Abusing Bleeding Edge Web Standards for AppSec Glory

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- Does AppSec stuff, usually.
- Mentors security startups, sometimes.
- “Mentors” others on AppSec, occasionally.
- Paid a buck to make Steve Ballmer dance, but just once.

@TheRyanLester

- Runs an E2EE communication startup
- Codes for an E2EE communication startup
- Ran QA automation at a rocket factory
- Got sued by Napster (and not for piracy)

Bleeding Edge Web Standards

For Your (Ab)use, we'll talk about these:

- SubResource Integrity
  SRI Fallback
- Content Security Policy
  CSP Meta-Hardening
- HTTP Public Key Pinning
  HPKP Suicide

But Why?

- New standards are frequently drafted.
- Many introduce unforeseen complications.
- Novel uses encourage future tweaks.

Source: Harold & Kumar Go to White Castle

SubResource Integrity

- Validate resources beyond your trust (e.g. CDNs)

```
<script
 src="https://code.jquery.com/jquery.min.js"
 integrity="sha256-[hash] sha256-[hash2]"
 crossorigin="anonymous"
 ~~fallback-src="jquery.min.js"~~>
</script>
```

- caniuse.com/subresource-integrity

SRI Fallback

Per the SRI Spec:

> NOTE
>
> On a failed integrity check, an `error` event is fired. Developers wishing to provide a canonical fallback resource (e.g., a resource not served from a CDN, perhaps from a secondary, trusted, but slower source) can catch this `error` event and provide an appropriate handler to replace the failed resource with a different one.

...so we implemented it for you.

SubResource Integrity

- Validate resources beyond your trust (e.g. CDNs)

```
<script
 src="https://code.jquery.com/jquery.min.js"
 integrity="sha256-[hash] sha256-[hash2]"
 crossorigin="anonymous"
 x-sri-fallback="jquery.min.js">
</script>
```

- caniuse.com/subresource-integrity

BUILDER **DEMO**

heisenberg.co/srifallbackdemo/

Kneel to the demo gods

SOURCE (Simplified BSD)

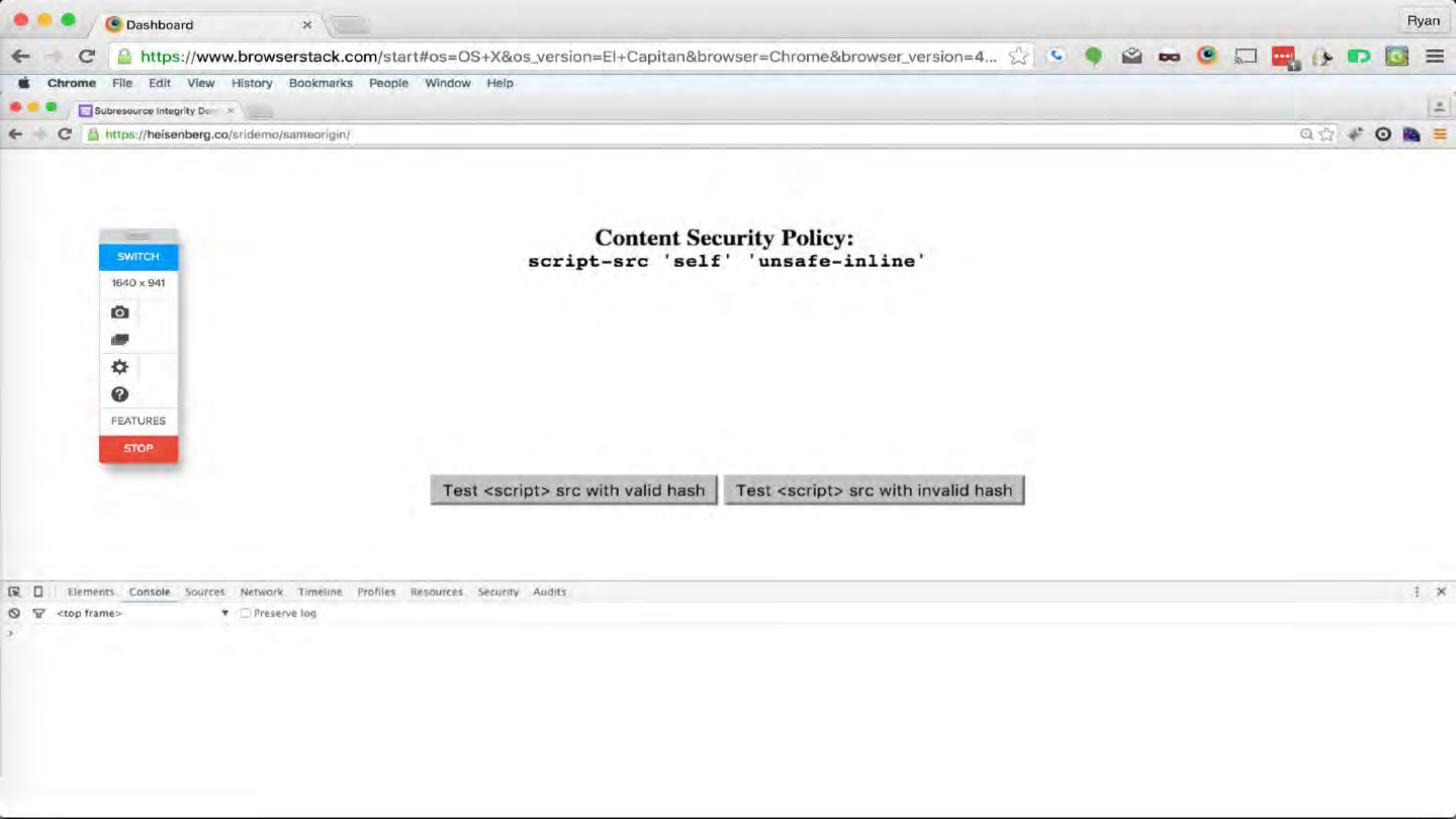
github.com/cyph/sri-fallback

Do source gods even exist?

CVE-2016-1636 **Demo**

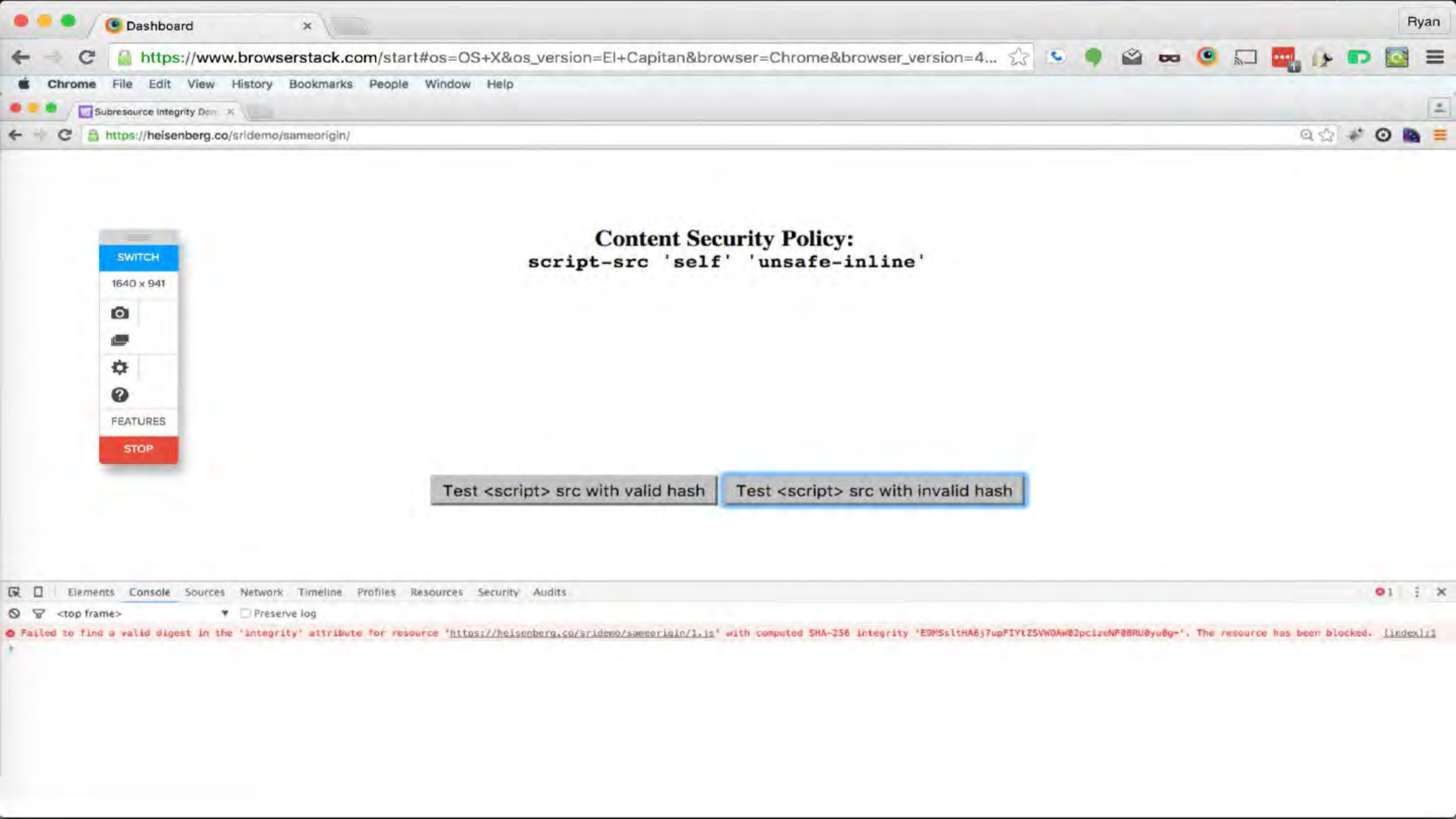
heisenberg.co/sridemo/sameorigin

(͡° ͜ʖ ͡°)


Dashboard
https://www.browserstack.com/start#os=OS+X&os_version=El+Capitan&browser=Chrome&browser_version=4...
Ryan
Chrome File Edit View History Bookmarks People Window Help
Subresource Integrity Dem
https://heisenberg.co/sridemo/sameorigin/
SWITCH
1640 x 941
FEATURES
STOP
Elements Console Sources Network Timeline Profiles Resources Security Audits
<top frame>
Preserve log

Content Security Policy:
`script-src 'self' 'unsafe-inline'`

Test <script> src with valid hash
Test <script> src with invalid hash

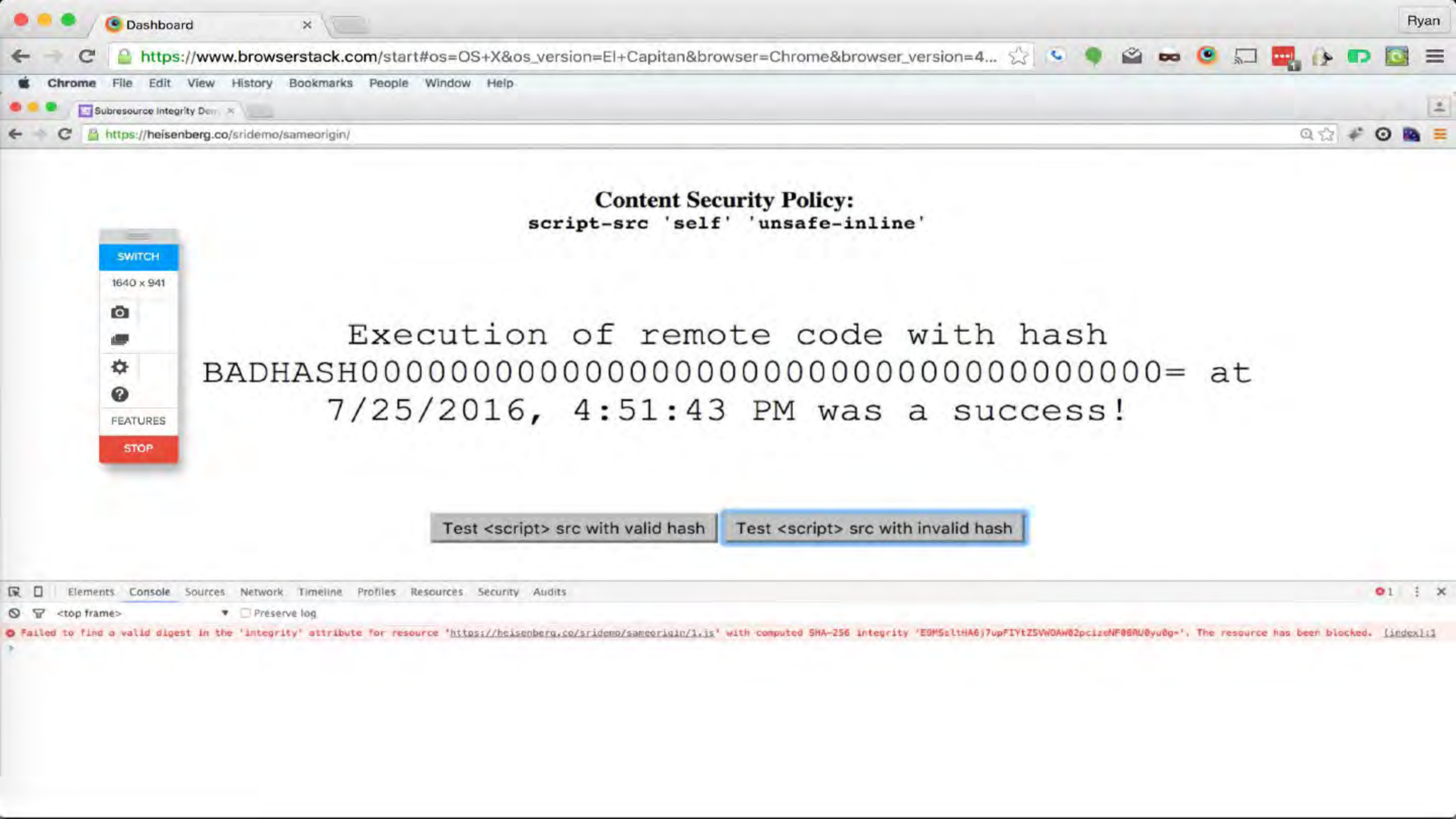


https://www.browserstack.com/start#os=OS+X&os_version=El+Capitan&browser=Chrome&browser_version=4...

https://heisenberg.co/sridemo/sameorigin/

Content Security Policy:
`script-src 'self' 'unsafe-inline'`

```
Failed to find a valid digest in the 'integrity' attribute for resource 'https://heisenberg.co/sridemo/sameorigin/1.js' with computed SHA-256 integrity 'E9MSsltHA6j7upFIYtZ5VW0AW02pcizeNF0BRU0yu0g='. The resource has been blocked.  (index):1
```


Dashboard
Ryan
https://www.browserstack.com/start#os=OS+X&os_version=El+Capitan&browser=Chrome&browser_version=4...
Chrome File Edit View History Bookmarks People Window Help
Subresource Integrity Dem
https://heisenberg.co/sridemo/sameorigin/
SWITCH
1640 x 941
FEATURES
STOP
Elements Console Sources Network Timeline Profiles Resources Security Audits
<top frame>
Preserve log

Content Security Policy:
`script-src 'self' 'unsafe-inline'`

```
Execution of remote code with hash
BADHASH0000000000000000000000000000000000= at
7/25/2016, 4:51:43 PM was a success!
```

Test <script> src with valid hash
Test <script> src with invalid hash

```
Failed to find a valid digest in the 'integrity' attribute for resource 'https://heisenberg.co/sridemo/sameorigin/1.js' with computed SHA-256 integrity 'E0MSsltHA6j7upFIYtZSVWOAW02pcizeNF08AU0yu0g='. The resource has been blocked.  (index):1
```

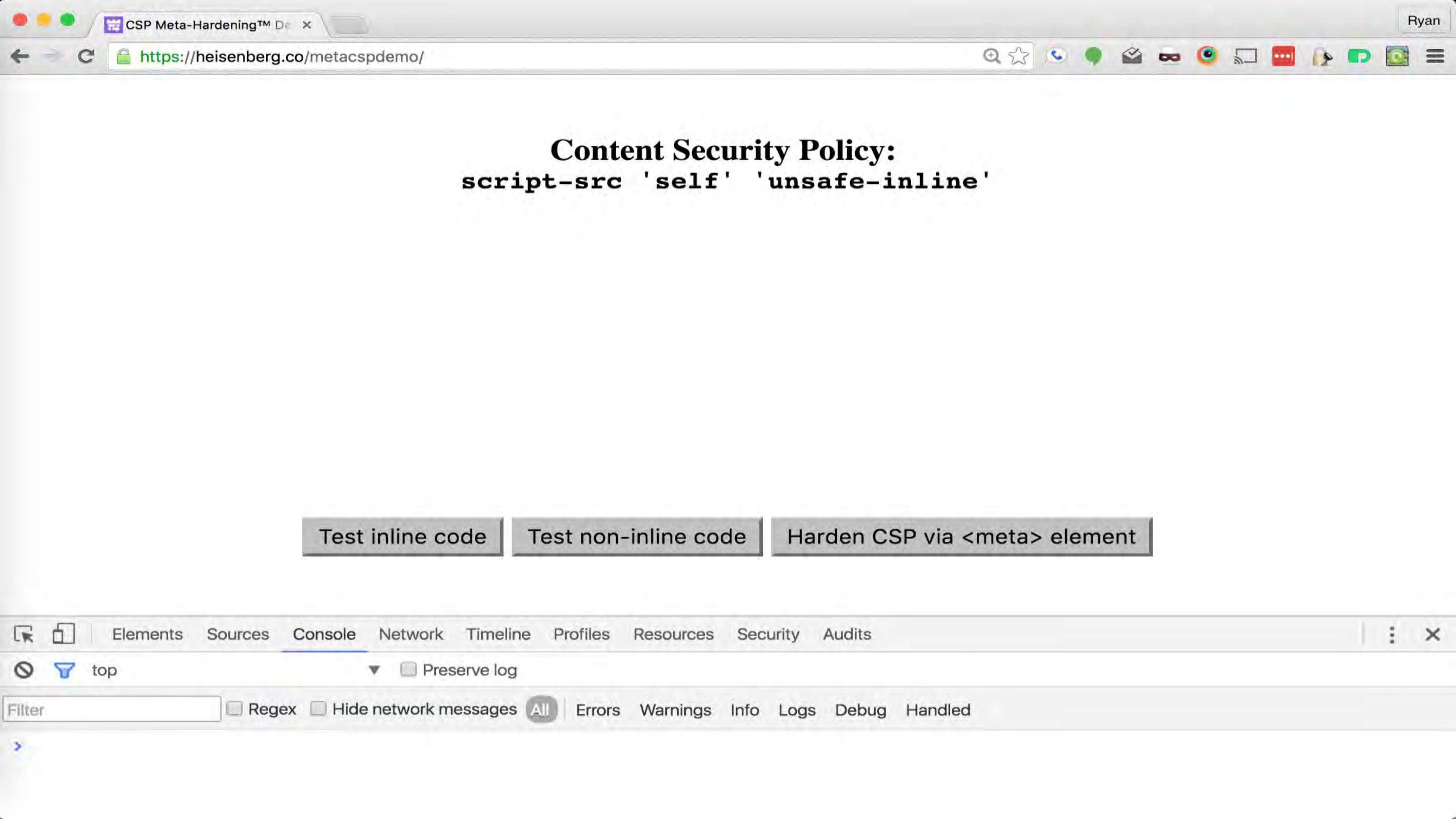
CSP Meta-Hardening

- Combines semi-strict header with strict `<meta>`.
- Allows for pre-loading of trusted complex logic.
- Does not work for the verbs `frame-ancestors`, `report-uri`, or `sandbox`.

BUILDER DEMO

heisenberg.co/metacspdemo/

Fall on thy sword for the demo gods.



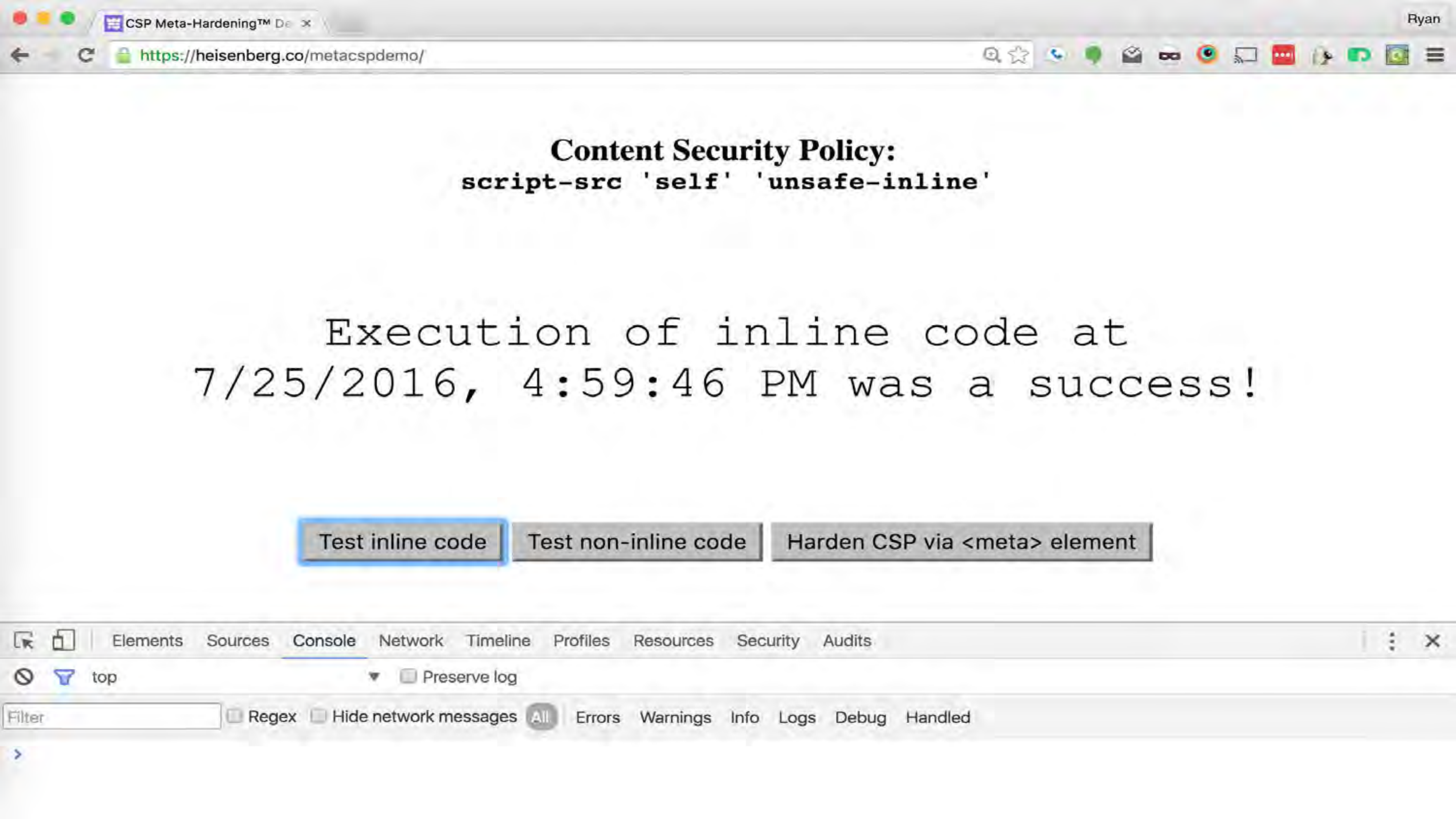
Content Security Policy:

`script-src 'self' 'unsafe-inline'`

Test inline code

Test non-inline code

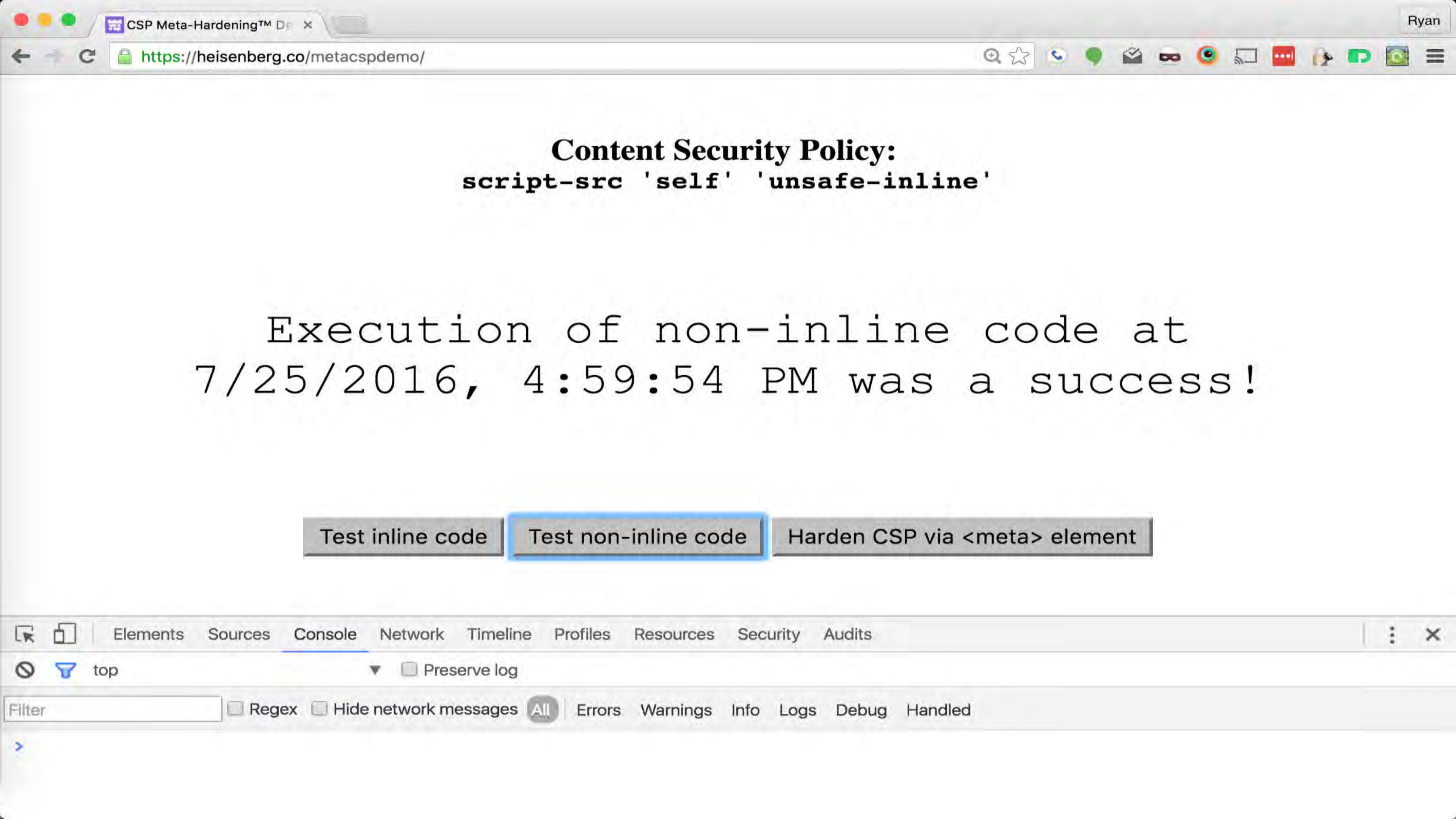
Harden CSP via <meta> element



Content Security Policy:

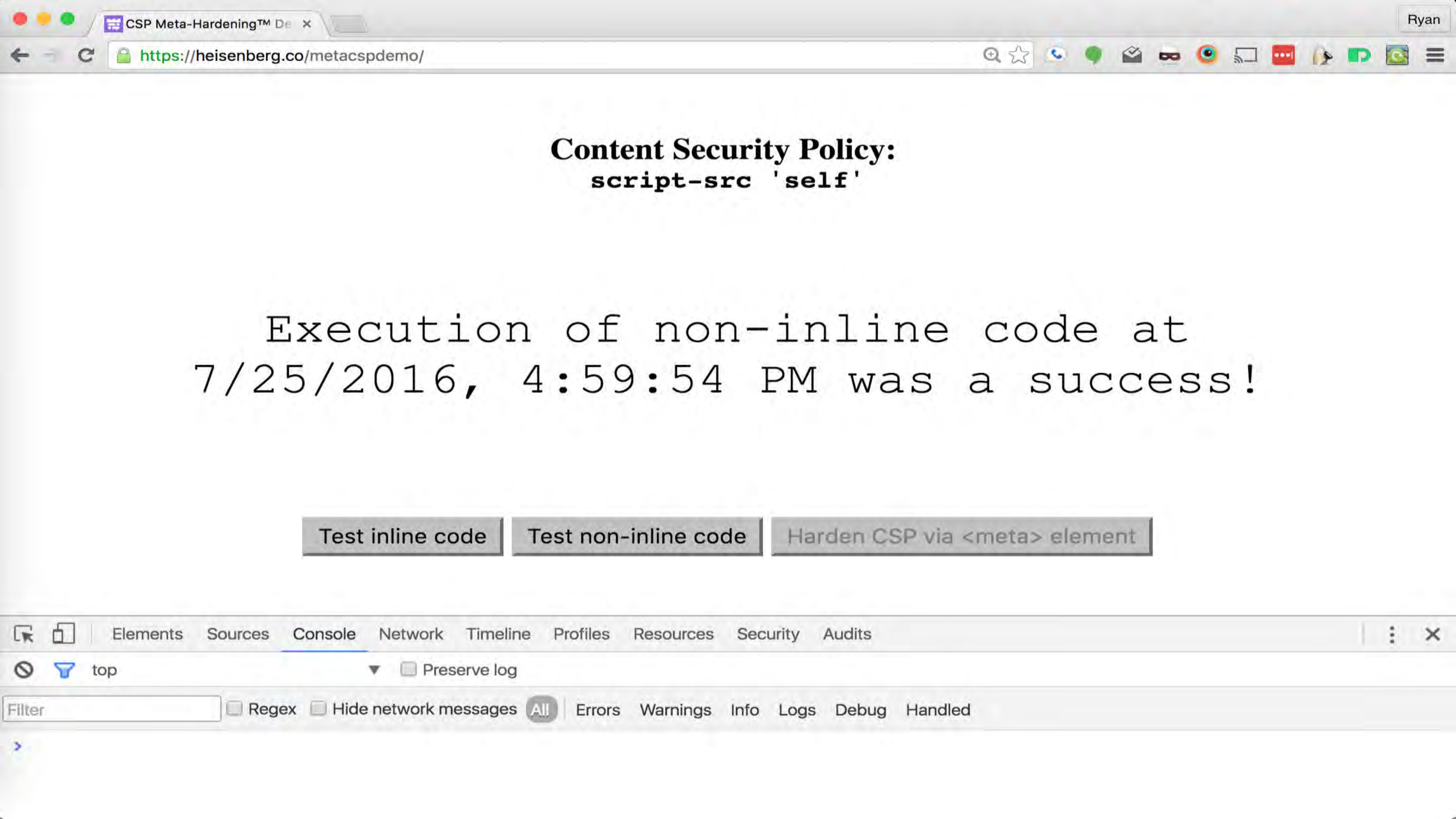
`script-src 'self' 'unsafe-inline'`

Execution of inline code at 7/25/2016, 4:59:46 PM was a success!



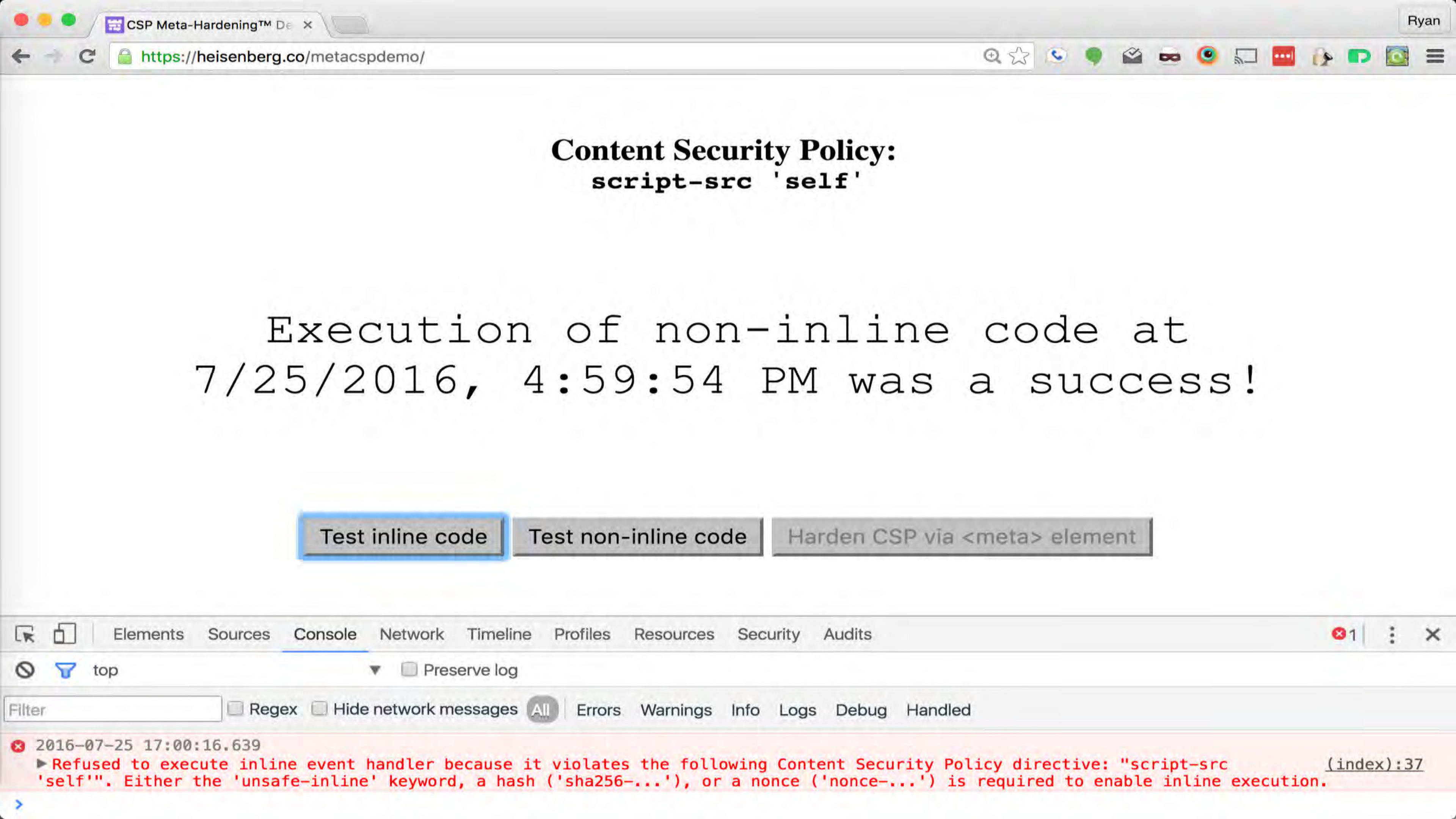
Content Security Policy:
script-src 'self' 'unsafe-inline'

Execution of non-inline code at 7/25/2016, 4:59:54 PM was a success!



Content Security Policy:
`script-src 'self'`

Execution of non-inline code at 7/25/2016, 4:59:54 PM was a success!



Content Security Policy:
script-src 'self'

Execution of non-inline code at 7/25/2016, 4:59:54 PM was a success!

```
2016-07-25 17:00:16.639
▶ Refused to execute inline event handler because it violates the following Content Security Policy directive: "script-src    (index):37
'self'". Either the 'unsafe-inline' keyword, a hash ('sha256-...'), or a nonce ('nonce-...') is required to enable inline execution.
```

CSP Meta-Hardening

Considerations

- *Static content only* in initial response!
- `X-XSS-Protection: 1; mode=block`

CSP Meta-Hardening

- Best for adapting a semi-recent application for use with CSP.
- Application’s trusted static logic is allowed to execute on initial load.
- Meta-Hardening prevents dynamic content from potentially executing later on.

Http Public Key Pinning

- This can ~~break~~ brick sites. Use Reporting!
  - (Chrome 46+ only; no reporting in Firefox 😐)

```
Public-Key-Pins-Report-Only:
max-age=5184000; includeSubdomains;
pin-sha256="az9AwClWuHM+fYV+d8Cv9B4sAwdcoUqj93omk18O/pc=";
pin-sha256="5UONcYAsFtYscIlFlm4+aodoL20RRHzGaOeoSNEZ+iA=";
report-uri="https://report-uri.io/report/[id]/reportOnly"
```

- caniuse.com/hpkp

HPKP Suicide

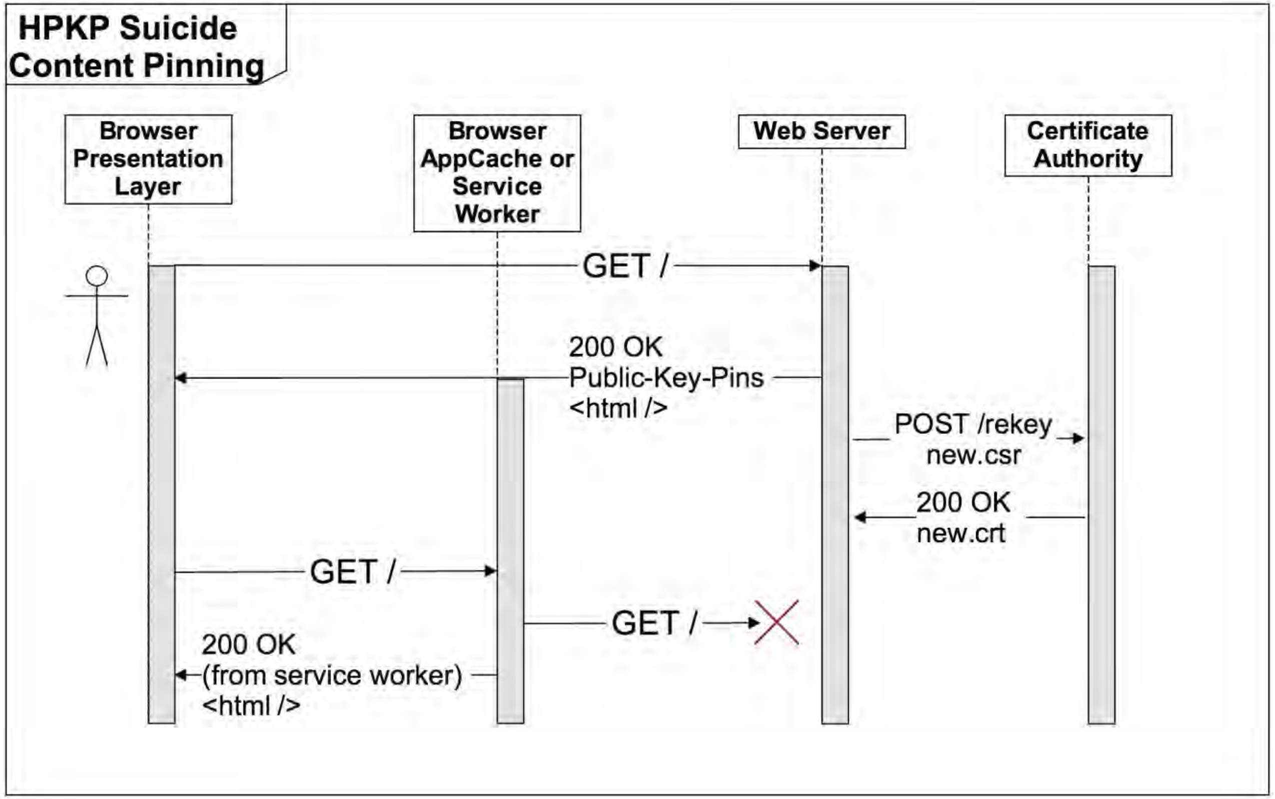
Deliberate self-bricking via HPKP + Rapid Key Rotation.

Let's spend 20 minutes on how we can use this:

- ~~to enable in-browser code signing~~
- to control content changes and harden SRI.
- to enable nuanced web content blocking. (NetSec)
- to track users…
- to be total jerks…

...in ways we shouldn't put in print.
(Thanks Jann Horn @ Cure53 for putting us onto this!)

HPKP Suicide



HPKP Suicide

for **Builders**

Wait, in-browser code signing? No extensions?

In theory.

In the last slide’s content pinning scheme, code signing logic goes in the ServiceWorker.

This effectively gets us Trust On First Use for current and future code.

HPKP Suicide for **Builders**

Why "In theory"? This sounds like it should work.

In fact, Cyph employs a mature, audited implementation of exactly this.

However, it was considered so novel that we had to apply for a patent on it.

But, you can come close to this for free if you…

HPKP Suicide for Builders

Control local storage updates! Harden SRI!

- Set HPKP max-age to count down to your deployment date.
- Rotate routinely.

HPKP Suicide

for Builders

Benefits:

- Retain control of front-end content between releases.
- Mitigate risks of SRI hash tampering server-side.
- **Decent security and performance gains**

HPKP Suicide

for **Builders**

Considerations:

- HPKP Suicide + SRI is a *design-time* decision!
  - Single Page Apps (SPAs) only
- Include mitigations such as halting distribution of HPKP headers if compromised.

BUILDER **DEMO**

redskins.io

I don't believe in demo gods

HPKP Suicide

for Builders

Web Content Gateway e.g. [SomeVendor]?
Lock your users out of sites even when they're not on your network!

1. For flagged domains, set HPKP headers.
2. Optionally, Rotate keys weekly at the gateway.

Done! (By us disclosing it, is this now prior art? ☺)

HPKP Suicide

for Builders

Oh... [**https://crt.sh/?id=19538258**](https://crt.sh/?id=19538258)

```
Issuer:
commonName             = VeriSign Class 3 Public
                         Primary Certification
                         Authority - G5

Subject:
commonName             = Blue Coat Public Services
                         Intermediate CA
organizationalUnitName = Symantec Trust Network
organizationName       = "Blue Coat Systems, Inc."
```

HPKP Suicide
for **Builders**

User tracking?

Well, we really shouldn't talk about this…

HPKP Suicide for Builders

But since this is DEF CON…

…let's track users!

HPKP Suicide

for **Builders**

Pre-requisites:

1. Lots of (sub)domains to pin
2. Browsers that allow HPKP incognito
3. Rapid Key Rotation

Let's Encrypt

(Thanks! ☺)

HPKP **SuperCookies**

Server-side

- **`/set:`** Returns HPKP header
- **`/check:`** No-op — no HPKP header, status code 200

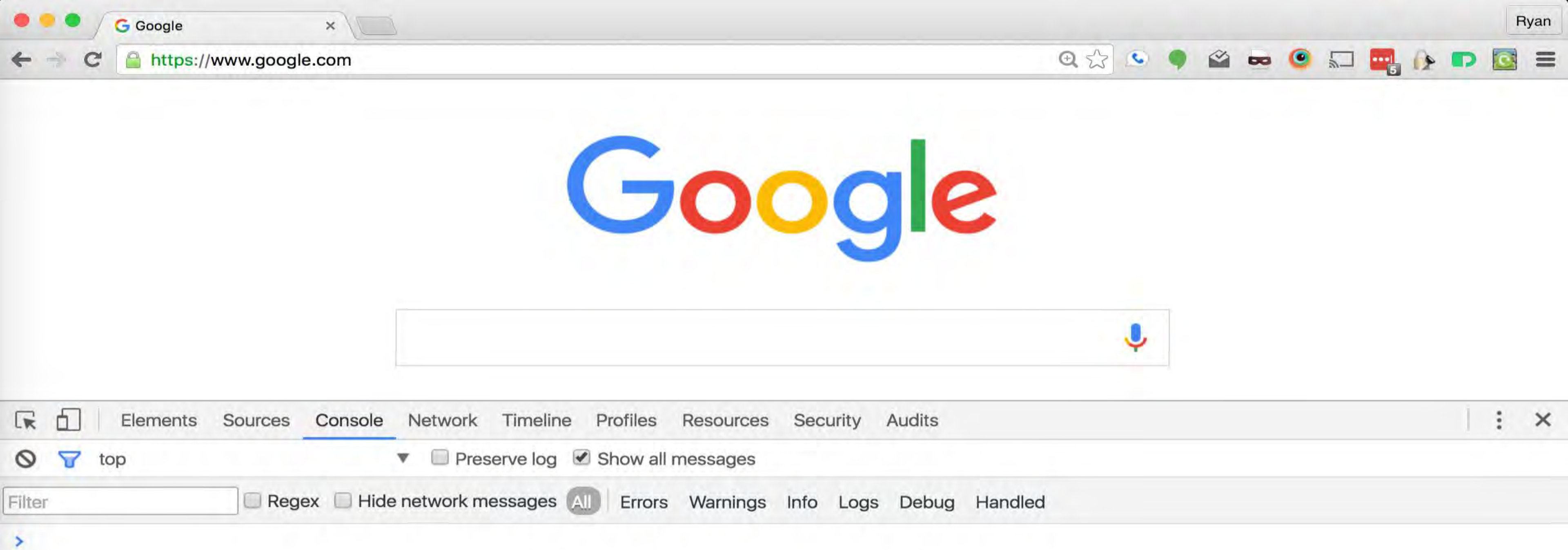
Client-side (JavaScript)

- **Set new ID:** Hit `/set` on random subset of domains
- **Check ID:** Hit `/check` on all domains; note failures

BUILDER **DEMO**

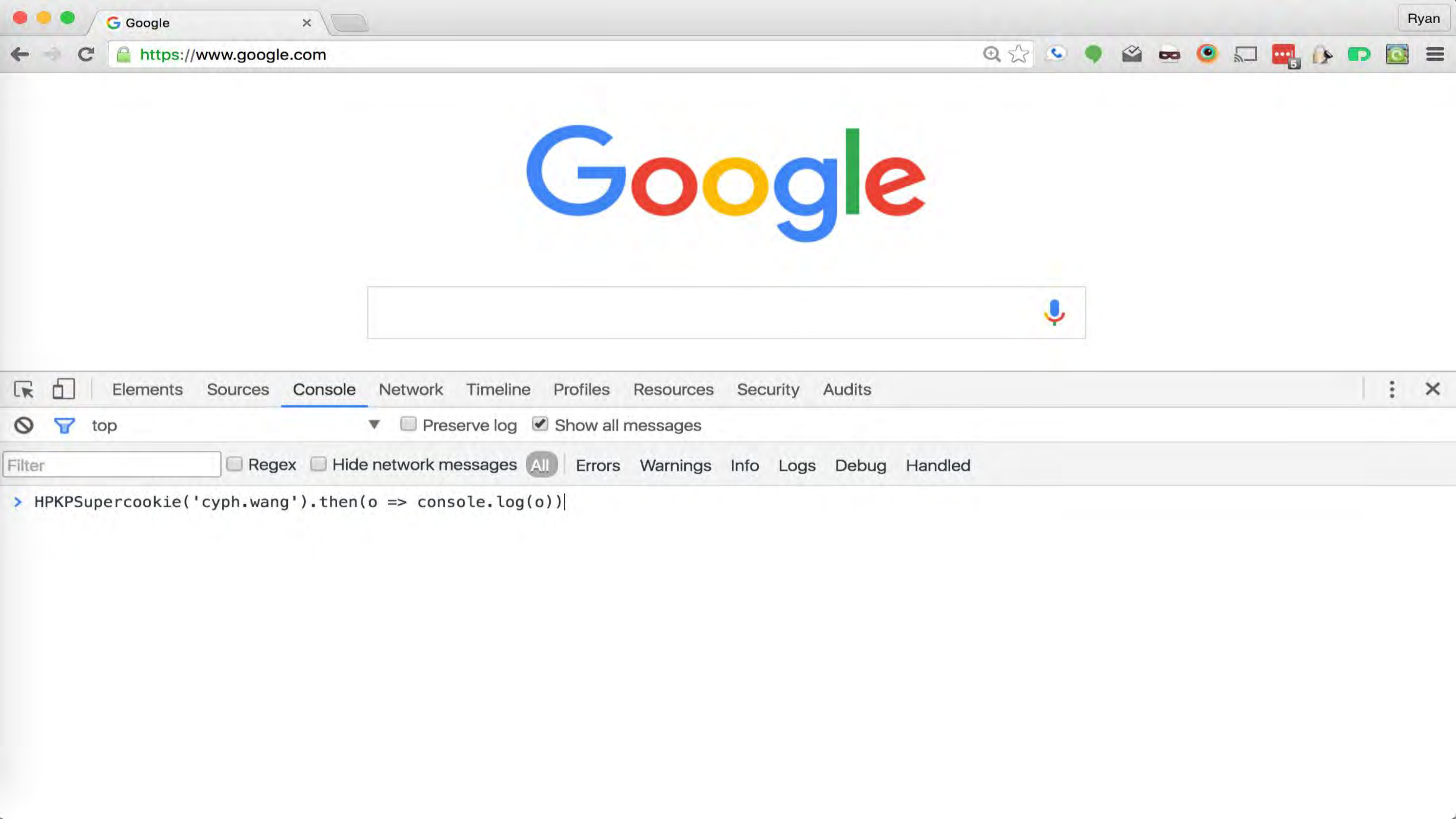
cyph.wang

I don't believe in demo gods

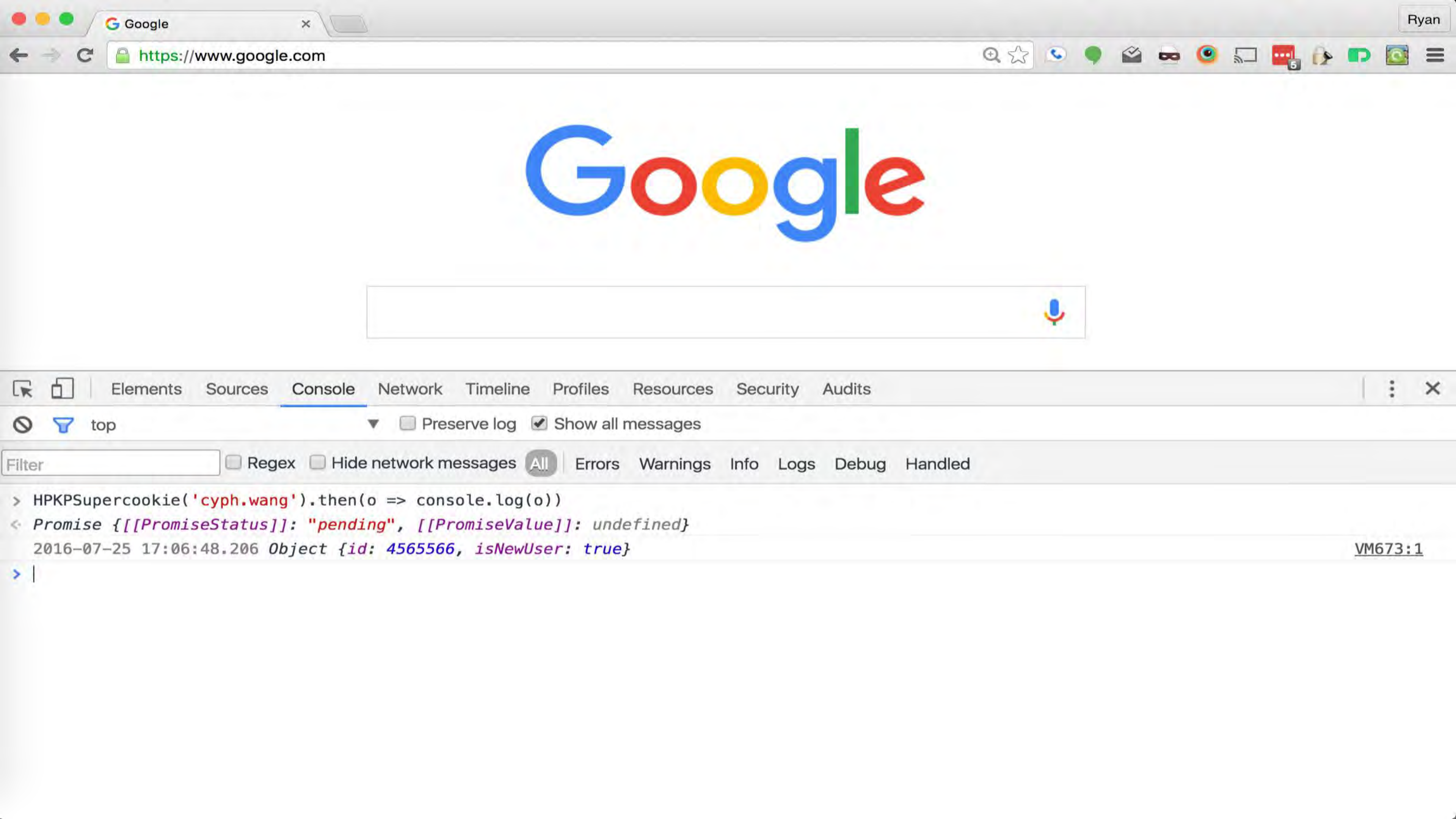


Not implemented by Google.

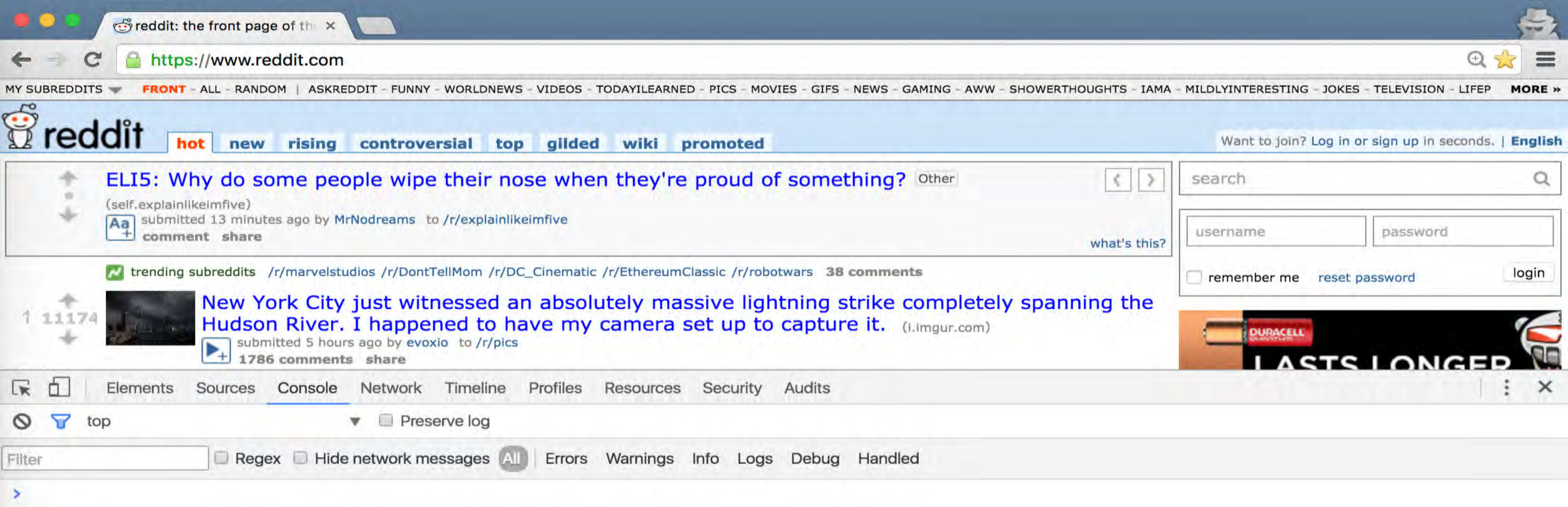
We only ran the script in console.



```
> HPKPSupercookie('cyph.wang').then(o => console.log(o))
```



```
> HPKPSupercookie('cyph.wang').then(o => console.log(o))
< Promise {[[PromiseStatus]]: "pending", [[PromiseValue]]: undefined}
  2016-07-25 17:06:48.206 Object {id: 4565566, isNewUser: true}          VM673:1
>
```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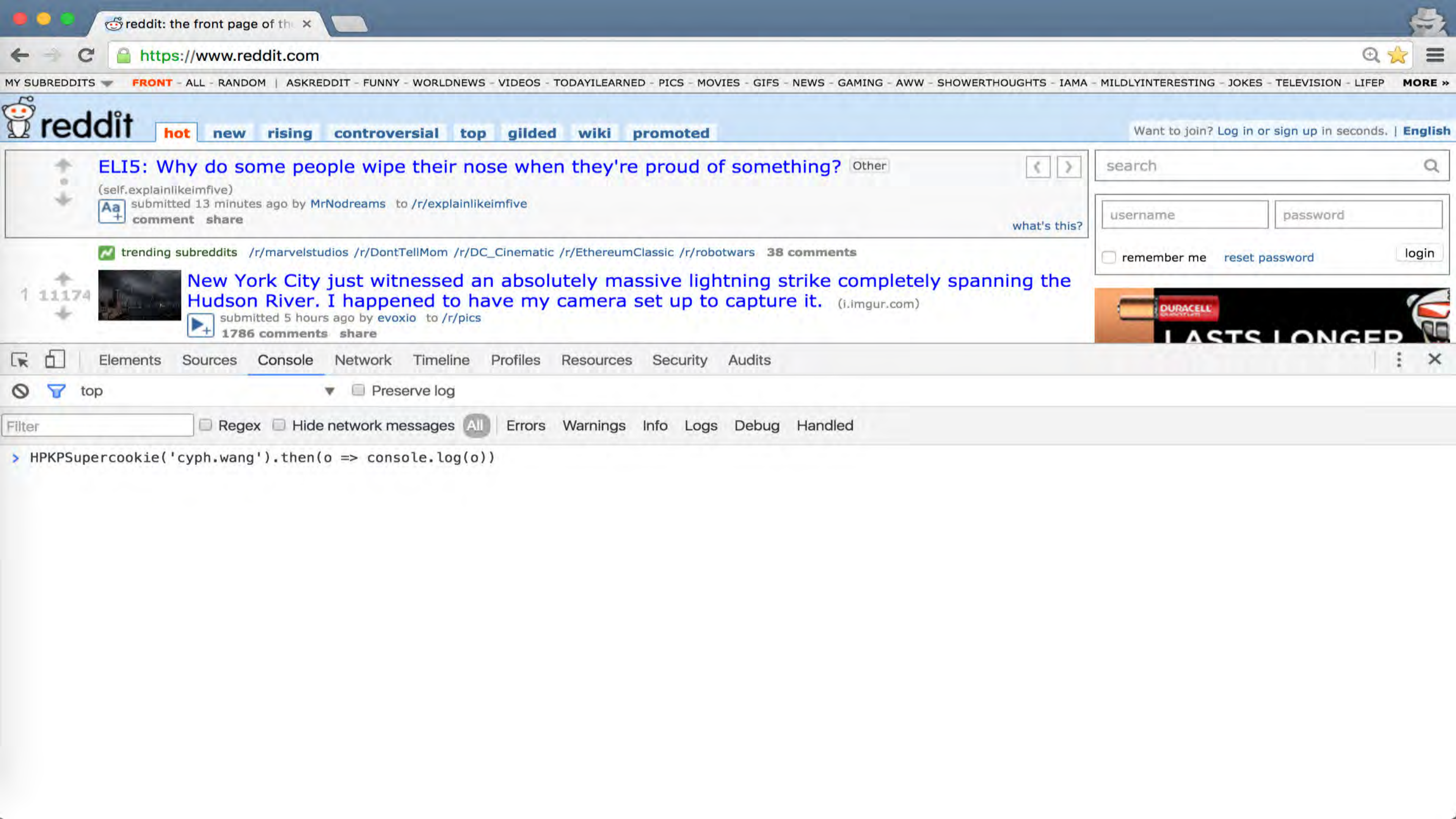
https://www.reddit.com
MY SUBREDDITS - FRONT - ALL - RANDOM | ASKREDDIT - FUNNY - WORLDNEWS - VIDEOS - TODAYILEARNED - PICS - MOVIES - GIFS - NEWS - GAMING - AWW - SHOWERTHOUGHTS - IAMA - MILDLYINTERESTING - JOKES - TELEVISION - LIFEP MORE »
reddit
hot new rising controversial top gilded wiki promoted
Want to join? Log in or sign up in seconds. | English
ELI5: Why do some people wipe their nose when they're proud of something? Other
(self.explainlikeimfive)
submitted 13 minutes ago by MrNodreams to /r/explainlikeimfive
comment share
what's this?
search
username
password
remember me reset password login
trending subreddits /r/marvelstudios /r/DontTellMom /r/DC_Cinematic /r/EthereumClassic /r/robotwars 38 comments
1 11174
New York City just witnessed an absolutely massive lightning strike completely spanning the Hudson River. I happened to have my camera set up to capture it. (i.imgur.com)
submitted 5 hours ago by evoxio to /r/pics
1786 comments share
DURACELL LASTS LONGER
Elements Sources Console Network Timeline Profiles Resources Security Audits
top
Preserve log
Filter
Regex
Hide network messages
All
Errors
Warnings
Info
Logs
Debug
Handled
>

Not implemented by Reddit.

We only ran the script in console.


```
> HPKPSupercookie('cyph.wang').then(o => console.log(o))
```

reddit: the front page of th
https://www.reddit.com
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search
username password
remember me reset password login
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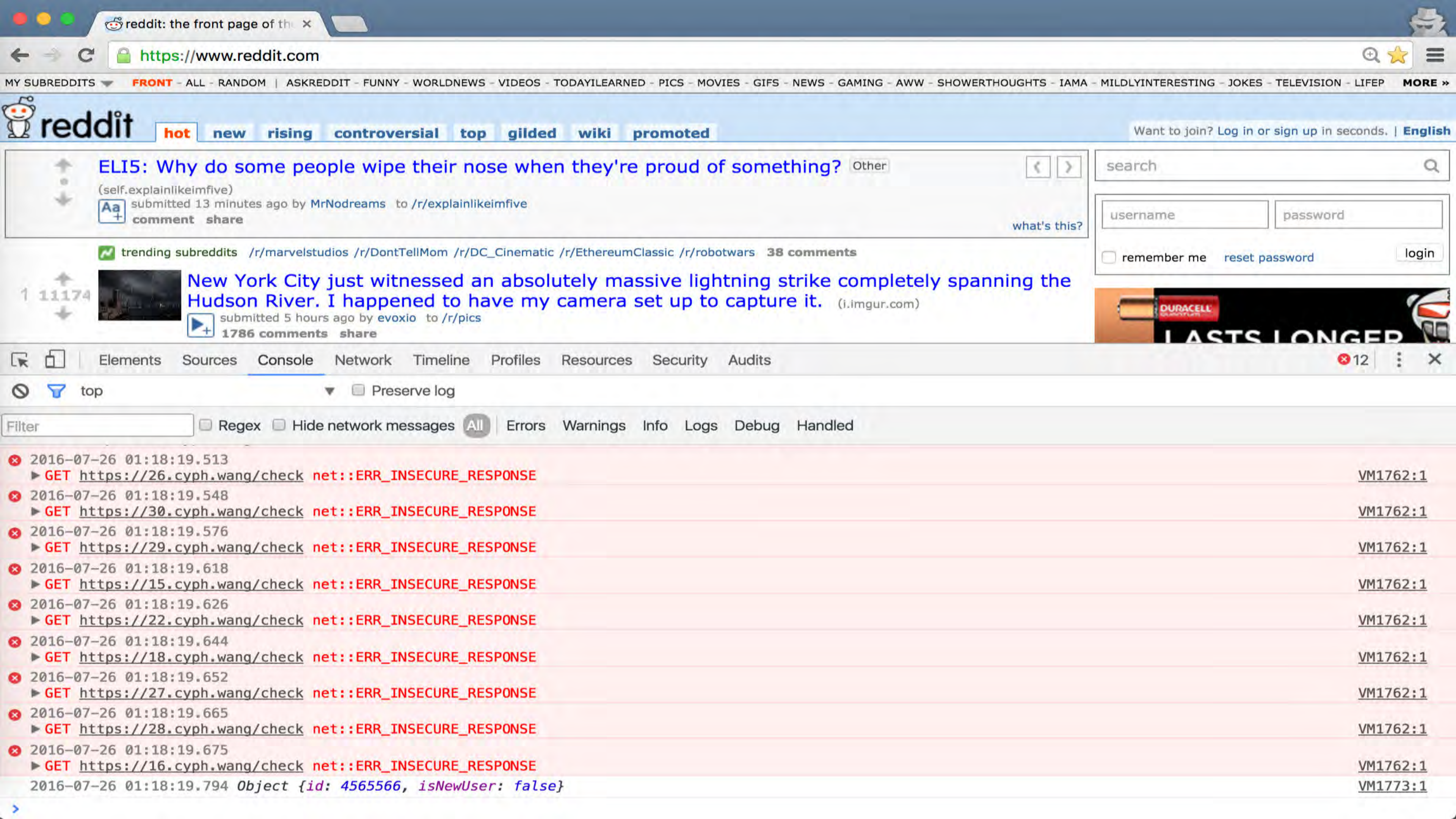


reddit: the front page of th

https://www.reddit.com

MY SUBREDDITS FRONT - ALL - RANDOM | ASKREDDIT - FUNNY - WORLDNEWS - VIDEOS - TODAYILEARNED - PICS - MOVIES - GIFS - NEWS - GAMING - AWW - SHOWERTHOUGHTS - IAMA - MILDLYINTERESTING - JOKES - TELEVISION - LIFEP MORE »

reddit hot new rising controversial top gilded wiki promoted

Want to join? Log in or sign up in seconds. | English

ELI5: Why do some people wipe their nose when they're proud of something? Other (self.explainlikeimfive)
submitted 13 minutes ago by MrNodreams to /r/explainlikeimfive
comment share
what's this?

trending subreddits /r/marvelstudios /r/DontTellMom /r/DC_Cinematic /r/EthereumClassic /r/robotwars 38 comments

1 11174 New York City just witnessed an absolutely massive lightning strike completely spanning the Hudson River. I happened to have my camera set up to capture it. (i.imgur.com)
submitted 5 hours ago by evoxio to /r/pics
1786 comments share

search
username password
remember me reset password login

DURACELL LASTS LONGER

Elements Sources Console Network Timeline Profiles Resources Security Audits 12

top Preserve log

Filter Regex Hide network messages All Errors Warnings Info Logs Debug Handled

```
2016-07-26 01:18:19.513
▶ GET https://26.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.548
▶ GET https://30.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.576
▶ GET https://29.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.618
▶ GET https://15.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.626
▶ GET https://22.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.644
▶ GET https://18.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.652
▶ GET https://27.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.665
▶ GET https://28.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.675
▶ GET https://16.cyph.wang/check net::ERR_INSECURE_RESPONSE          VM1762:1
2016-07-26 01:18:19.794 Object {id: 4565566, isNewUser: false}      VM1773:1
>
```

HPKP **SuperCookies**

Considerations:

Risk: DoSing tracker domains as a public service

1. Domain whitelist for your own tracker, or
2. App-issued and tracker-verified nonce if analytics is your business model.

The pattern described is similar to others here:

https://tools.ietf.org/html/rfc7469#section-5

SOURCE (New BSD)

github.com/cyph/hpkp-supercookie

Do source gods even exist?

HPKP Suicide
for Builders

…to be total jerks?

we ***really*** shouldn't talk about this…

Who are we kidding?

This is DEF CON.

HPKP Suicide for Breakers

Pre-requisites:

1. A high-traffic target
2. A way to shell the box
3. A free certificate authority

Let's Encrypt

(Sorry ☹)

RansomPKP

1. Determine target[1]
2. Generate ransom keypair (the recovery key)
3. Pwn[2] target webserver.
4. Generate new lockout keypair + CSR[3]
5. ?
6. Profit!

Ransom**PKP**

❓ While owned users < n

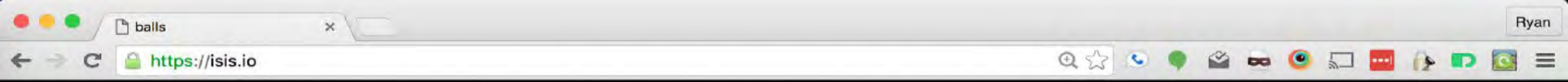
1.
```
"public-key-pins:
max-age=31536000; includeSubdomains;
pin-sha256= LOCKOUT_KEY;
pin-sha256= RANSOM_KEY"
```
2. If owned users = n,
    1. Generate new lockout keypair + CSR[3]
    2. Blow old lockout keypair. This locks out n users.
    3. $n = 0$

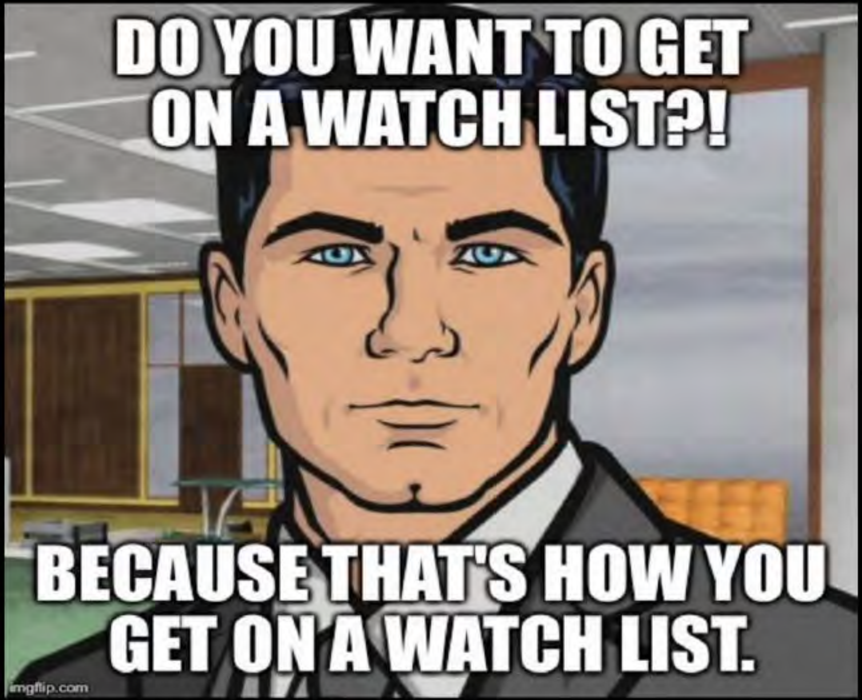
Breaker Demo

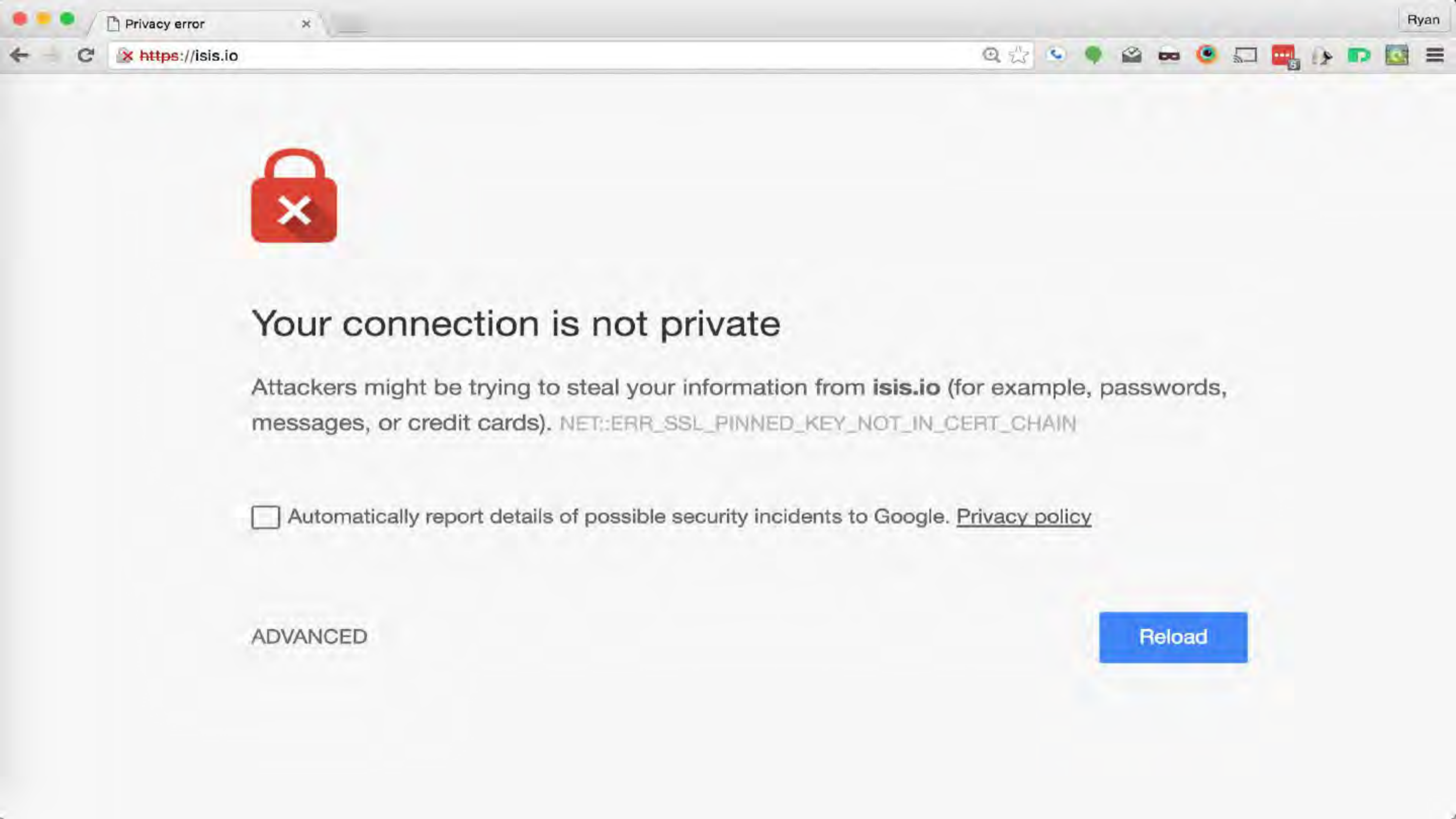
isis.io

"You tweachewous miscweant!"

-- Elmer Fudd


balls
https://isis.io
Ryan


DO YOU WANT TO GET ON A WATCH LIST?!
BECAUSE THAT'S HOW YOU GET ON A WATCH LIST.
imgflip.com



Your connection is not private

Attackers might be trying to steal your information from **isis.io** (for example, passwords, messages, or credit cards). NET::ERR_SSL_PINNED_KEY_NOT_IN_CERT_CHAIN

☐ Automatically report details of possible security incidents to Google. Privacy policy

HPKP Suicide

Ransom**PKP**

Considerations (i.e. why this is *not* a High):

1. Let's Encrypt rate limit: 20 certs weekly.
2. Chrome + Firefox have HPKP lockout mitigations
3. You still need to pop the box.

Ransom**PKP**

Programmatic Mitigations:

Chromium:

WontFix

Pre-Mitigated

Firefox:

Match Chrome

HPKP Max Age

Let's Encrypt:

WontFix

Out of Scope

HPKP Suicide

Ransom**PKP**

Partial Host Mitigations

1. Use DNS Certification Authority Authorization (CAA) – RFC 6844.
2. Use HPKP; monitor headers for changes.
3. Try not to get popped.

HPKP Suicide

Ransom**PKP**

End User Mitigations (Clearing key pins):

1. Chrome: chrome://net-internals/#hsts
2. ~~Chrome: (alt): clear *any* browsing data. "due to a curly brace mishap, we've been clearing it over-aggressively for years."~~ (CVE-2016-1694) Clear your cache ☺
3. Firefox: about:config >> security.cert_pinning.enforcement_level = 0, visit site to take new header, re-enable.

SOURCE (New BSD)

github.com/cyph/ransompkp

Do source gods even exist?

Hat Tip

To Geller Bedoya, DigiCert, @el_d33, Jonn Callahan, Jann Horn and all of Cure53, Samy Kamkar, Jim Manico, Mike McBryde, Jim Rennie and his superb legal skill, Garrett Robinson, John Wilander, Doug Wilson, as well as the Chrome, Firefox, and Let's Encrypt security teams for their contributions.

github.com/cyph/appsec-glory

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