Dissecting CSRF Attacks & Defenses

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Cross Site Request Forgery

- The confused, session-riding deputy
- Pros & cons of current countermeasures
- Improving verification of CSRF tokens -- DEMO
- Improving defenses -- DEMO & SPECS!

By Your Command

- Cross-origin requests are a core part of how the web works.
- Effective CSRF only cares about generating a request that affects a server-side context.

```html
<!DOCTYPE html>
<html>
<head>
  <meta http-equiv="refresh" content="0; url=https://another.origin/CSRF">
  <link ref="prefetch" href="https://another.origin/CSRF">
</head>
<body>
  <img src="https://another.origin/CSRF" alt="">
  <iframe sandbox src="https://another.origin/CSRF"></iframe>
</body>
</html>
```

Are You ~~Experienced~~ Authorized?

- Fundamentally, we want to distinguish between a user-intended action and a browser-initiated one.
  - Cross-origin requests that assume the victim's authorization are the problem (i.e. session riding)

- HTML thrives on aggregating content from different Origins -- there's no reason to change this.

Forging Ahead

- Creation
  - SOP restricts reading the response from a cross-origin request, not making one
  - Cross Origin Resource Sharing makes aggregation more flexible -- and has positive implications for blocking CSRF.
- Counterfeit
  - Predictable name/value pairs
  - Valid, invalid, stripped Referer, Origin headers

Castles Made of Sand

- Tie the request to the user's session -- authorization vs. authentication.

- Add a secret (e.g. entropy) to make it harder to counterfeit
  - Double submit cookie
  - Anti-CSRF token (nonce)

Secrets* & Entropy

- PRNG
- hash(hash(hash(...(PRNG)...)))
- HMAC-SHA256(PRNG, secret)
  - HMAC-MD5
  - HMAC-SHA512

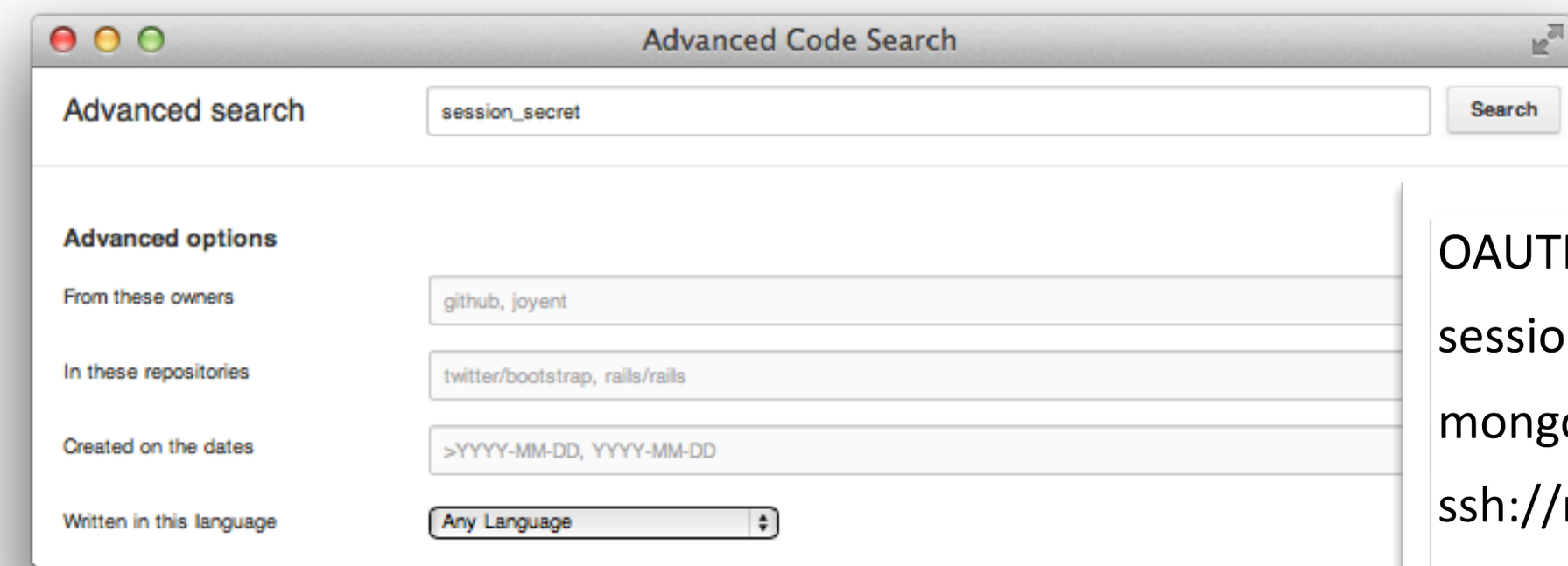
*Puvrs jnf n gbnfgre.

HMAC

- Requires a strong secret
- Something other than the default value
  - “keyboard cat”
- Something outside a dictionary
  - 1
  - 123
  - secret
  - Shad0wfax

explore .~~gitignore~~

- Distributed, collaborative secrets
  - http://www.phenoelit.org/blog/archives/2012/12/21/let_me_github_that_for_you/
  - http://nakedsecurity.sophos.com/2013/01/25/do-programmers-understand-private/



OAUTH_CONSUMER_SECRET

session_secret

mongodb://admin

ssh://root@

hmac-sha256

...

Entropic Horror

- BH2012 -- PRNG: Pwning Random Number Generators
- sjcl.random
- openssl rand 32 -hex

CSRF Cloaks Bad Design

- POST/GET method ignorance
- Password change mechanisms that don't require current password
- Missing barriers that rely on authentication to perform actions.
  - e.g. check-out and shipping to known vs. new address
- Loose coupling of authentication, authorization, and session.

Mobile Apps

- Recreating vulns from first principles
  - Using HTTP instead of HTTPS
  - Not verifying HTTPS certs
  - But at least the apps are signed...

- More areas to explore
  - Not a browser, but making HTTP requests
  - CSRF potential of malevolent ad banners

Detection

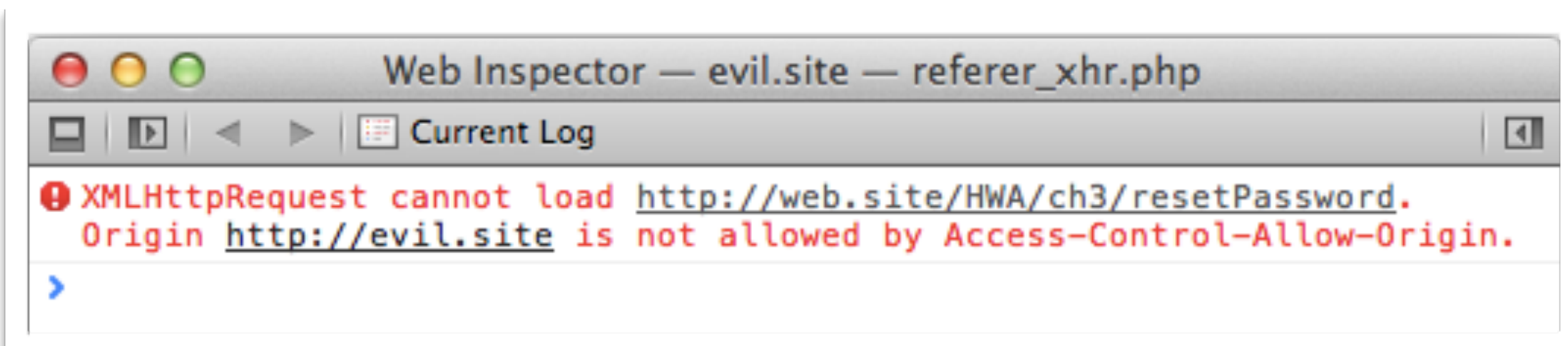
- Pattern-based detection of token names
  - Security by regex-icity
  - Checks for presence, not effectiveness

- Active test
  - “Cookie Swap” between user session contexts
  - Determine enforcement, not predictability

DEMO

Cross Origin Resource Sharing

- Control the forgery (i.e. creation) of “non-simple”, cross-origin requests
  - X-CSRF: 1
  - XCSRF /foo HTTP/1.1



Rely on SOP & HTML5

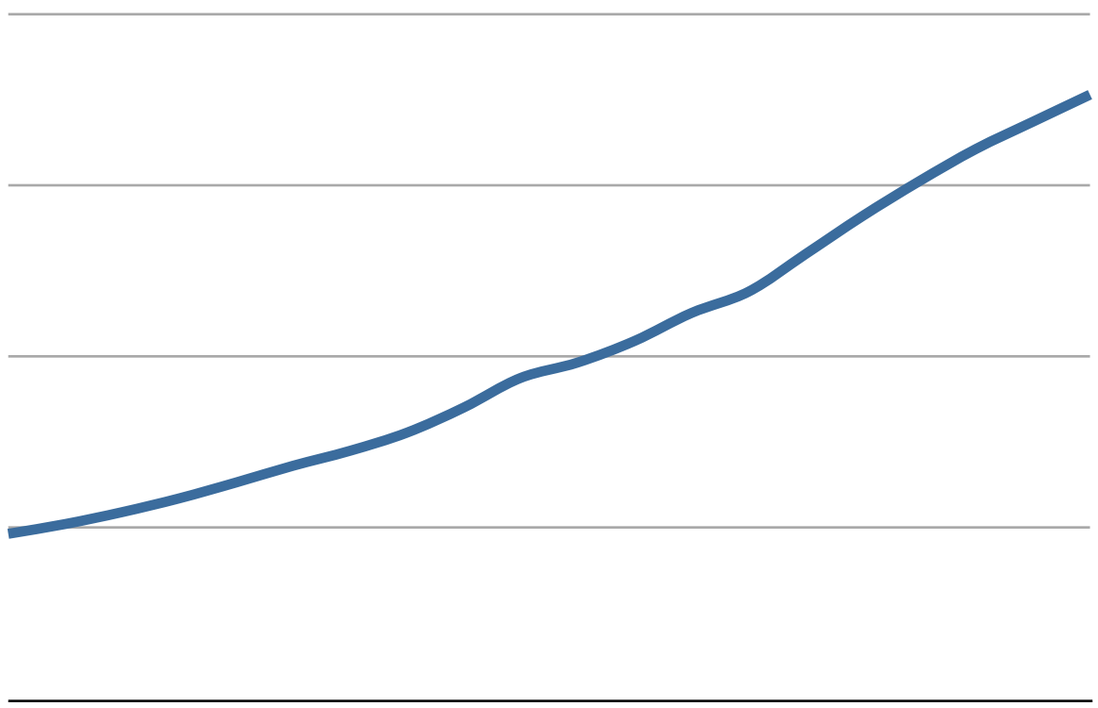
- Guarantees same Origin (or allowed cross-Origin)
  - But only for “non-simple” XHR requests
  - Must start inspecting the Origin header
- Limitations
  - Must be part of app’s design and implementation
  - Breaks “simple” cross-origin requests

Crosstown Traffic

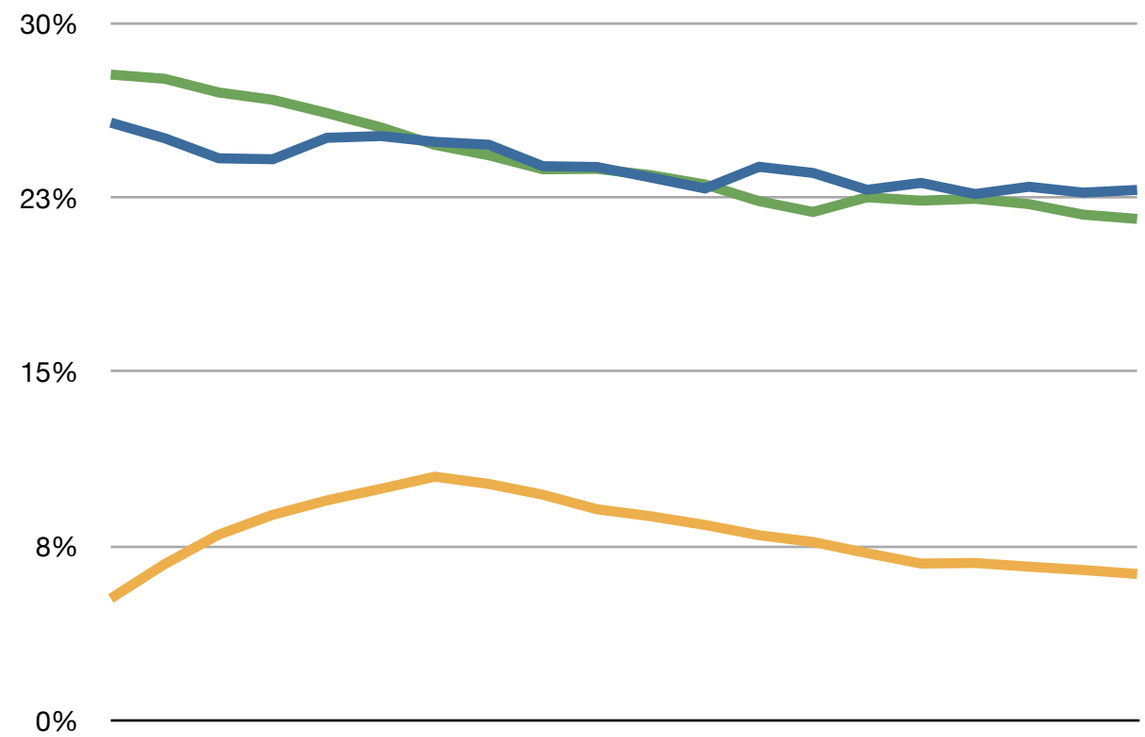
- HTML injection, cross-site scripting
  - It's executing in Same Origin
  - CSRF countermeasures are intended to prevent cross-origin attacks
  - Start using Content Security Policy

- DNS, cache poisoning, sniffing, ...
  - Start using HSTS
  - Where did DNSSEC go?

Background Radiation of Insecurity



Total Scans



Insecure Flash/Scan
Insecure Java/Scan
Insecure Silverlight/Scan

20 months starting November 2011

Speaking of CSP

```
<!doctype html>
<html>
<head>
<meta http-equiv="X-WebKit-CSP"
      content="img-src 'none'; report-uri
'https://csrf.target/page?a=1&b=2&c=3'">
</head>
<body>
<img alt="" src="whatever">
</body>
</html>
```

Partial POST Request Forgery

```
POST /page?a=1&b=2&c=3 HTTP/1.1
Host: csrf.target
User-Agent: Mozilla/5.0 ...
Content-Length: 116
Accept: */*
Origin: null
Content-Type: application/x-www-form-urlencoded
Referer: http://web.site/HWA/ch3/csrf.html
Cookie: sessid=12345
Connection: keep-alive

document-url=http%3A%2F%2Fcsrf.target%2FHWA
%2Fch3%2Fcsrf.html&violated-directive=default-
src+%27none%27
```

... --- ...

AND THEY HAVE A PLAN.

Security of Sessions

- Focus on the abuse of session context
  - Session-riding, confused deputy

- Control when cookies accompany requests initiated from a cross-origin resource
  - Similar to CORS enforcement of “non-simple” requests
  - Isolate the user’s session context

Simplicity of Settings

- Syntax like CSP, behavior like CORS
  - Simple behavior with fewer chances of mistakes
  - Leverage pre-flight
- Don’t require changes to application code
  - Add headers via WAF
  - Provide more flexibility by opt-in to exceptions

Should Often Succeed

- Don’t break the web, ease adoption
  - Ad banners
  - “first visit”, blank browsing context
  - Deal with domains & subdomains vs. Origins

- Browsers have to support it
  - Old, unpatched browsers forsaken to the demons of insecurity anyway

Some Ordinary Syntax

- On the web application, define a policy:

```
Set-Cookie: cookieName=...
Content-Security-Policy:

sos-apply=cookieName; ‘self‘
sos-apply=cookieName; ‘any‘
sos-apply=cookieName; ‘isolate‘
sos-apply=*; ‘self’
```

Policies

- **self** -- trigger pre-flight, cookie included only from same origin unless given exception
- **any** -- trigger pre-flight, cookie included unless given exception
- **isolate** -- no pre-flight, no exceptions. Cookie only included from same Origin.

- (?) `sos-remove=`*`cookieName`* to remove policy

Some Ordinary Syntax

- If a cookie has a policy (or no policy), and a request is generated by a resource from the same Origin.
  - ...work like the web works today.
- If a cookie has a policy of ‘isolate’, and a request is generated by a cross-origin resource.
  - ...never include the cookie.
- If a cookie has a policy of ‘any’ or ‘self’, and a request is generated by a cross-origin resource.
  - ...make a pre-flight check

Why Pre-Flight?

- Cookies apply site-wide (including subdomains!), without granularity of resources.
  - The /path attribute is broken
- An SOS policy instructs the browser for **default** handling of a cookie.
- A particular resource can declare an **exception** by responding to the pre-flight.

Pre-Flight Request

- (prereq) A policy of ‘any’ or ‘self’
- (prereq) Cross-origin resource initiates request
- Browser makes CORS-like request:

```
OPTIONS http://web.site/resource?a=1&b=2 HTTP/1.1
Host: web.site
User-Agent: ...
Origin: http://evil.site
Access-Control-SOS: cookiename cookiename2
Connection: keep-alive
Content-Length: 0
```

Pre-Flight Response

- Web app receives a pre-flight request.
- Supply an expires value so the browser can cache the response.
- ...if a policy should be enforced for the specific resource:

```
HTTP 200 OK
Access-Control-SOS-reply: ‘allow’ | ‘deny’; expires=seconds
```

Pre-Flight Response

- ...if the resource is not exceptional, browser follows established policy
  - ‘any’ would include the cookie for cross-origin
  - ‘self’ would exclude the cookie for cross-origin

- Benefits
  - Web app can enforce per resource, per cookie
  - Sees the Origin header
  - Expiration eases performance with caching

Two Sets

- Policy applies to cookies for all resources (entire Origin)
- Policy can be adjusted by a resource
- Pre-flight response shouldn't leak information about cookies for which it has a policy
  - If the client can't ask for the right cookie, then no response.
  - Respond with 'deny' if the cookie doesn't exist

Remember

- Browser tracks...
  - Cookies for which a policy has been applied.
  - Resources that respond to cross-origin requests with exceptions to the policy.
  - Cookies and destination origin, source origin doesn't matter
- Web App
  - Applies a policy at each Set-Cookie
  - Applies a policy at a bottleneck

Goals

- Ease adoption
  - Familiar syntax
  - Small command set
- Acknowledge performance
  - Cache pre-flight responses
  - Only track “all other origins” to origin, not pairs of origins

DEMO

The “WordPress Problem”

- Strong anti-CSRF token is present in WordPress trunk
- WP plugins keep forgetting to use it
  - ../wp-admin/admin.php?page=...
- Must continually protect every new action
- ...or protect the /wp-admin/ directory
  - sos-apply=*cookieName*; ‘self’

Mitigate Social Engineering

- Should prevent situations where user is tricked onto clicking a link/submitting a form on attacker's page (i.e. different origin) that submits to targeted origin

- Use X-Frame-Options to deal with clickjacking

If 6 Was 9

- No secrets, no entropy
  - Easier on embedded devices, fewer mistakes
- Enforcement by origin
  - Exception-based for flexibility
  - Shift state tracking from server to browser
- Pre-flight can be handled by WAF
- ‘isolate’ and expire deal with overhead of pre-flight
  - (Which is only for cross-origin anyway)

When Old Becomes New

- Update browsers
  - Still have to support legacy, although the window to the past is shrinking
  - People still use old browsers for good reasons, TorBrowser using FireFox ESR
- Fix frameworks
  - Use cryptographically secure PRNG
  - Don’t reuse example passphrases
  - Use XHR brokering with custom headers
  - Separate authentication and authorization

Summary

- Use HSTS
- Use CORS (i.e. “non-simple” requests)
- Send an SOS

SIX: ALL OF THIS HAS HAPPENED BEFORE.
BALTAR: BUT THE QUESTION REMAINS, DOES ALL OF THIS HAVE TO HAPPEN AGAIN?

Thank You!

- DefCon HTTP Time Bandit
  - Friday 2:30pm, Track 2

- http://deadliestwebattacks.com

References

- http://research.microsoft.com/en-us/um/people/helenw/papers/racl.pdf
- https://media.blackhat.com/bh-us-12/Briefings/Argyros/BH_US_12_Argyros_PRNG_WP.pdf
- http://www.adambarth.com/papers/2008/barth-jackson-mitchell-b.pdf