SCIENCE
PASSION
TECHNOLOGY

Continuous User Behavior Monitoring using DNS Cache Timing Attacks

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NDSS 2026

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DNS

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- ⇒ DNS cache timing attacks

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- Prior work lacked eviction mechanisms
- Find reliable eviction primitives
- ⇒ Evict+Reload-style attack
- Concurrent work: Moav et. al. [2] focus on the router cache

Measuring the DNS Cache

Execution Contexts

We consider 3 different execution contexts:

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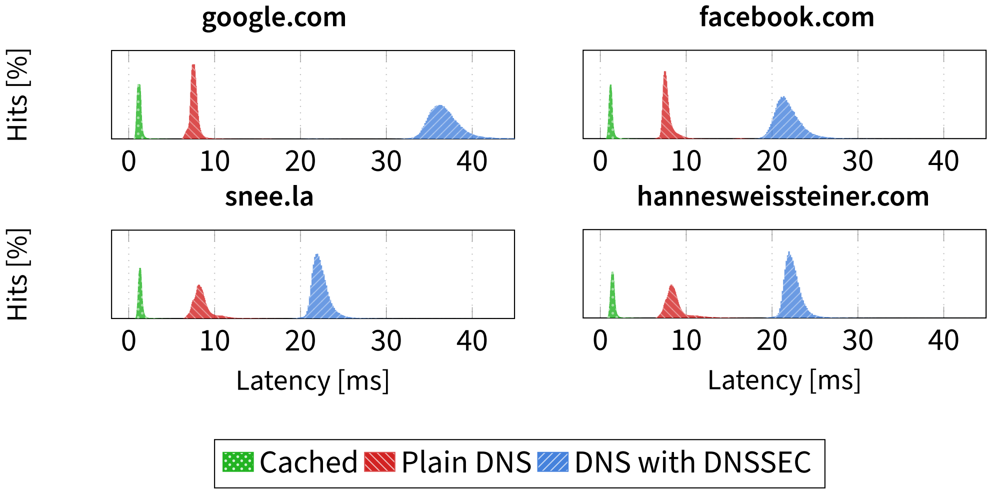
- `resolvectl show-caches`: Privileged operation
- `resolvectl query`: reports “Data from: (network | cache)”
- Without access to `resolvectl`: Timing attack required

Native Code Execution (Linux)



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- Virtual Machines in `libvirt`’s default configuration

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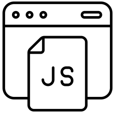
- Application Sandboxes

JavaScript



JavaScript

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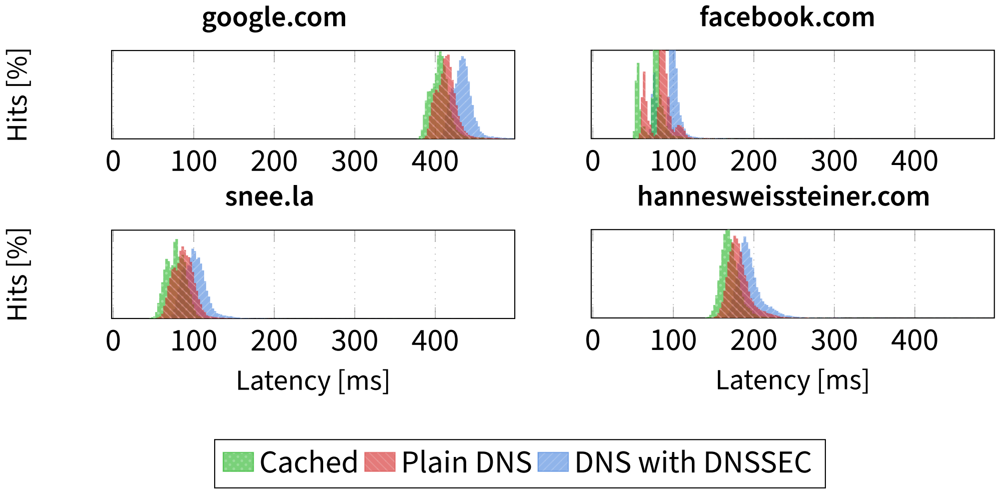
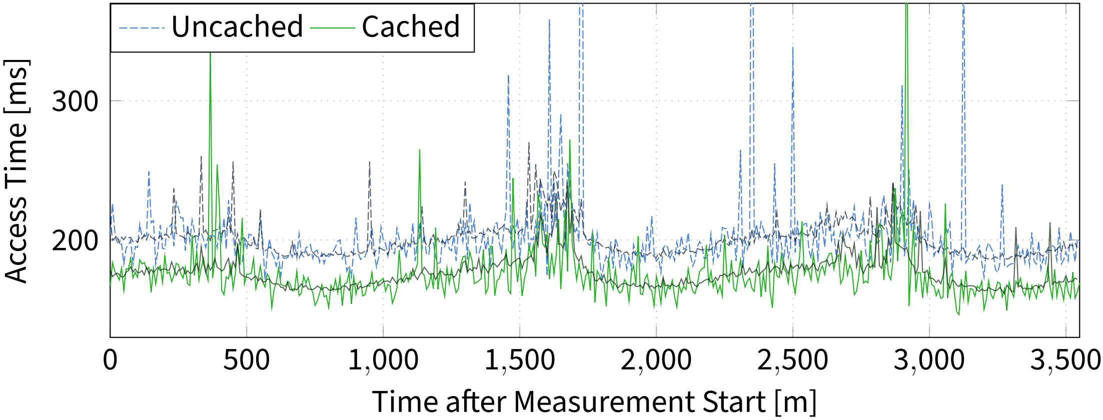
- `fetch` accesses the target server ⇒ Noise
- `CORS` avoids most data transfer

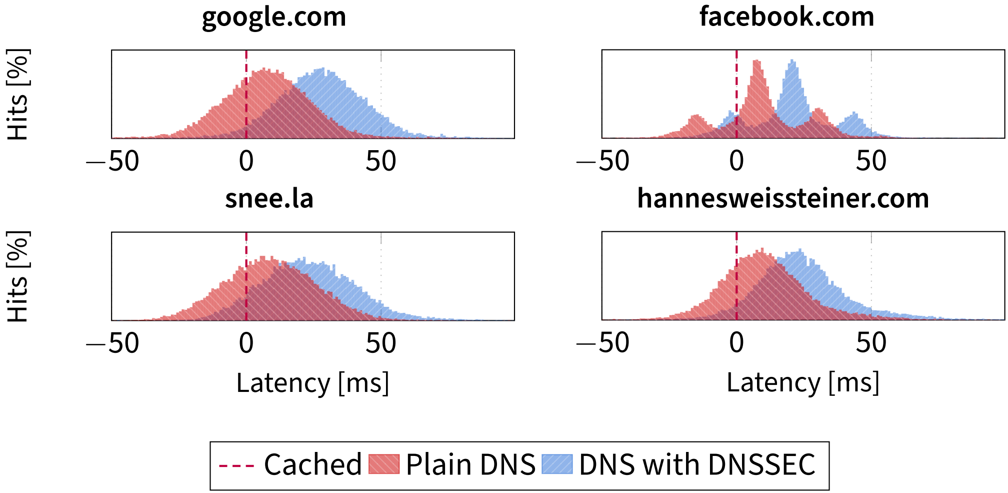
JavaScript


google.com
facebook.com
snee.la
hannesweissteiner.com
Hits [%]
Hits [%]
0
100
200
300
400
Latency [ms]
Latency [ms]
Cached
Plain DNS
DNS with DNSSEC

JavaScript


Uncached
Cached
Access Time [ms]
300
200
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Time after Measurement Start [m]

JavaScript


google.com
facebook.com
snee.la
hannesweissteiner.com
Hits [%]
Hits [%]
−50
0
50
Latency [ms]
Latency [ms]
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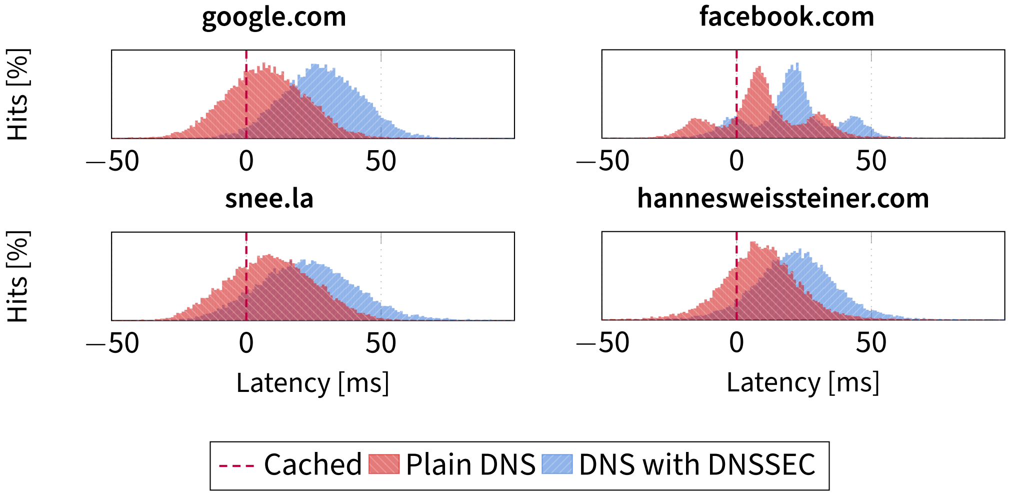
- Use CSS font alternatives to serialize requests

Scriptless

```
body {
  font-family: "DMTFont";
}

@font-face {
  font-family: "DMTFont";
  src: url("https://attacker.com/measurement-start"),
       url("https://target-domain.com/random-value"),
       url("https://attacker.com/measurement-end");
}
```

Scriptless


google.com
facebook.com
snee.la
hannesweissteiner.com
Hits [%]
Hits [%]
−50
0
50
−50
0
50
−50
0
50
−50
0
50
Latency [ms]
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	DNSSEC	Average Offset	Standard Deviation	False Negatives
Native	✓	20.663 ms	1.677 ms	0.000 %
	✗	6.701 ms	1.517 ms	0.006 %
JavaScript	✓	20.356 ms	16.871 ms	13.641 %
	✗	8.942 ms	17.487 ms	24.192 %
JS 50 Mbit/s	✓	82.363 ms	18.041 ms	1.110 %
	✗	22.902 ms	31.044 ms	13.209 %
JS 300 Mbit/s	✓	35.998 ms	35.368 ms	9.839 %
	✗	16.567 ms	34.029 ms	19.630 %
Scriptless	✓	20.744 ms	17.102 ms	12.494 %
	✗	9.395 ms	18.039 ms	23.463 %

Evicting the DNS Cache

Eviction

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- We demonstrate 4 primitives

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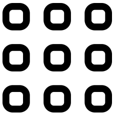
- ⊕ Fastest primitive
- ⊖ Only available from unsandboxed native code

Eviction using Individual Requests



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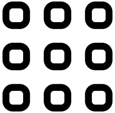

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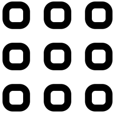

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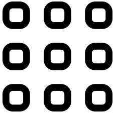

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- ⇒ Evict cache using maximum-TTL entries

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- ⊖ Hole-punching is implementation-specific

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- Problem 2: Public DNS server limits

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- ⊖ Not possible using most public DNS servers

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- ⊕ Very fast
- ⊖ Specific to `systemd-resolved`
- ⊖ Fixed in `systemd` 256+ for most DNS servers (EDE support)

Eviction Results

Primitive	Availability			Eviction
	Native	JS	HTML	Time
Direct Flushing	✓	✗	✗	10.987 ms
Many Requests	✓	✓	✓	5.109 s
Large Response	✓	✓	✓	1.387 s
Error-Based	✓	✓	✓	79.1 ms

Browser Cache Eviction

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End-to-End Attacks

Native Cross-VM

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True Positives 22 999	False Negatives 3 502
False Positives 240	True Negatives 314 498

(F_1 Score 92.48%)

JavaScript End-to-End

Setup:

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JavaScript End-to-End

Setup:

- Attacker running in Browser
- Victim accesses random set out of 10 Domains
- Attacker monitors from JavaScript, evicts using error-based eviction
- Also bypasses browser cache

Domain	DNSSEC	
	✗	✓
`amazon.com`	81.63 %	91.67 %
`pornhub.com`	85.71 %	80.77 %
`reddit.com`	86.49 %	97.78 %
`wikipedia.com`	95.24 %	91.67 %
Macro-average	78.89 %	82.86 %

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- **macOS:** Possible by evicting using individual requests
- **Windows:** Theoretically possible, no working eviction primitive yet

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- **Firefox** also sees the responsibility mostly with the resolver
- **Apple** is planning to address the issue in a future update

Conclusion

- We demonstrated an Evict+Reload attack on local DNS caches
- Our attack works native, from JavaScript or scriptless, even over VPN
- No fixes have been deployed yet, the attack is still possible today

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Acknowledgments

This research was made possible by generous funding from:

Funded by the European Union

fssec erc

European Research Council
Established by the European Commission

SPyCoDe FWF
Der Wissenschaftsfonds.

Google

Supported in part by the European Research Council (ERC project FSSec 101076409), and the Austrian Science Fund (FWF project NeRAM 10.55776/I6054 and FWF SFB project SPyCoDe 10.55776/F85). Additional funding was provided by generous gifts from Google. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the funding parties.

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[2] Gilad Moav et al. **DNS FLaRE: A Flush-Reload Attack on DNS Forwarders.** USENIX Security. 2025.