The Quiet Side Channel... Smuggling with CL.0 for C2

The Quiet Side Channel... Smuggling with CL.0 for C2 - d3d (M. B. Johnson), Malicious Group.

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Content

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Most people think HTTP smuggling requires complex header tricks or broken protocol parsing. But sometimes, the most effective exploits aren't based on complexity — they're based on trust. In this paper, I'll show how a simple misalignment in expectations between front-end and back-end servers can be quietly exploited to build an undetectable channel. No special headers. No payload gymnastics. Just a clean way in — and a clean way out. And once we're in, we'll turn this into a functioning C2 channel that rides through even the most hardened infrastructure.

Prerequisites

To get the most out of this research, it's helpful to have a solid grasp of Request Smuggling, Desync gadgets and Cache Poisoning vulnerabilities, especially `CL.0` (*malformed content length*) variations along with some familiarity with Python development for the PoC. Additionally, an understanding of how different reverse proxies, CDNs, or WAFs process and normalize headers will help when testing across environments. While a deep understanding isn't necessary just to follow along, recreating the techniques on your own will require careful attention to the steps outlined.

To help you get up to speed before diving in, here are some resources that provide useful background for what's discussed in this paper.

[What is HTTP request smuggling? Tutorial & Examples | Web Security Academy In this section, we'll explain HTTP request smuggling attacks and describe how common request smuggling vulnerabilities can arise. Labs If you're already... [image: image]Web Security Academy [image: ima

ge]](https://portswigger.net/web-security/request-smuggling?ref=blog.malicious.group#what-is-http-request-smuggling)

[CL.0 request smuggling | Web Security Academy Request smuggling vulnerabilities are the result of discrepancies in how chained systems determine where each request starts and ends. This is typically due… [image: image]Web Security Academy [image: image]](https://portswigger.net/web-security/request-smuggling/browser/cl-0?ref=blog.malicious.group)

Having reviewed the necessary context, let's move on to the discovery process.

Discovery

The initial step in this research was identifying inconsistencies in how different servers and intermediaries interpret and process HTTP requests. Rather than relying on known bug chains to increase impact, I focused on subtle protocol deviations—specifically in how edge infrastructure and backend systems parse ambiguous or malformed headers. By observing response behavior and using tooling to fuzz combinations of headers, I uncovered a parsing discrepancy that laid the foundation for a new smuggling primitive.

Before diving into the technical details, let's walk through the high-level steps of the discovery process to ensure a shared understanding:

- Identify a target that is vulnerable to `CL.0` request smuggling.
- Verify whether the vulnerability leads to global cache poisoning.
- Assess the stability and sensitivity of the cache while it remains poisoned.

While this may sound straightforward, each step requires careful attention to detail. Successfully completing this checklist sets the stage for developing the PoC tool. Let's break down how to approach each phase effectively.

Finding Targets

***Disclaimer:** **The following domain enumeration is purely for demonstration purposes. None of the listed domains were targeted in any attack, nor are they, to the best of my knowledge, vulnerable to desynchronization attacks. This section is intended solely to illustrate the methodology behind the attack research and tool development process.**

To narrow our focus, we'll target infrastructure operating behind major cloud and CDN providers such as Akamai (`akamaiedge.net`), Azure (`azureedge.net`), and Oracle Cloud (`oraclecloud.com`). Rather than demonstrate how to exploit the ASN footprints of these providers at scale, we'll limit ourselves to endpoints within their respective namespaces—easily discovered using tools like `chaos-client` , `subfinder` , `bbot` , or similar subdomain enumerators.

[image: image]

At this stage, we can start identifying which companies are utilizing specific instances within the `akamaiedge.net` network. To do this, we'll use the `tlsx` tool from ProjectDiscovery to extract and analyze TLS certificate data from servers listening on port 443.

[image: image]

This is where things start to get interesting—we can now begin mapping which companies are leveraging specific instances within the `akamaiedge.net` network.

While an ethical hacker might focus strictly on extracting domains that fall within the scope of public bug bounty programs, the objective of this paper is more expansive. Instead of targeting a handful of monetizable assets, the focus is on demonstrating the widespread and systemic nature of the vulnerability across a global attack surface.

Next, I'll parse all domains from the `tlsx.log` output and save them into a `domains.txt` file to prepare for the following step.

[image: image]

With the company domains separated, let's verify which have active DNS with web services we can take a poke at using the tool `httpx`.

***Note: **Remember, just because the *** *tlsx** **output shows a domain being mapped via TLS to a specific IP, DOES NOT MEAN the DNS is also routing to that IP. (hint, hint)**

[image: image]

After running `httpx` we now have a list of both HTTP and HTTPS endpoints for domains that we know are using the `akamaiedge.net` services.

***Disclaimer:** *For obvious legal reasons, I would highly recommend sticking to domains that are either part of a BBP/VDP program, or at least have a * `/security.txt` file.

Testing Targets

There are two primary options for testing endpoints.

***Option 1 - **Burp Suite + HTTP Request Smuggler bApp:*

The first is using the *Burp Suite * `Request Smuggler` extension, which allows you to check various HTTP and HTTPS endpoints after importing them into Burp's sitemap. While Burp does support bulk URL imports without requiring live crawling, performance can still be an issue—it's not the fastest approach. If you decide to go this route, I recommend the following steps.

Completely disable `Live Audit from Proxy` checks

[image: image]

Now modify the `Live passive crawl from Proxy` options by clicking on the 3 dots which creates a dropdown, the click on `settings`.

[image: image]

Under the settings, highlight the `Scan Configuration` settings and `edit` the policy.

[image: image]

After pressing `edit`, you need to deselect everything except for the following options. So, `Links` and `The item itself` should be the only enabled items.

[image: image]

Once done, save everything and close out back to the main screen. Next, we need to send the `httpx` list to **Burp Suite** and we can do this by using `curl` on the command line.

[image: image]

At this point **Burp Suite** should start lighting up with incoming URLs to the sitemap. Once done, select all of them and right-click to open up the options window, and select `Request Smuggler` and select the `cl.0` option.

[image: image]

Once the `cl.0` window opens, it will overwhelm you will choices to pick from. To narrow this down, each option (minus a few) is a different `cl.0` smuggling gadget. For this paper I will be using `nameprefix` , `nameprefix2` , `options` and `head` , so make sure those are also selected before moving forward.

[image: image]

On pressing `Ok` the attack probe will start. On getting a positive hit, it looks like the following in the Burp Suite UI:

[image: image]

***Option 2 - **Custom tooling:*

Alternatively, there's a **custom tool** I've developed specifically for this purpose. While it's currently private, it will be released soon and offers a significantly more streamlined workflow for this type of analysis.

To use this tool, you purely just feed the `httpx` file to the python tool directly and it will do the rest to parse out positive results.

[image: image]

All the positive hits get sent to both Discord via Discord hook to private channel, and to a file named `cl0.log` . At anytime during the fuzzing process, you can check the `cl0.log` file for positive hits to start working on manual investigation.

[image: image]

As you can see by the results above, this issue is wide-spread and is more than likely being abused in many ways by many different people.

So now that we have a means of discovering these bugs, let's take a closer look at one of the gadgets to get a better idea of what is going on.

Testing Attributes

Once we've identified potential positives, we need to manually review each hit to confirm not only that the technique is effective, but also that the behavior aligns with what we need for establishing a reliable communication channel. Let's dive into what that looks like in more detail.

For building a communications channel, we need to find vulnerable machines that have the following attributes:

- Desync allows for global poisoning
- Desync allows caching data on redirects (3xx)

The first point is obvious since we require global caching, but the reason for requiring the 3xx redirects is so that we can poison a redirection which shows up in the `Location` header for the client as you will see in a moment. Also, the client doesn't have to follow the 3xx redirections, as it is purely a suggestion.

The following image is of a `nameprefix1` gadget, which is a typical `POST` request but using another request as its content, while using a malformed `Content-Length` header.

[image: image]

When executing the request above, the `redacted.tld` domain responds with a `Location: https://www.redacted.tld` header. This indicates that the non-`www` version consistently redirects to the `www` subdomain, completely disregarding the POST body I included—as shown below.

[image: image]

However, what happens if I sent the exact same request, 3 to 5 times in a row?

[image: image]

Notice the difference? After hitting the send button several times, the server shifted from ignoring the POST content to fully adopting the smuggled endpoint—thanks to the `CL.0` gadget—and included it in the `Location` header as part of the redirect. In this proof-of-concept, we successfully smuggled `/robots.txt`, but it could just as easily be any file or arbitrary string, since the server responds with a standard 301 redirect. ***This is important to remember.***

While we've confirmed the behavior locally, the real question is whether it impacts the global cache. To test this, one of my go-to techniques is spinning up a VM on DigitalOcean or Linode to simulate a normal user—looping a `curl` request every few seconds. This allows me to observe whether the poisoned redirect has been cached and is affecting external clients.

[image: image]

While running a `curl` loop every 2 seconds to continuously request the main domain of the target company, I switched over to a second machine and began sending the same malformed requests. The red output clearly shows that the global cache was successfully poisoned—causing all incoming users to be redirected to `/robots.txt`.

Note: **It's an interesting behavior, but without any further exploit chains, this is essentially a temporary Denial of Service (DoS). An attacker could redirect traffic to an error page or * `*/favicon.ico*` , but on its own, this type of bug would typically be rated as **low **- **medium severity** in most bug bounty programs.*

However, from a logging and detection perspective, the attack currently relies on sending a `POST` request to trigger the desynchronization—specifically by smuggling a body using a malformed `Content-Length` header. While this technique is effective, it can serve as an indicator of compromise (IoC) due to the unusual presence of a body in a `POST` to non-API endpoints. In contrast, a `GET`-based gadget—if viable—would likely appear less suspicious in logs and could evade basic anomaly detection more easily especially if the client never follows the 3xx redirect.

Using the `GET` method with a `Content-Length` header may seem invalid at first, since `GET` requests typically do not include a body. However, many web servers, CDNs, and proxies do not strictly enforce this part of the HTTP specification. Instead, they tolerate or ignore the presence of a body

in a `GET` request — especially if a `Content-Length` header is present. In a lot of cases, the `POST` can be swapped with the `GET` verb without losing the underlying desync functionality. Here is the updated `nameprefix1` gadget shown above, but using `GET` verb instead.

[image: image]

This leniency can lead to discrepancies between how front-end and back-end systems parse the same request. For example:

- A proxy (like a CDN) may assume `GET` requests never have a body and may **ignore the `Content-Length`** header entirely, forwarding the request as-is.
- Meanwhile, a backend server may honor the `Content-Length` and **wait for a body**, leading to a desynchronization in state between the two systems.

This inconsistent parsing behavior is exactly what enables request smuggling attacks using `GET` — even though it's uncommon, it works on misaligned implementations. Some systems are also optimized for performance and don't strictly validate headers they don't expect, further enabling this behavior.

With the discovery process done, let's take a look at how we could weaponize this simple technique to create a communication channel using `GET` smuggle gadgets to a vulnerable domain.

Development

Now that we've explored how the desynchronization works and what behavior to look for, the next step is to operationalize this into tooling. For this, I'll be using PyCharm Professional to develop a script that can both send and listen for responses across the vulnerable domains. During the reconnaissance phase, you'll likely uncover multiple valid request templates or "gadgets" that trigger the desired behavior — these will need to be encoded into the PoC to automate testing and verification.

The concept is that the attacker is either disguising malicious traffic by leveraging well-known, legitimate domains, or exploiting a domain that is already whitelisted or permitted within the target network environment. Let's take a look and setting this up.

Code

The following code is just a PoC to demonstrate how this works, and not optimized or weaponized for mass exploitation.

[GitHub - maliciousgroup/CacheC2Channel: A request smuggling desync to global cache channel PoC to accompany paper on blog.malicious.group. A request smuggling desync to global cache channel PoC to accompany paper on blog.malicious.group. - maliciousgroup/CacheC2Channel [image: image]GitHubmaliciousgroup [image: image]]
(https://github.com/maliciousgroup/CacheC2Channel?ref=blog.malicious.group)

The tool above is intended solely for demonstrating the issue. It requires adaptation to the specific target environment to function correctly. As such, it is not a plug-and-play solution and will be ineffective without a clear understanding of the underlying mechanics.

I'm not going to walk through the PoC line by line, as it's fairly straightforward and includes comments to explain each method's purpose. The key concept to understand is that instead of smuggling a benign endpoint like `/robots.txt`, the script sends an encoded or encrypted message. The client then receives a `3xx` redirect with the message embedded in the `Location` header. By intentionally avoiding the redirect, the client avoids triggering a `404` error, which helps keep the communication stealthy and less noticeable in logs.

To demonstrate the effectiveness of this technique, I've selected a high-profile company with both a `.com` and a `.cn` domain. Regardless of the TLD, both domains are vulnerable to the same issue. This highlights how an attacker can selectively target domains based on network traffic patterns or exploit domains that are already trusted and whitelisted.

The included PoC contains a file named `PoC.txt`, which sends a message encoded in Base64 — though in a real-world scenario, it would likely use AES or another form of obfuscation.

Let's look at the vulnerable `.com` domain...

[image: image]

The command above uses the `-u` option to specify the target URL for routing traffic and the `-l` option to activate listener mode. In this mode, the tool continuously polls the target with GET requests at short intervals for a set duration. As shown in the example output, the smuggled data was successfully captured. Next, we'll look at the corresponding process for sending the data.

[image: image]

The example above shows the sending side of the process. It uses the same `-u` option to specify the target URL but switches to the `-s` option to enable sending mode. The user can specify which data to send — in this case, the `PoC.txt` file. Once selected, the desynchronization process begins. As shown in the previous image, the transfer was successful, even though the channel relies solely on GET requests.

During my research, I identified multiple high-profile domains — including `.mil`, `.gov`, `.cn`, and others — all vulnerable to the same desynchronization-based attack. Despite being on different infrastructure and serving vastly different audiences, they shared the same underlying flaw. This highlights how widespread and impactful the technique can be. However, discovering these vulnerabilities isn't trivial; it requires a solid understanding of how HTTP desync works across various server configurations and CDNs.

If you're a security researcher interested in learning more about how this technique works, feel free to reach out to me on X (@deadvolvo). What I've shared here only scratches the surface of this communication channel. There's much more under the hood, but I've intentionally left out the deeper mechanics to avoid handing over a full playbook to potential malicious actors. Serious researchers willing to explore further will benefit from hands-on experimentation and analysis.
