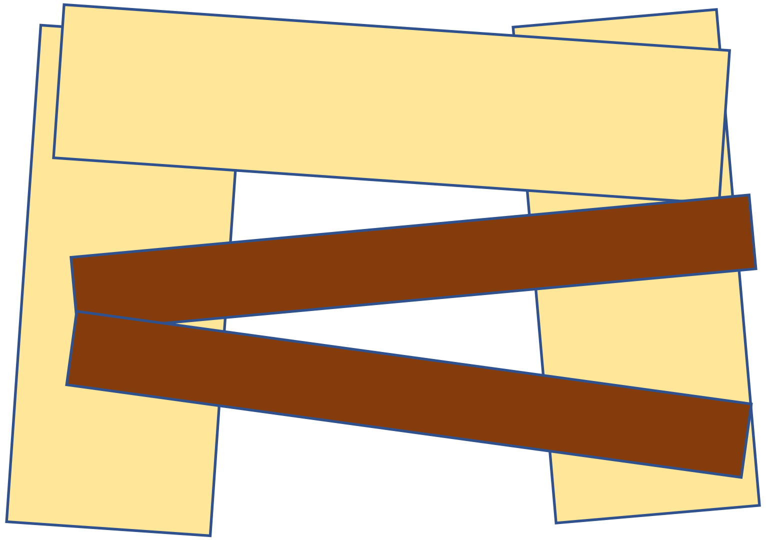


No Entry
For Attackers

- No Direct Memory Accesses
- Reduced Clock Resolution

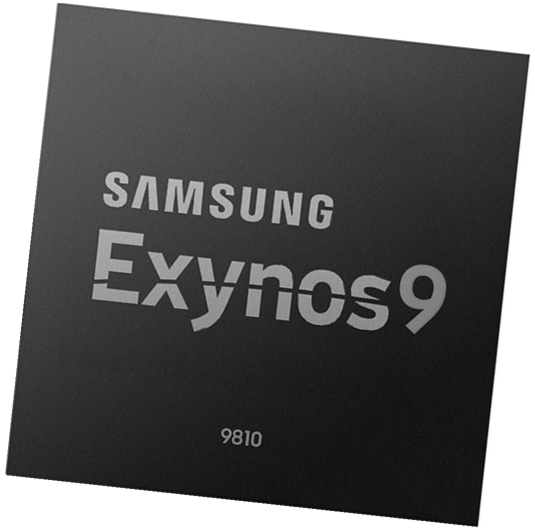
Our Research Questions

- RQ1: What are the minimal requirements for μ-architectural side-channel attacks in browsers?



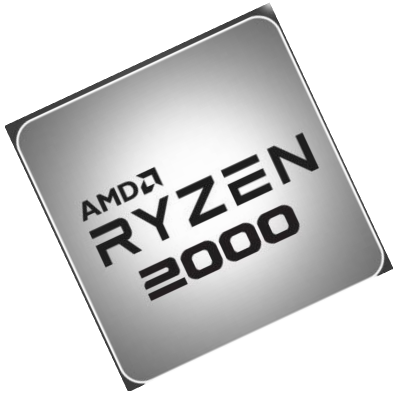
Our Research Questions

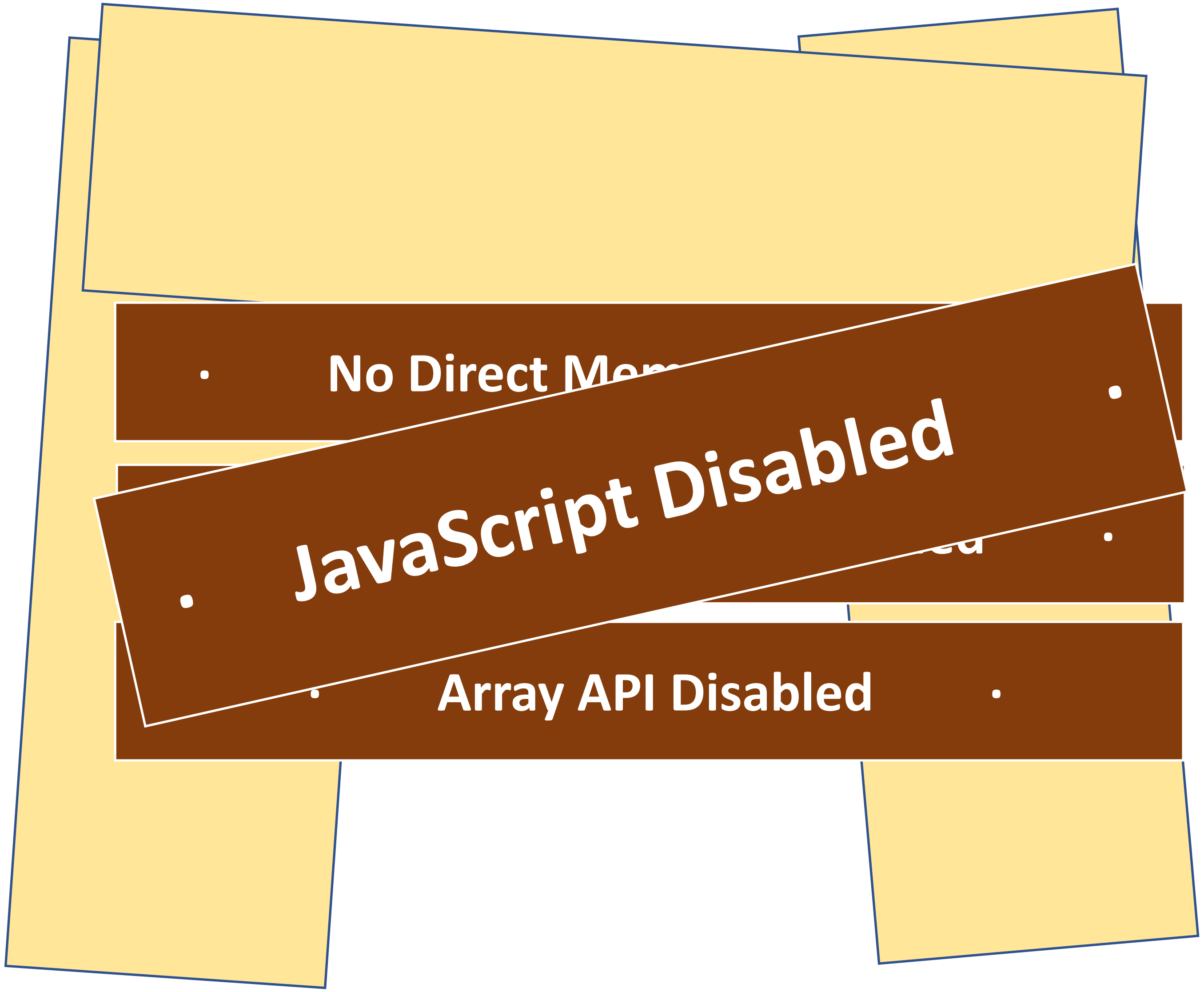
- RQ2: Can processor diversity prevent side-channel attacks?



Contributions

- RQ1: End-to-end of remote cache attacks with no timers , no arrays, and no JavaScript
- RQ2: An architecturally-agnostic attack that works on ARM, AMD, Intel and Apple M1





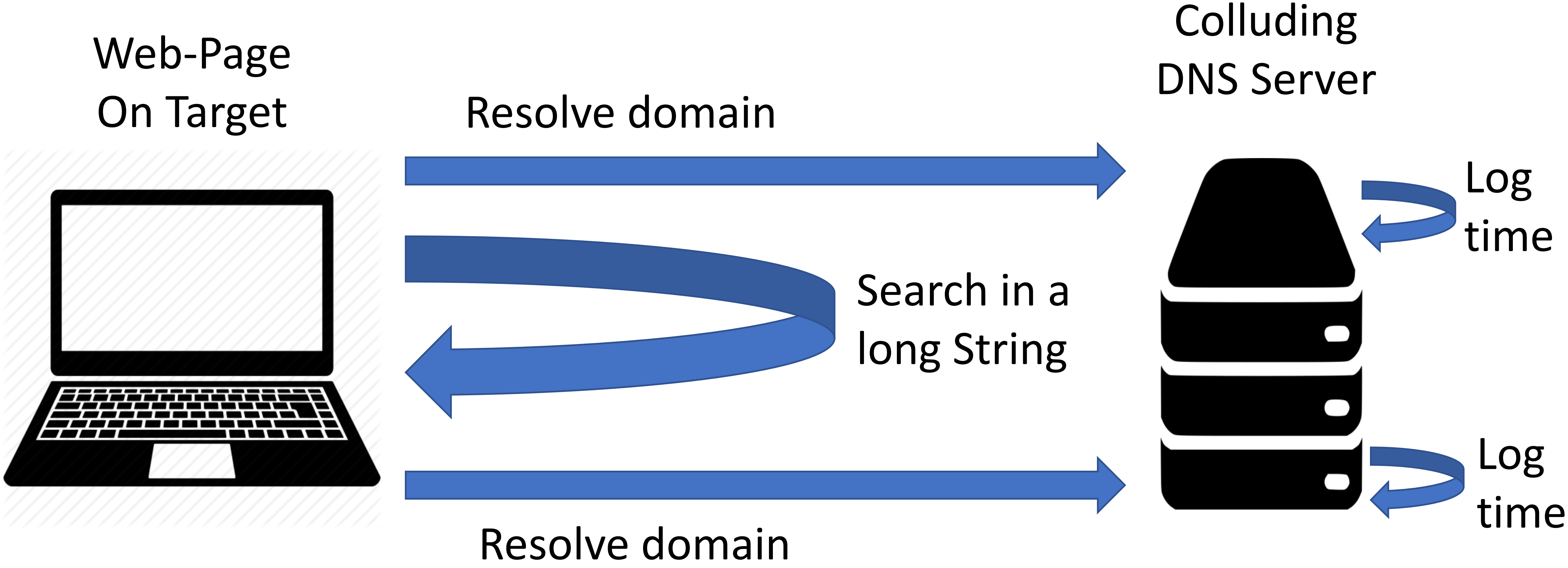
No Direct Mem

JavaScript Disabled

ed

Array API Disabled

Attack : CSS Prime+Probe [New!]



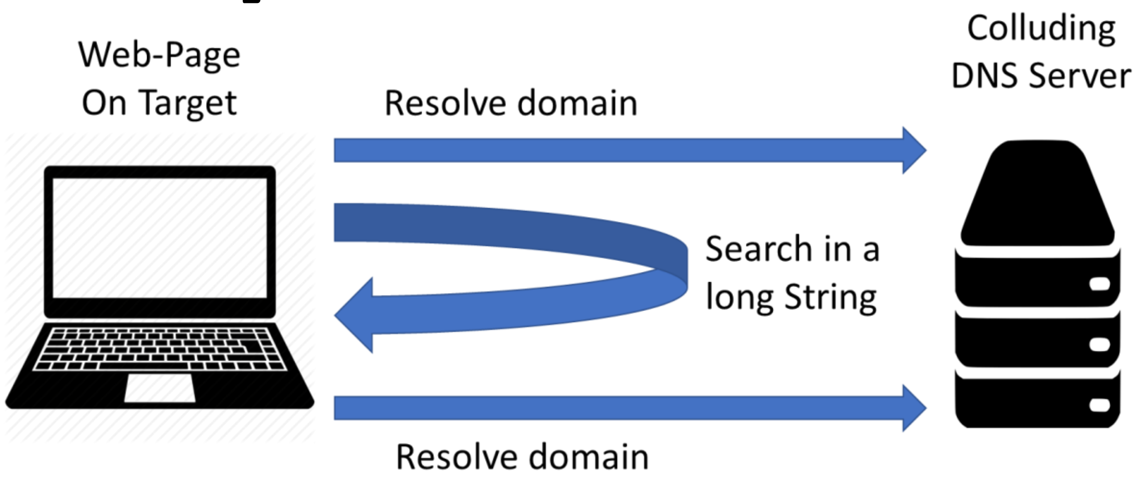
Attack : CSS Prime+Probe [New!]

```
<div id="pp" class="AAA…AAA">
  <div id="s1">X</div>
  <div id="s2">X</div>
  <div id="s3">X</div>
 .
 .
 .
</div>
```

Search non existing string

==

Probe the LLC



Resolve non existing image

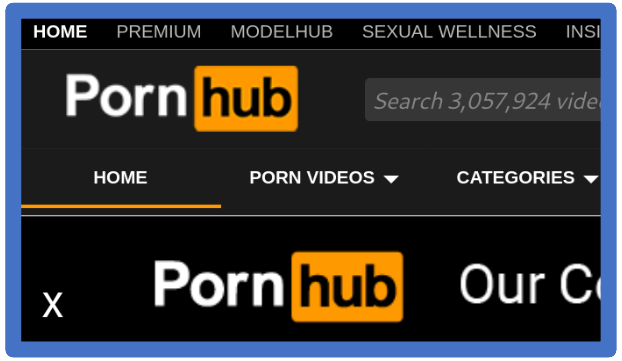
==

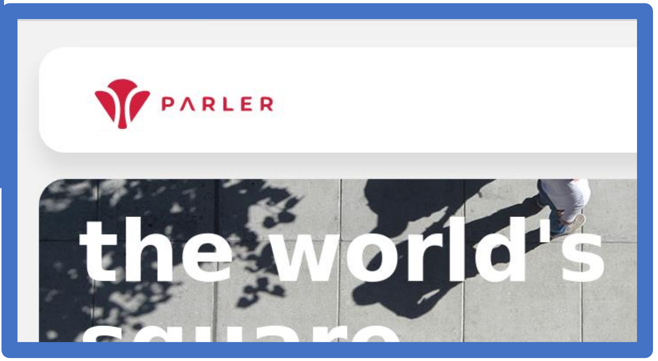
TIMER

```
#pp:not([class*= 'jigbaa']) #s1 {
  background-image: url('https://knbdsd.badserver.com');
}
#pp:not([class*= 'akhevn']) #s2 {
  background-image: url('https://pjemh7.badserver.com');
}
```

Evaluation

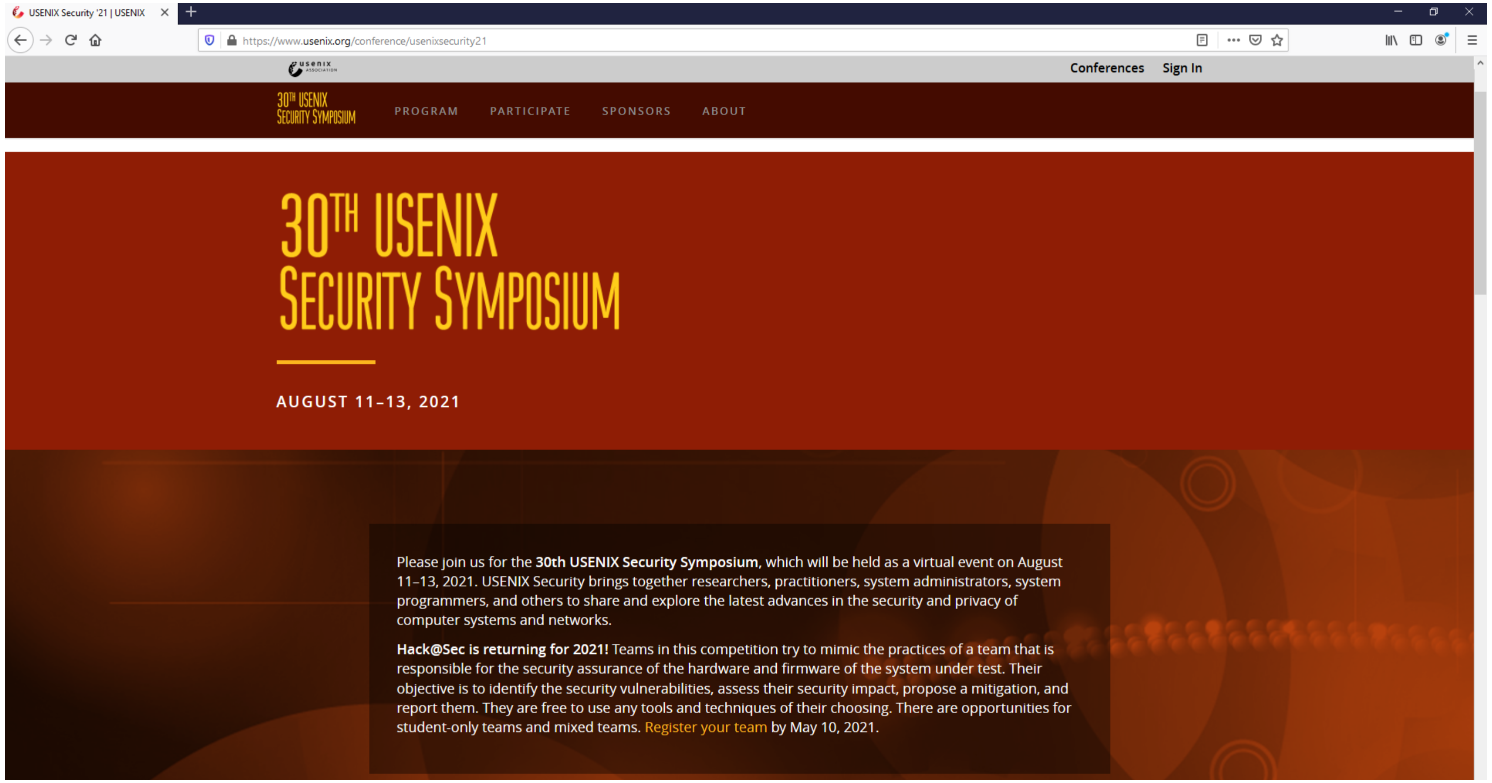
- Our method is probably not effective for cryptanalysis
- So, what is it good for?





Website Fingerprinting

Webpage Rendering



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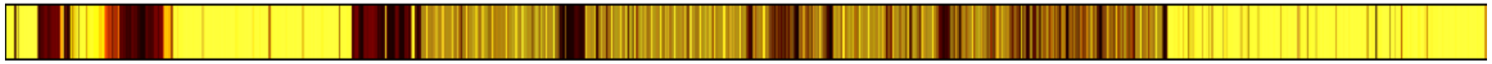
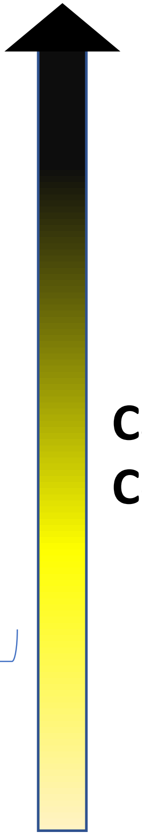
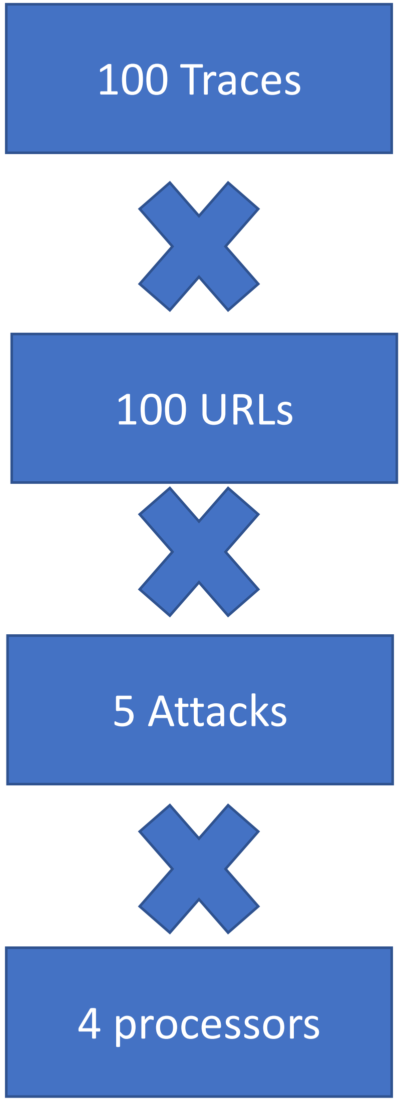


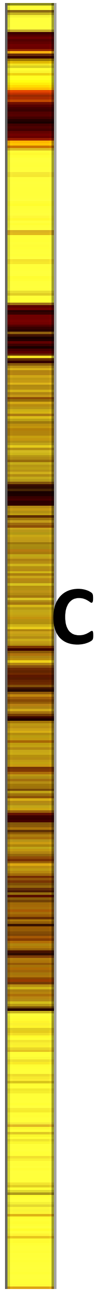
Cache Contention Measurement

Time (msec)

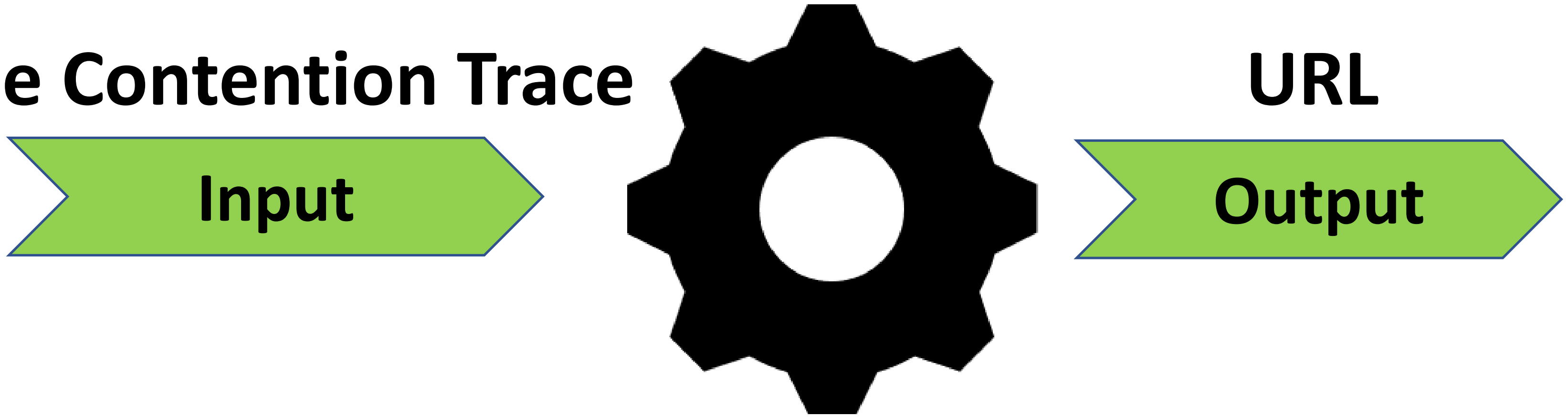


Cache Contention

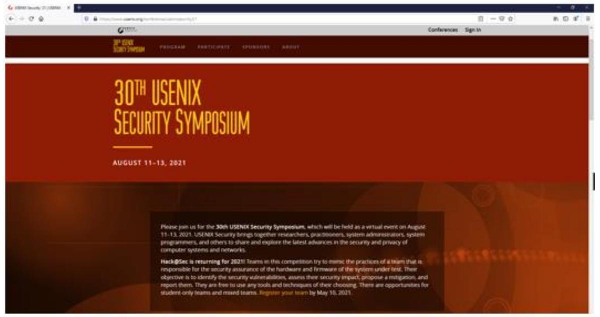




Deep Learning Models


Cache Contention Trace

URL



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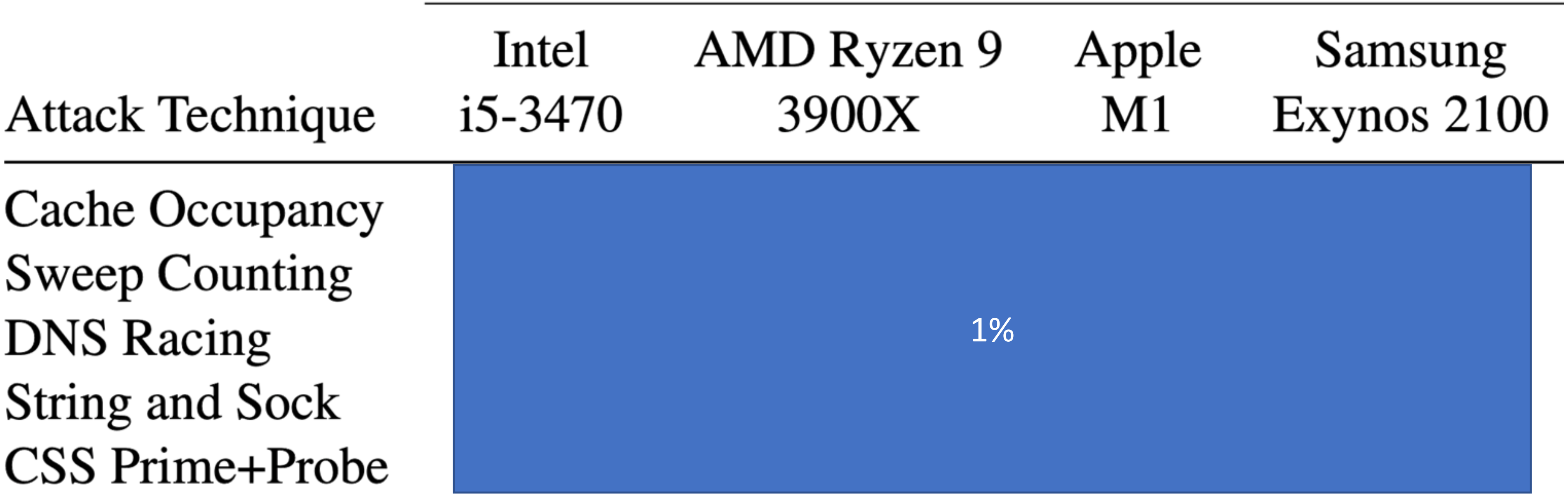
Results



Attack Technique	Intel i5-3470	AMD Ryzen 9 3900X	Apple M1	Samsung Exynos 2100
Cache Occupancy				
Sweep Counting				
DNS Racing				
String and Sock				
CSS Prime+Probe				

1%

Conclusion

- Restricted environments don’t prevent cache contention attacks.
- Lower attack requirements make it architectural agnostic.
- Protection against µ-architectural leaks should be applied at the source, not at the receiver

https://orenlab.sise.bgu.ac.il/p/PP0