

CVE-2026-41238: How Prototype Pollution Turns DOMPurify Into an XSS Gadget

CVE-2026-41238: How Prototype Pollution Turns DOMPurify Into an XSS Gadget - Paul Reed, trace37.

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Content

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CVE: [CVE-2026-41238](#)

Finder: [trace37 labs](#)

Affected: DOMPurify 3.0.1 through 3.3.3

Impact: XSS bypass via prototype pollution chain

CVSS: 7.1 (High)

Advisory: [GitHub Security Advisory](#)

Patch: [Version 3.4.0](#)

Discovery

In a [previous post](#), I described a large-scale evolutionary fuzzing system designed to find zero-day CVEs in DOMPurify's core sanitization logic. It incorporated fitness functions that measured partial success, mutation operators modeled after cryptanalytic rotors, and a multi-track architecture splitting effort between mXSS, hook bypasses, and integration bugs.

That system was designed to find bypasses in DOMPurify's HTML parsing — the traditional attack surface. What was actually found was something different. Not a parsing bug. Not an mXSS. A **prototype pollution gadget** hiding in DOMPurify's configuration parser, activated by a single JavaScript operator that every developer uses without thinking.

Two characters. `||`. That's all it took.

This is not a claim that DOMPurify was wholesale broken until 3.4.0 dropped this week. For the vast majority of applications, DOMPurify sanitizes correctly and the bypass is unreachable. The vulnerability requires a **prototype pollution primitive** that can inject `RegExp` instances — not strings, not booleans, actual `RegExp` objects — into `Object.prototype`. Most PP vectors (URL query strings, JSON payloads) produce strings and cannot reach this code path.

But for applications where both conditions are met — a PP gadget that preserves types (postMessage handlers with vulnerable deep-merge, server-side PP via jsdom) and DOMPurify 3.0.1+ with default config — the bypass is **deterministic, not probabilistic**. Every call to `DOMPurify.sanitize(input)` inherits the polluted values. Every custom element passes. Every event handler survives. The sanitizer is completely neutralized, on every invocation, until the pollution is cleared.

THE VULNERABILITY — ONE LINE, TWO CHARACTERS

src/purify.js : line 590

```
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || {};
```

That `{}` inherits from `Object.prototype`. If an attacker has polluted the prototype, DOMPurify inherits that poison.

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1. Background: Prototype Pollution Meets Sanitization

Prototype Pollution in 60 Seconds

In JavaScript, every object inherits properties from a shared ancestor called `Object.prototype`. This inheritance mechanism — the prototype chain — is fundamental to how the language works. But it has a dangerous side effect: if an attacker can write to `Object.prototype`, every object in the entire application inherits the attacker's values:

```
// Attacker achieves prototype pollution via some gadget
Object.prototype.isAdmin = true;

// Later, somewhere else in the application...
const user = {};
console.log(user.isAdmin); // true — inherited from the polluted prototype
```

Prototype pollution (PP) vulnerabilities are everywhere. They've been found in lodash, jQuery.extend, qs, deep-extend, merge-deep, minimalist, and dozens of other libraries. Most are treated as moderate-severity bugs on their own — the standard response is “you need a gadget to make it dangerous.”

DOMPurify just became that gadget.

Why This Matters

DOMPurify is the industry standard for XSS prevention. 24M+ weekly npm downloads. Used by GitHub, Notion, Slack, Discord, WordPress. When DOMPurify says HTML is safe, applications trust that verdict absolutely. A bypass doesn't just affect DOMPurify — it affects every application downstream.

This is a novel, previously undisclosed attack vector. Prototype pollution gadgets in DOMPurify have been found before — but none targeting this code path, and none that work against the default configuration:

| Prior Research | Target | Prerequisite | Status | | | [GHSA-cj63-jhhr-wcxv](#) | Array.prototype pollution of ALLOWED_ATTR | Requires USE_PROFILES in config | Fixed in 3.3.2 | | | [BlackFan / Securitum](#) | ALLOWED_ATTR via in operator | Ancient versions (pre-2.0.13) | Fixed in 2.0.13 | | | [CVE-2024-47875](#) (CVSS 10.0) | Nesting-based mXSS bypass | Default config | Fixed in 2.5.0 / 3.1.3 | | | [CVE-2024-45801](#) | __depth check weakening via PP | Specific deep nesting | Fixed in 3.1.3 | | | [CVE-2025-26791](#) | Template literal regex bypass | SAFE_FOR_TEMPLATES config | Fixed in 3.2.4 | | | [Mizu.u.re](#) | CUSTOM_ELEMENT_HANDLING namespace confusion | Explicit CEH config (not PP) | Fixed in 3.0.8 | |

This new CVE vector is distinct on every axis: different prototype (Object.prototype vs Array.prototype), different property (tagNameCheck / attributeNameCheck vs ALLOWED_ATTR), different code path (CUSTOM_ELEMENT_HANDLING || {} fallback), and critically — **no special DOMPurify configuration required**. The standard call that every tutorial teaches, every README recommends, and every application uses — DOMPurify.sanitize(input) — is the vulnerable path.

It's worth noting the depth of existing DOMPurify security research. Kevin Mizu (@Kevin_Mizu) has published extensive work on DOMPurify internals — from mXSS via the style/title/comment regex, to hook misconfigurations (forceKeepAttr , setAttribute in hooks, insertBefore node manipulation), to post-sanitization mutations (jQuery, TinyMCE, Unicode toUpperCase normalization), to server-side charset sniffing bypasses. His [two-part series on mizu.re](#) is the most comprehensive public analysis of DOMPurify's attack surface. Securitum's Micha Bentkowski and BlackFan documented the original ALLOWED_ATTR prototype pollution gadgets. RyotaK (Flatt Security) identified the

`USE_PROFILES` `Array.prototype` vector (GHSA-cj63-jhhr-wcxv) and the `ADD_ATTR` URI validation bypass (CVE-2024-6780), both fixed in 3.3.2.

None of this research identified the `CUSTOM_ELEMENT_HANDLING || {}` fallback as a prototype pollution gadget — HOWEVER, that is because the vulnerable pattern **didn't exist** until relatively recently.

The `|| {}` fallback was introduced as a **regression in DOMPurify 3.0.1** (commit [967b8da](#), Feb 2023) while fixing a config-reset issue for custom elements. Prior versions used `Object.create(null)` and were not affected. The regression is easy to miss because DOMPurify's initial declaration at module load time still correctly uses `Object.seal(create(null, {...}))` — a sealed, prototype-less object. The vulnerability only appears because `_parseConfig()` **overwrites** that sealed object with a plain `{}` on every call when no `CUSTOM_ELEMENT_HANDLING` config is provided. The safe initialization masks the unsafe reassignment introduced by the bugfix.

The 3.3.2 security fix specifically hardened `ALLOWED_ATTR` against prototype pollution but left the `CUSTOM_ELEMENT_HANDLING || {}` fallback untouched. The vulnerable line persists in the current release (3.3.3).

2. The Vulnerable Code Path

How DOMPurify Handles Custom Elements

Web Components are a standard part of the modern web. Custom elements — HTML tags with a hyphen in the name, like `<my-component>` — are everywhere. DOMPurify needs to handle them, so it provides the `CUSTOM_ELEMENT_HANDLING` config option:

```
// Application explicitly configures custom element support
DOMPurify.sanitize(input, {
  CUSTOM_ELEMENT_HANDLING: {
    tagNameCheck: /^my-/ ,      // Only allow tags starting with "my-"
    attributeNameCheck: /^data-/ , // Only allow data-* attributes
  }
});
```

Most applications don't use this option. They call `DOMPurify.sanitize(input)` with no config, or with config that doesn't mention custom elements. This is where the bug lives.

The Config Parser

When DOMPurify parses its configuration, it hits this code at line 590 of `src/purify.js` (line ~1120 in the unminified dist):

```
// Line 590 — THE VULNERABLE LINE
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || {};
```

Let's trace the execution for a default-config call:

```
%%{init: {'theme': 'dark', 'themeVariables': { 'lineColor': '#58a6ff', 'primaryTextColor': '#e6edf3', 'primaryBorderColor': '#e6edf3' }}
flowchart TD
    A["DOMPurify.sanitize(input)"] --> B["_parseConfig(cfg)"]
    B --> C{"cfg.CUSTOM_ELEMENT_HANDLING ?"}
    C --> |"undefined (default)"| D["Fallback: <strong>{}</strong>"]
    C --> |"Explicit object"| E["Use provided config"]
    D --> F["<strong>{}</strong> inherits from Object.prototype"]
    F --> G{"Object.prototype polluted?"}
    G --> |"YES"| H["tagNameCheck = /.*/ <br/> attributeNameCheck = /.*/"]
    G --> |"NO"| I["tagNameCheck = undefined <br/> (safe — custom elements blocked)"]
    H --> J["ALL custom elements pass <br/> ALL attributes allowed"]
    J --> K["XSS via event handlers"]
    E --> L["Lines 591-598 execute <br/> Explicit values override prototype"]
    L --> M["Safe — controlled by application"]

    style D fill:#2a0000,stroke:#f85149,color:#e6edf3
    style F fill:#2a0000,stroke:#f85149,color:#e6edf3
    style H fill:#2a0000,stroke:#f85149,color:#e6edf3
    style K fill:#f85149,stroke:#f85149,color:#fff
    style M fill:#238636,stroke:#238636,color:#fff
```

The Critical Detail

There's a subtle but critical detail in how DOMPurify's config parser works. After line 590 creates the `CUSTOM_ELEMENT_HANDLING` object, lines 591-598 check the **original config**, not the new object:

```
// Line 590: Module-scope variable gets the fallback {}
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || {};

// Lines 591-598: Check the ORIGINAL config (cfg), not CUSTOM_ELEMENT_HANDLING
if (cfg.CUSTOM_ELEMENT_HANDLING &&
    isRegexOrFunction(cfg.CUSTOM_ELEMENT_HANDLING.tagNameCheck)) {
    CUSTOM_ELEMENT_HANDLING.tagNameCheck = cfg.CUSTOM_ELEMENT_HANDLING.tagNameCheck;
}

// ... same for attributeNameCheck and allowCustomizedBuiltInElements
```

When `cfg.CUSTOM_ELEMENT_HANDLING` is `undefined` (the default case):

- `CUSTOM_ELEMENT_HANDLING` is assigned `{}` — a regular object inheriting from `Object.prototype`
- The `if (cfg.CUSTOM_ELEMENT_HANDLING && ...)` conditions are **all false** — because `undefined` is falsy

- `tagNameCheck` and `attributeNameCheck` are **never explicitly set** on the object
- They resolve via the **prototype chain**

If `Object.prototype.tagNameCheck` has been polluted with `/.*/`, DOMPurify now thinks every custom element name is allowed. If `Object.prototype.attributeNameCheck` is `/.*/`, every attribute — including event handlers — passes through.

Where the Polluted Values Flow

Later in sanitization, at line 973:

```
if (CUSTOM_ELEMENT_HANDLING.tagNameCheck instanceof RegExp) {  
  if (regExpTest(CUSTOM_ELEMENT_HANDLING.tagNameCheck, tagName)) {  
    // Tag is allowed as a custom element  
  }  
}
```

With `tagNameCheck = /.*/` inherited from the polluted prototype, `/.*/` is indeed `instanceof RegExp`, and `regExpTest(/.*/, anyTagName)` always returns `true`. Every custom element passes. The same logic applies to `attributeNameCheck` for attribute validation.

PROTOTYPE CHAIN RESOLUTION — THE INHERITANCE TRAP

3. Exploitation: From Pollution to XSS

The Constraint: Custom Elements Only

This bypass only works with custom elements — HTML tags containing a hyphen. Standard tags like `<img>`, `<script>`, and `<svg>` are handled by DOMPurify's allowlist/blocklist logic, which is separate from `CUSTOM_ELEMENT_HANDLING`. The custom element check only fires when:

- The tag is not in `FORBID_TAGS`
- `_isBasicCustomElement(tagName)` returns true (the tag name contains a hyphen)

This means payloads must use tags like `<x-x>`, `<my-evil>`, `<a-b>` — any name with at least one hyphen. This is not a significant limitation: custom element names are arbitrary, and event handlers fire on any element.

A defender might ask: “doesn't DOMPurify also sanitize attribute *values*?” It does — for URI-type attributes like `href` and `src`, DOMPurify checks for dangerous schemes (`javascript:`, `data:`). But event handler attributes (`onfocus`, `onclick`, `onerror`) are dangerous because of the *attribute name*, not the value. Normally DOMPurify strips these attribute names entirely. The bypass works because `attributeNameCheck = /.*/` tells DOMPurify to allow *any* attribute name on custom elements — including event handlers. The value sanitizer never fires because the attribute name itself was supposed to be the first line of defense.

Effective Payloads

The most reliable XSS payloads use `onfocus` with `tabindex` and `autofocus` — they fire without user interaction:

```
<x-x onfocus=alert(document.cookie) tabindex=0 autofocus>
```

When DOMPurify outputs this unchanged and the application inserts it via `innerHTML`, the browser:

- Parses the custom element (valid per the HTML spec — unknown elements are treated as `HTMLElement`)
- Sets `tabindex=0` (makes the element focusable)
- Applies `autofocus` (browser immediately focuses the element)
- Fires the `onfocus` event handler **XSS executes**

Other working payloads:

```
<!-- Click-triggered -->
```

```
<my-tag onclick=alert(1)>click me</my-tag>
```

```
<!-- Hover-triggered (with large hit area) -->
```

```
<evil-el onmouseover=alert(1) style="display:block;padding:20px">hover me</evil-el>
```

```
<!-- Pointer-triggered (fullscreen overlay) -->
```

```
<pwn-ed onpointerover=alert(1) style="display:block;width:100vw;height:100vh">
```

What Configurations Are Vulnerable?

Config Pattern	Vulnerable?	Why
<code>DOMPurify.sanitize(input)</code>	YES	No config
<code>cfg.CUSTOM_ELEMENT_HANDLING</code> is undefined	YES	<code>{}</code> fallback
Empty config same path	YES	<code>DOMPurify.sanitize(input, { CUSTOM_ELEMENT_HANDLING: null })</code>
<code>null</code> <code>{}</code> same fallback	NO	<code>DOMPurify.sanitize(input, { CUSTOM_ELEMENT_HANDLING: {} })</code>
Explicit object	YES	lines 591-598 execute, no prototype inheritance
<code>DOMPurify.setConfig({})</code> then <code>.sanitize(input)</code>	YES	Same <code>_parseConfig</code> path

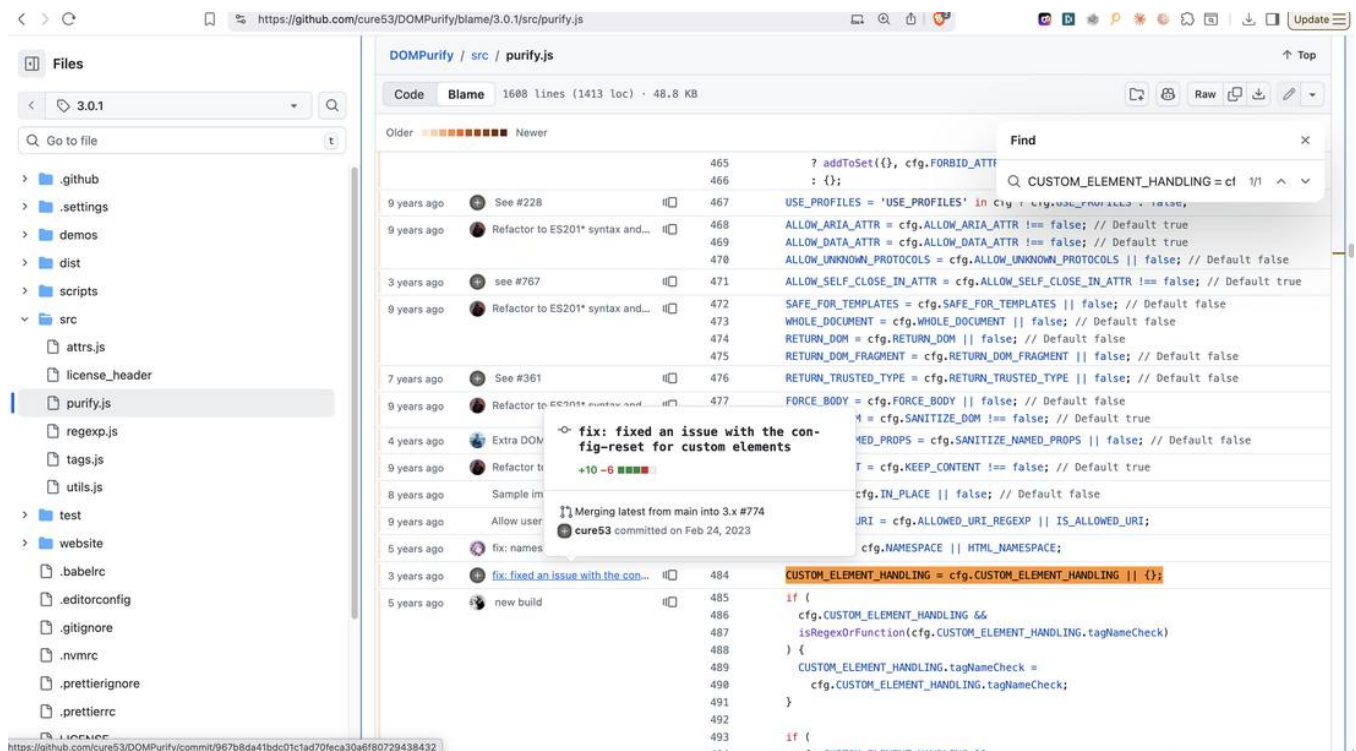
The first three patterns cover the vast majority of real-world DOMPurify usage.

4. Version Archaeology: When Did This Break?

Git blame tells the exact story. The vulnerable `|| {}` pattern was introduced in commit [967b8da](#) on **February 24, 2023**, with the message:

```
fix: fixed an issue with the config-reset for custom elements
```

The commit was merged into the 3.x branch via [PR #774](#) and first shipped in **DOMPurify 3.0.1**. The developer was solving a real problem — ensuring `CUSTOM_ELEMENT_HANDLING` configuration properly resets between `sanitize()` calls. The fix replaced the previous null-prototype initialization with a config-driven assignment plus a fallback. The fallback chosen was `{}`.



Git blame: DOMPurify 3.0.1, `src/purify.js` line 484. Commit `967b8da` — "fix: fixed an issue with the config-reset for custom elements" — introduced the `|| {}` fallback.

In DOMPurify 3.0.0 and all 2.x versions, the initialization used `Object.create(null)`:

```
// DOMPurify ≤ 3.0.0 — SAFE
CUSTOM_ELEMENT_HANDLING = Object.create(null);
// No prototype chain. Object.prototype pollution has no effect.

// DOMPurify 3.0.1+ — VULNERABLE
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || {};
// {} has Object.prototype in its chain. Pollution flows through.
```

VERSION TIMELINE

2.x — 3.0.0

`Object.create(null)`

SAFE — no prototype chain

3.0.1 — 3.3.3

`cfg.CEH || {}`

VULNERABLE — `{}` inherits prototype

3.3.2 (partial fix)

Fixed USE_PROFILES PP

GHSA-cj63 — different vector

This is a one-line regression introduced while fixing a different bug. The original config-reset issue was real — `CUSTOM_ELEMENT_HANDLING` needed to be reassigned from the config on each call. The fix works correctly for that purpose. The problem is the fallback: `|| {}` creates a regular object that inherits from `Object.prototype`, while the original `Object.create(null)` did not. The change looks equivalent at first glance — but `{} and Object.create(null) are fundamentally different objects in JavaScript's prototype model. A bugfix for config isolation inadvertently opened a prototype pollution gadget.`

5. Proof of Concept

Minimal Reproduction

```
// 1. Simulate prototype pollution (in reality, this comes from
// a separate gadget: lodash.merge, qs, jQuery.extend, etc.)
Object.prototype.tagNameCheck = /.*/;
Object.prototype.attributeNameCheck = /.*/;

// 2. Application sanitizes user input with DEFAULT config
const clean = DOMPurify.sanitize(
  '<x-x onfocus=alert(document.cookie) tabindex=0 autofocus>'
);

// 3. "Sanitized" output still contains the event handler
console.log(clean);

// <x-x onfocus="alert(document.cookie)" tabindex="0" autofocus="">

// 4. When inserted into DOM, XSS fires automatically
document.body.innerHTML = clean;

// alert() executes. Session cookies exfiltrated.
```

Browser-Verified PoC

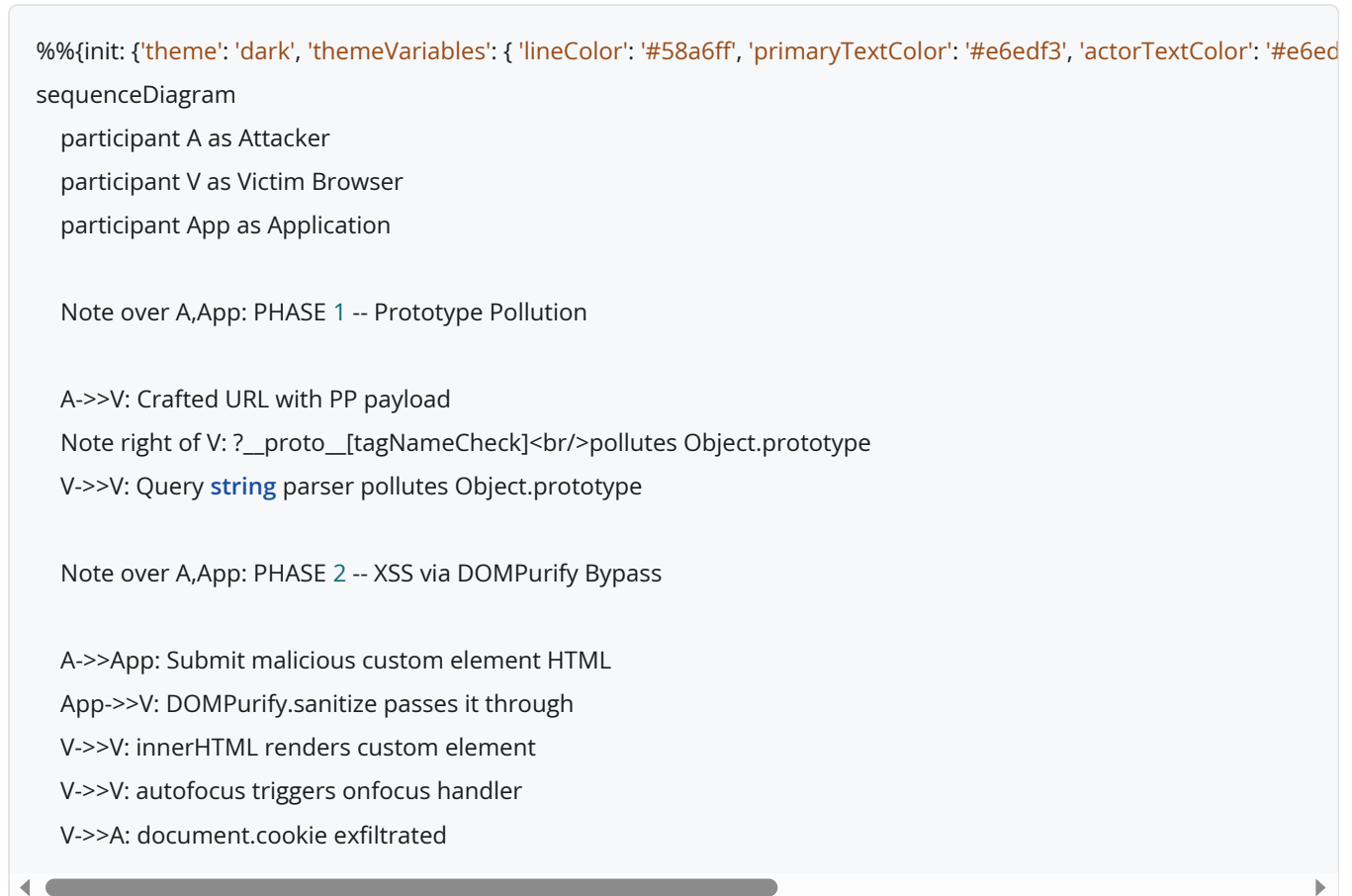
This was confirmed in Chrome with DOMPurify 3.3.3 loaded from npm. The PoC HTML file (included in the advisory materials) walks through four steps:

- **Pollute** — Sets `Object.prototype.tagNameCheck` and `attributeNameCheck` to `./.*`
- **Sanitize** — Calls `DOMPurify.sanitize()` with three different XSS payloads using default config
- **Render** — Injects the “sanitized” output into the DOM
- **Verify** — Cleans up pollution and confirms DOMPurify works correctly again

All three payloads survive sanitization and execute when rendered.

What a Real Attack Chain Looks Like

In practice, the attacker doesn't call `Object.prototype.tagNameCheck = /.*/` directly. They exploit a **separate prototype pollution vulnerability** in a dependency loaded on the same page, then submit malicious HTML through whatever input the application sanitizes with DOMPurify.



6. Impact and Attack Scenarios

CVSS Score

CVSS 3.1 Base Score: 7.1 (High) — AV:N/AC:H/PR:N/UI:R/S:C/C:H/I:L/A:N

The High complexity rating reflects the prototype pollution prerequisite. But PP gadgets are **extremely prevalent** in the JavaScript ecosystem:

KNOWN PROTOTYPE POLLUTION GADGETS IN THE WILD

lodash.merge / _defaultsDeep

jQuery.extend (deep)

qs / query-string parsers

deep-extend / merge-deep

minimist (CLI argument parsers)

flat / unflatten utilities

Any one of these, present on the same page, provides the pollution primitive needed for this chain.

Attack Scenarios

Scenario 1: Forum / CMS with rich HTML input A forum allows HTML formatting in posts. DOMPurify sanitizes input before rendering. If the forum also uses a query string parser vulnerable to PP (e.g., an older version of `qs`), an attacker can craft a URL that pollutes the prototype, then submit a post containing `<x-x onfocus=alert(document.cookie)>`. Every user who views the post — with the polluted prototype still active — gets XSS.

Scenario 2: Markdown preview with DOMPurify A documentation platform renders user markdown through a pipeline that includes DOMPurify. A PP vulnerability in any dependency in the rendering pipeline enables the same chain. The attacker's markdown contains custom element HTML that DOMPurify would normally strip.

Scenario 3: Third-party widget with shared prototype A page embeds a third-party widget that introduces a PP vulnerability. The main application uses DOMPurify for sanitization. The widget's PP pollution flows into the main application's DOMPurify calls, bypassing sanitization for any user-generated content rendered after the widget loads.

7. The Fix

What I Suggested

My advisory proposed a minimal one-line fix — change line 590 from:

```
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || {};
```

To:

```
CUSTOM_ELEMENT_HANDLING = cfg.CUSTOM_ELEMENT_HANDLING || create(null);
```

This would eliminate the prototype chain inheritance by using `create(null)` (DOMPurify's alias for `Object.create(null)`), the same pattern used elsewhere in the codebase and in the original 3.0.0 initialization. This fix is correct and sufficient for the reported vulnerability.

What cure53 Actually Shipped (3.4.0)

cure53 went further. Rather than patching the single `|| {}` fallback, they restructured the entire `CUSTOM_ELEMENT_HANDLING` config block to defend in depth:

```

// 1. Read from cfg with objectHasOwnProperty guard + type check + clone
const customElementHandling =
  objectHasOwnProperty(cfg, 'CUSTOM_ELEMENT_HANDLING') &&
  cfg.CUSTOM_ELEMENT_HANDLING &&
  typeof cfg.CUSTOM_ELEMENT_HANDLING === 'object'
    ? clone(cfg.CUSTOM_ELEMENT_HANDLING)
    : create(null);

// 2. ALWAYS start from a prototype-less object
CUSTOM_ELEMENT_HANDLING = create(null);

// 3. Copy individual properties with hasOwnProperty + type validation
if (
  objectHasOwnProperty(customElementHandling, 'tagNameCheck') &&
  isRegexOrFunction(customElementHandling.tagNameCheck)
) {
  CUSTOM_ELEMENT_HANDLING.tagNameCheck = customElementHandling.tagNameCheck;
}

// ... same for attributeNameCheck and allowCustomizedBuiltInElements

```

This is a defence-in-depth approach that closes the vulnerability at **three** levels:

- **objectHasOwnProperty(cfg, ...)** — prevents inherited properties from being read off the config object itself
- **create(null)** for both the temp variable and the final assignment — eliminates prototype chain at two separate points
- **clone()** on user-provided config before reading — isolates from any mutation after the check

My one-liner would have fixed the reported bug. cure53's restructuring additionally hardens against future PP vectors that might target the config object or intermediate variables. This is the kind of defensive response you want to see from a security library maintainer.

Application-Level Mitigation

For applications that cannot immediately upgrade to 3.4.0, providing an explicit `CUSTOM_ELEMENT_HANDLING` in the config bypasses the vulnerable fallback path entirely:

```

DOMPurify.sanitize(input, {
  CUSTOM_ELEMENT_HANDLING: {
    tagNameCheck: null,
    attributeNameCheck: null
  }
});

```

When an explicit object is provided, `cfg.CUSTOM_ELEMENT_HANDLING` is truthy, so the conditional blocks execute and explicitly set the values — overriding any prototype pollution.

The Broader Lesson

The Pattern to Watch For

Any time a security-critical library uses `|| {}` as a fallback for configuration objects, it creates a potential prototype pollution gadget. The safe pattern is `|| Object.create(null)`. This applies to:

- Sanitization libraries (DOMPurify, sanitize-html)
- Template engines (Handlebars, EJS, Pug)
- Authentication libraries (Passport, auth0-js)
- Any library that makes security decisions based on config values

If the config fallback inherits from `Object.prototype`, an attacker with a PP primitive can inject values that alter the library's security behavior.

8. Real-World Exploitation: The Type Constraint

The PoC works. The vulnerability is confirmed. But there's a critical constraint that determines how exploitable this is in practice — and understanding it separates theoretical risk from real-world impact.

The Problem: RegExp, Not Strings

DOMPurify's custom element validation uses an `isRegexOrFunction` check:

```
const isRegexOrFunction = function (testValue) {  
  return testValue instanceof RegExp || testValue instanceof Function;  
};
```

For the bypass to work, `Object.prototype.tagNameCheck` must be an actual `RegExp` instance — not the string `".*"`, not the number `1`, not `true`. The `instanceof RegExp` check is strict.

This matters because **the most common prototype pollution vectors produce strings, not RegExp instances:**

PP VECTOR TYPE CONSTRAINTS

URL query string PP

```
?__proto__[tagNameCheck]=.*
```

Produces STRING `".*"` — fails `instanceof RegExp`

JSON body PP

```
{"__proto__": {"tagNameCheck": ".*"}}
```

JSON has no RegExp type — always strings

postMessage PP

```
postMessage({...}, "*", [port])
```

structuredClone preserves RegExp instances

This type constraint is the reason the vulnerability hasn't been trivially mass-exploited despite the `|| {}` fallback existing since 2023. Most PP vectors in the wild are URL-based or JSON-based, and neither can inject RegExp instances.

Three Paths to Real-World Exploitation

Path A: postMessage handlers (highest probability)

The `postMessage` API can transmit real JavaScript objects — including `RegExp` instances — via the browser's [structured clone algorithm](#). If an application:

- Loads DOMPurify 3.0.1–3.3.3
- Has a `window.addEventListener('message', ...)` handler that deep-merges received data without origin validation

...then an attacker can send a message containing `{tagNameCheck: /.*/, attributeNameCheck: /.*/}` from a cross-origin iframe, pollute the prototype through the handler's merge, and trigger the DOMPurify bypass.

```
// Attacker's page — embeds target in iframe
const iframe = document.createElement('iframe');
iframe.src = 'https://target.com/page-with-dompurify';
document.body.appendChild(iframe);

iframe.onload = () => {
  // postMessage transmits RegExp instances intact (structuredClone preserves type).
  // This alone does NOT pollute Object.prototype — the receiving code must perform
  // a vulnerable deep merge (e.g., lodash.merge, custom recursive assign) that
  // interprets __proto__ as a prototype setter and copies the RegExp values up
  // the chain. The postMessage API is the *transport*, not the *gadget*.
  iframe.contentWindow.postMessage({
    __proto__: {
      tagNameCheck: /.*/,
      attributeNameCheck: /.*/
    }
  }, '*');
};
```

The `postMessage` API is the transport — it preserves `RegExp` types that URL query strings and JSON cannot. But the pollution itself requires a vulnerable merge handler on the receiving end. Wildcard `postMessage` handlers with deep-merge patterns are common — especially in applications using third-party widgets, analytics SDKs, and embedded iframes.

Path B: Other config fallbacks with weaker type checks

The `CUSTOM_ELEMENT_HANDLING` path requires `RegExp`. But `DOMPurify`'s config parser has **other** `|| {}` and `|| false` fallbacks that may accept simpler types. If any config property:

- Uses a `|| {}` or `|| []` fallback (inherits from prototype)
- Influences security decisions
- Accepts booleans, strings, or numbers (not just `RegExp`)

...then URL-based PP works, and the blast radius expands dramatically. A partial audit of `_parseConfig`:

```
// These all use || or !== checks — worth auditing for PP impact:  
SAFE_FOR_TEMPLATES = cfg.SAFE_FOR_TEMPLATES || false;  
WHOLE_DOCUMENT = cfg.WHOLE_DOCUMENT || false;  
RETURN_DOM = cfg.RETURN_DOM || false;  
FORCE_BODY = cfg.FORCE_BODY || false;  
SANITIZE_DOM = cfg.SANITIZE_DOM !== false; // Default true  
SANITIZE_NAMED_PROPS = cfg.SANITIZE_NAMED_PROPS || false;  
KEEP_CONTENT = cfg.KEEP_CONTENT !== false; // Default true
```

The `cfg` object is produced by `DOMPurify`'s `clone()` function, which uses `Object.create(null)` — so these specific properties are safe from prototype pollution on the `cfg` side. But this illustrates the general pattern: any security-relevant library that reads config from a prototype-inheriting object without type validation is a potential gadget.

Path C: Server-side with jsdom

When `DOMPurify` runs server-side via `jsdom` (the [recommended server-side setup](#)), PP primitives from request body parsers or deep-merge utilities operate in the same Node.js process. Server-side PP is often achievable through:

- Express body-parser with `extended: true` (uses `qs` under the hood)
- Deep merge utilities in middleware chains
- Configuration loading from user-controlled JSON

The exploitation constraints are the same (`RegExp` instance required), but server-side environments have more pathways to achieve object injection with preserved types compared to URL-based client-side vectors.

What This Means for Defenders

Practical Risk Assessment

The type constraint means this vulnerability is **not trivially exploitable via URL parameters** — the most common PP vector. This limits drive-by exploitation.

However, applications that combine `DOMPurify` with **postMessage handlers, deep-merge utilities processing untrusted objects, or server-side PP vectors** are at genuine risk. The fix is one line and has no functional side effects — there is no reason to delay patching.

Immediate mitigation: Pass an explicit `CUSTOM_ELEMENT_HANDLING: {}` in your DOMPurify config. This overrides the prototype chain regardless of pollution state.

The RegExp constraint means this is unlikely to surface on top-tier bug bounty programs — those targets tend to have strict CSP, minimal third-party widget embedding, and server architectures that don't expose prototype pollution to the browser. The applications most likely to be affected are further down the maturity curve — which is not great news for bounty hunters, but means bad actors with a prototype pollution scanner and a DOMPurify fingerprint could find a rich vein of targets that have no idea their sanitizer has been silently neutralized. Indeed, I have discovered two such targets in recent days. They are platforms that embed third-party widgets with wildcard `postMessage` handlers and deep-merge patterns — analytics dashboards, marketing platforms, SaaS tools that integrate multiple vendor scripts on the same page. They are Node.js backends using Express with `body-parser` in extended mode (which uses `qs` under the hood) running DOMPurify via `jsdom` for server-side sanitization. They are applications built by teams that chose DOMPurify because it's the industry standard and trusted its default config without considering prototype pollution as a threat to the sanitizer itself.

For these applications, the bypass is total. Not partial, not conditional on a specific DOMPurify configuration option. The default call — `DOMPurify.sanitize(input)` — is the vulnerable path. The one every tutorial teaches. The one 24 million weekly npm downloads execute.

9. Disclosure Timeline

Date	Event
2026-04-04	Vulnerability discovered during DOMPurify fuzzing research (Fer mat project)
2026-04-04	Confirmed in Chrome with DOMPurify 3.3.3
2026-04-04	Verified distinct from GHSA-cj63-jhhr-wcxv and CVE-2024-45801
2026-04-04	Advisory drafted, responsible disclosure initiated via GHSA-v9jr-rg53-9pgp
2026-04-14	cure53 accepted the advisory
2026-04-15	cure53 requested CVE assignment
2026-04-14	DOMPurify 3.4.0 released with fix — restructured <code>CUSTOM_ELEMENT_HANDLING</code> config parsing to use <code>create(null)</code> at all levels with <code>objectHasOwnProperty</code> guards
2026-04-16	CVE-2026-41238 assigned
2026-04-20	Advisory unembargoed, public disclosure

Conclusion

Two characters turned DOMPurify from the web's most trusted sanitizer into a prototype pollution gadget.

The `|| {}` pattern is one of the most common idioms in JavaScript. It looks defensive — “if the value is missing, use an empty object.” But in a security context, “empty” isn't empty. `{}` carries the full weight of `Object.prototype` in its prototype chain, and in a language where prototype pollution vulnerabilities are endemic, that inheritance is an attack surface.

DOMPurify's original code (3.0.0 and earlier) used `Object.create(null)`. That safe pattern was removed during a refactor in 3.0.1, replaced by an idiom that looked equivalent but broke a security invariant that had been in place since the library's creation.

The fix I suggested was one line: `|| create(null)` instead of `|| {}`. cure53's actual fix in 3.4.0 went further — they restructured the entire config block to eliminate prototype inheritance at every level. The final assignment is always `create(null)`. Properties are copied individually with `objectHasOwnProperty` guards and `isRegexOrFunction` type checks. User-provided config is `clone()`'d before reading. It's a defense-in-depth approach that not only closes this vulnerability but hardens against an entire class of future PP gadgets in the config parser.

The lesson is broader than one line: in security-critical code, `{}` and `Object.create(null)` are not interchangeable. They never were. And when a maintainer responds to a vulnerability report by hardening beyond the minimum fix, that's how trust in a security library is maintained.

This post is part of an ongoing series relating to my research into [trust-transitions in modern web applications](#).

Cite this post

APA

```
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