HTTP Security Headers

A technology history through scar tissue

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All Day DevOps

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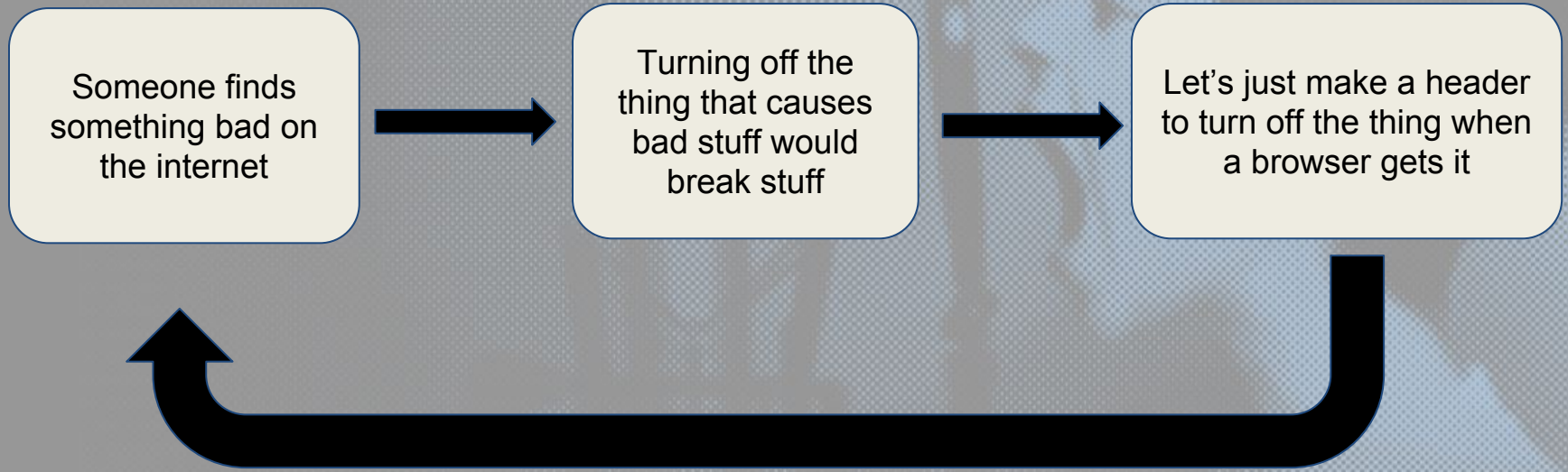
Security Header Flowchart

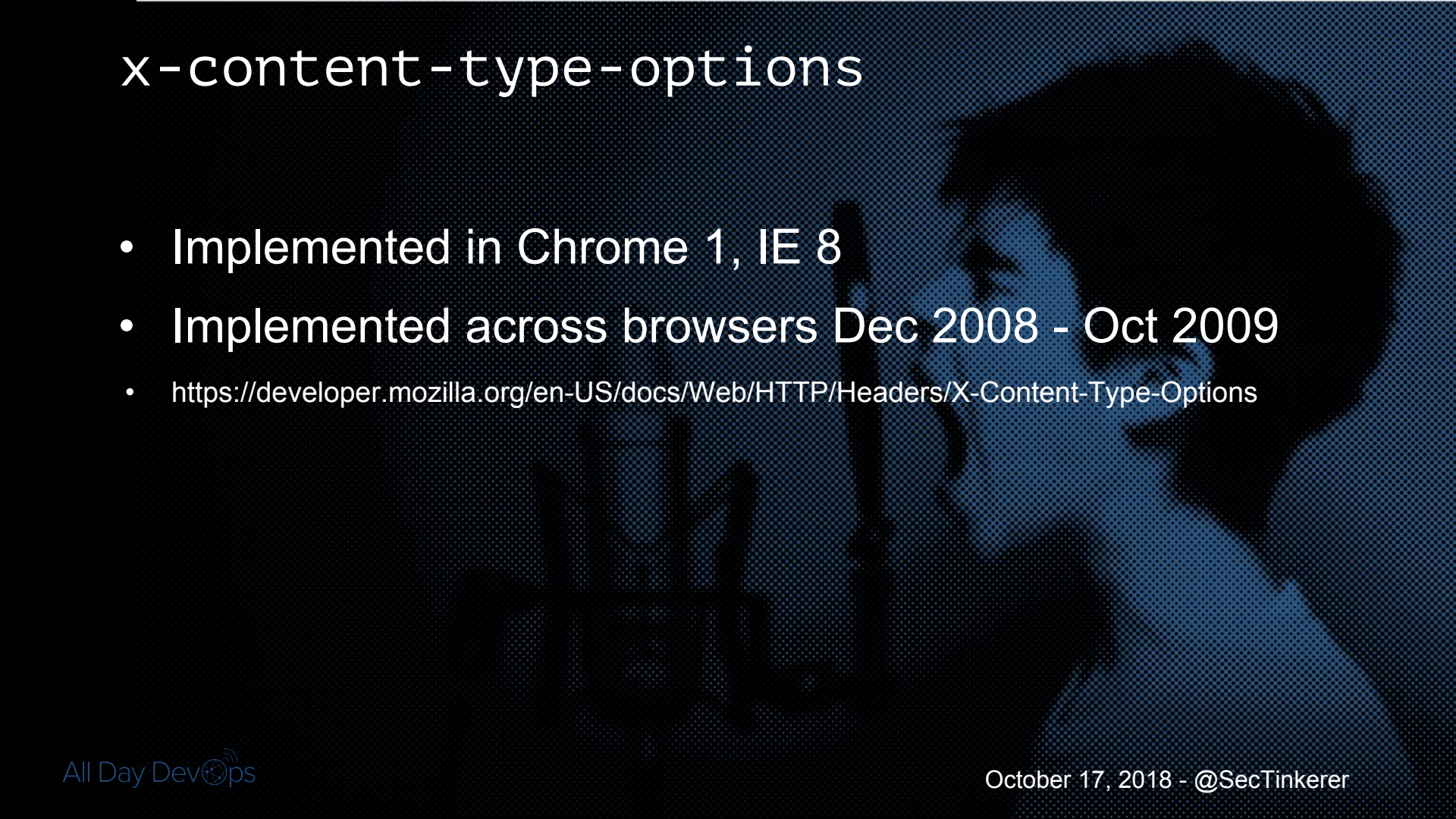


Headers we'll cover

- `x-content-type-options`
- `x-xss-protection`
- `x-frame-options`
- `strict-transport-security`
- `referrer-policy`
- `feature-policy` (kinda, it's not quite here yet)
- `content-security-policy`
- Managing CSPs at LendingClub

x-content-type-options

- Implemented in Chrome 1, IE 8
- Implemented across browsers Dec 2008 - Oct 2009
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/X-Content-Type-Options



What's the bad thing?

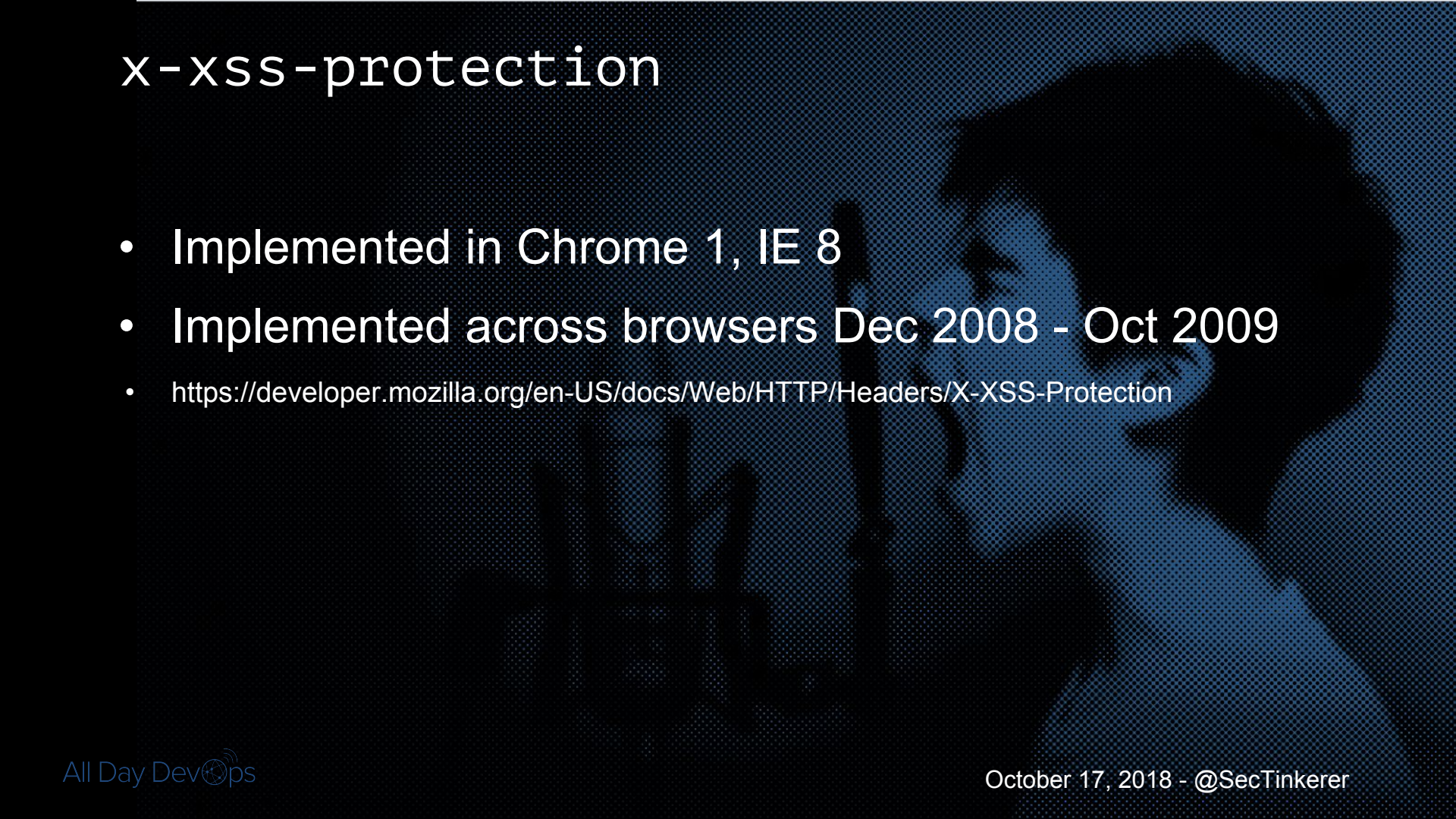
- Upload executable files with a non-executable MIME type
- Attacker tricks upload of malicious JavaScript as foo.txt (`text/plain` MIME)
- Browser 'sniffs' the file as actually JavaScript. Changes to `application/javascript` MIME and executes

Set to `x-content-type-options: nosniff`

Tells browsers to not try and guess MIME types of files

Just set your MIME types correctly

x-xss-protection



- Implemented in Chrome 1, IE 8
- Implemented across browsers Dec 2008 - Oct 2009
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/X-XSS-Protection

What's the bad thing?

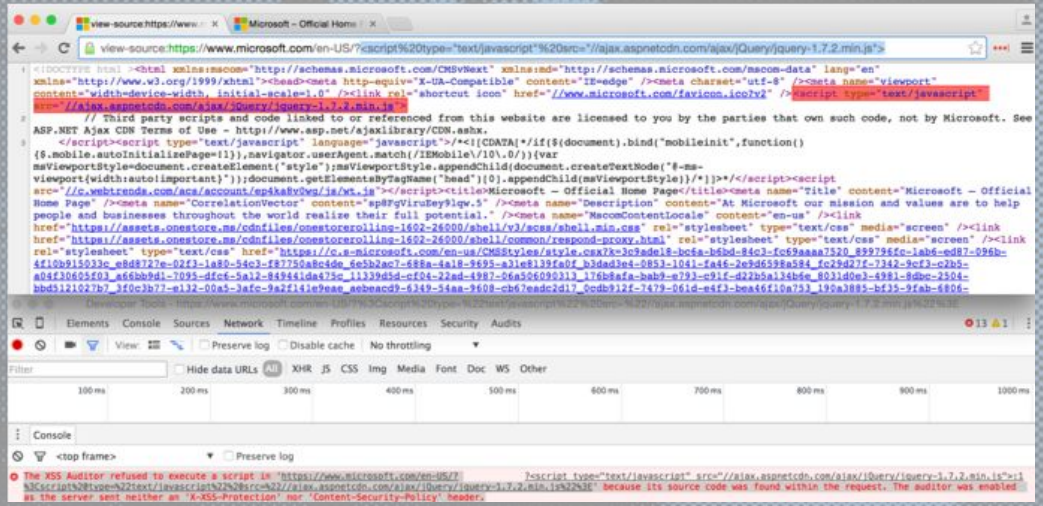
- Reflected Cross Site Scripting (XSS)
- Rolled out in IE 8, off by default could be enabled by headers
- Stops the lowest hanging XSS fruit

```
GET /index.php&name=<script>badstuff</script>

<html>
…
<body>
<p>Hello<script>badstuff</script>!
</p>
…
```

What to set?

- `x-xss-protection: 1`
  - Turns on the filter (already on by default in most browsers). Kinda silly.
- `x-xss-protection: 1; mode=block`
  - Instead of stripping out what it thinks, blocks the entire request
  - MS10-002 abused the filter to perform XSS attacks through the XSS filter
  - XSS filter can be used to knock out legit scripts
  - **CSP header is better**

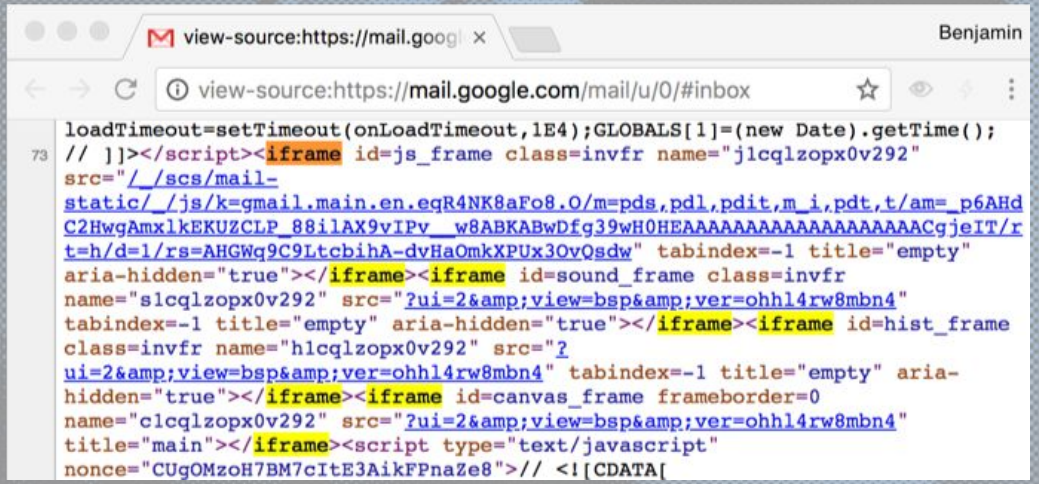


x-frame-options

- Implemented in Chrome 4, Firefox 3.6.9, IE 8
- Implemented across browsers Oct 2009 – Sept 2010
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/X-Frame-Options

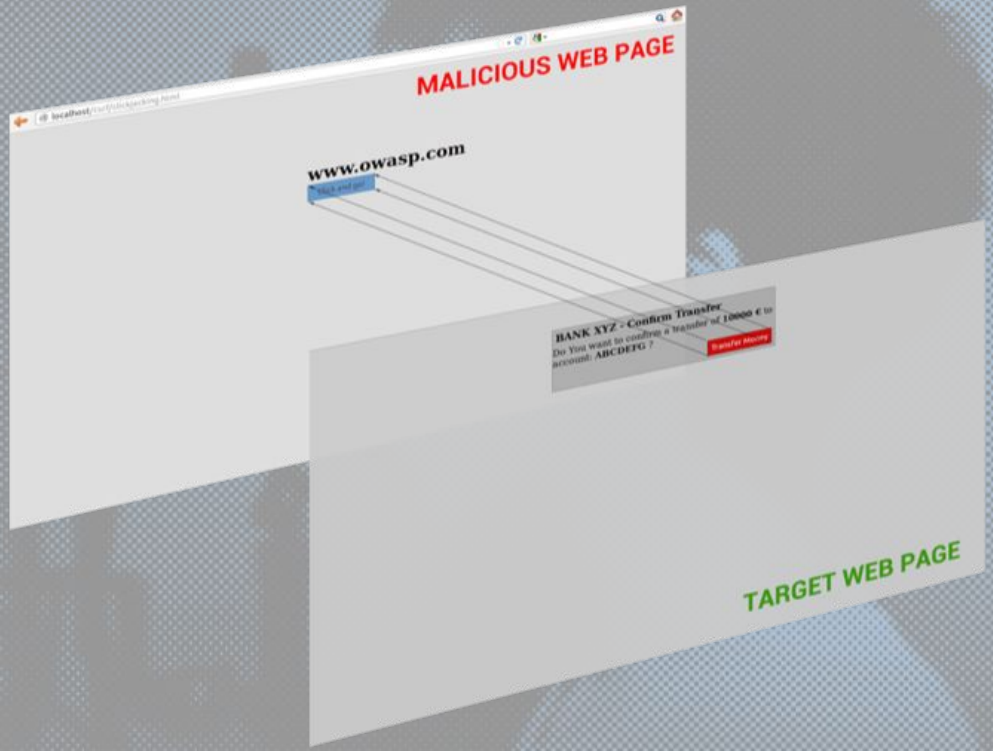
<frame> (deprecated) <iframe> <object>

- Embeds pages in other pages
- <frame> is obsolete in HTML5, but
- <iframe> is still in gmail and will probably never die



What's the bad thing?

- Clickjacking
- Drawing a cosmetic top above actual buttons
- Add keystroke logging JS



What to set?

- `x-frame-options: DENY`
  - No embedding at all
- `x-frame-options: SAMEORIGIN`
  - Allow embedding from the same origin as embedded page
- `x-frame-options: ALLOW-FROM https://example.com`
  - Allow embedding only on specifically outlined locations

(`content-security-policy: frame-ancestors 'none';` also works, but only in some modern browsers. No IE, No Microsoft Edge on mobile)

`https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Content-Security-Policy/frame-ancestors`

strict-transport-security

- Implemented in Chrome 4, Firefox 4, IE 11
- Implemented across browsers January 2010 – October 2013
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Strict-Transport-Security

What's the bad thing?

Where's example.com?

example.com is at 42.42.42.42

Great. Give me http://example.com 42.42.42.42 port 80

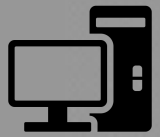
Let's do HTTPS instead. 301 Redirect https://example.com

No problem. Give me https://example.com 42.42.42.42 port 443

Here's my TLS cert

I trust that cert. I'll load the page

<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en"><head><meta content=..



What's the bad thing?

Where's example.com?

example.com happens to be me! 192.168.1.1

Great. Give me http://example.com 192.168.1.1 port 80

Give me https://example.com 42.42.42.42 port 443

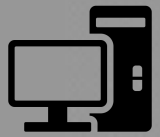
Here's my TLS cert

Sure whatever, give me the page

<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en"><head><script src="evil.com/bad.js" …

<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en"><head><meta content=..

Sweet. Lemme just go run evil.com/bad.js



HTTP

HTTPS

What's the bad thing?

Where's example.com?

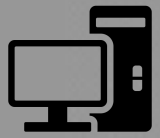
example.com happens to be me! 192.168.1.1

Great. Give me http://example.com 192.168.1.1 port 80

Wait, example.com has HSTS enabled! Give me https://example.com 192.168.1.1 port 443

Uh, okay, here's my cert

This cert is junk! Don't load!



HTTPS

What to set?

- `strict-transport-security: max-age=<expire-time>`
  - All further requests to that site will be over HTTPS until age expires
- `strict-transport-security: max-age=<expire-time>; includeSubDomains`
  - All further requests to that site & subdomains will be over HTTPS until age expires
- `strict-transport-security: max-age=<expire-time>; includeSubDomains; preload`
  - All further requests to that site & subdomains will be over HTTPS until age expires and it will get preloaded into browsers
  - Preload requires:
    - `max-age=31536000` or higher (one year)
    - `includeSubDomains`
    - valid HTTPS cert, serving HTTPS on all subdomains
    - redirect port 80 to port 443 (if listening on port 80)
  - If any subdomain can't handle HTTPS **it will break**. By design, no quick rollbacks.
  - https://hstspreload.org/

referrer-policy

- Implemented in Chrome 61, Firefox 52, no Safari or Microsoft Edge support
- Implementation started in browsers March 2017
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Referrer-Policy

What's the bad thing?

- When someone clicks a link off your site, you can leak specific information about a user in the "referer" (sic) header
- Maybe your site is sensitive
- Or specific URLs can be used to identify users

```
referer:_https://www.lendingclub.com/account/
loanPerf.action?loan_id=88783584&order_id=124
783505&note_id=131056825

referer: https://site-govt-doesnt-like.com

referer: https://twitter.com/SecTinkerer
```

What to set?

- Depends on your site. Common good choices are:
- `referrer-policy: strict-origin`
  - Only sends the origin and not URI info. Won't send over HTTP (`referer: https://www.lendingclub.com`)
- `referrer-policy: strict-origin-when-cross-origin`
  - Only sends origin as a referer when links off your site. Internally, the header keeps the full uri. Won't send the header over HTTP
- `referrer-policy: no-referrer`
  - Just don't send the referer header ever

feature-policy

- Just Chrome; no IE, Edge, Firefox or Safari support
- New this year
- Allows or denies browser features
- “Like CSP for features!”

- https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Feature-Policy
- https://developers.google.com/web/updates/2018/06/feature-policy

Basic support	60	No	No	No	47	No	60	60	No	No	47	No	No

content-security-policy

- Implemented in Chrome 25, Firefox 23, IE 10
- Implemented across browsers Sept 2012– April 2013
- Supersedes the previous x-xss-protection, x-frame-options headers
- https://developer.mozilla.org/en-US/docs/Web/HTTP/CSP

What’s the bad thing?

- Somewhere, somehow, something on your site that you don’t want running is there
- CSP let’s you lock down content that page can load to a whitelist
- And it will report back to you anything that’s in violation

Restrict any content!

- URLs that are loaded with script interfaces
- Fonts
- Frames
- Form submission endpoints
- What plugins can run
- Images
- Manifest files
- What <audio> <video> and <track> elements can load
- What <object>, <embed> and <applet> elements can load
- JavaScript
- CSS
- And defaults for everything else

Build from the ground up

- `content-security-policy: default-src 'self'; report-uri /csp/report`
  - Only load content from the same origin (no subdomains!) anything else send a report
- `content-security-policy: default-src 'self'; connect-src ‘self’ *.optimizely.com; report-uri /csp/report`
  - Adds the ability to run connect to any optimizely.com subdomain
- `content-security-policy: default-src 'self'; connect-src ‘self’ *.optimizely.com; script-src 'unsafe-inline' 'self' js-agent.newrelic.com; report-uri /csp/report`
  - Adds the ability to run inline JavaScript and scripts from js-agent.newrelic.com

What's this in real life? (news.google.com)

- Specifying a nonce (a unique per request, base64 value string) makes modern browsers ignore "unsafe-inline"

  `<script nonce="aWQGtiBJUDdHaq1L6xfcPaQBMeA"> … </script>`

- Yes, you can have multiple content-security-policy headers. Additions can only restrict. Most strict policy wins.

What's this in real life? (facebook.com)

```
content-security-policy: default-src * data: blob:;script-src *.facebook.com *.fbcdn.net *.facebo
ok.net *.google-analytics.com *.virtualearth.net *.google.com 127.0.0.1:* *.spotilocal.com:*
'unsafe-inline' 'unsafe-eval' *.atlassolutions.com blob: data: 'self';style-src data: blob:
'unsafe-inline' *;connect-src *.facebook.com facebook.com *.fbcdn.net *.facebook.net *.spotil
ocal.com:* wss://*.facebook.com:* https://fb.scanandcleanlocal.com:* *.atlassolutions.com att
achment.fbsbx.com ws://localhost:* blob: *.cdninstagram.com 'self' chrome-extension://boadgeo
jelhgndaghljhdicfkmllpafd chrome-extension://dliochdbjfkdbacpmhlcpmleaejidimm;
```

What's this in real life? (twitter.com)

content-security-policy: script-src https://connect.facebook.net https://cm.g.doubleclick.net https://ssl.google-analytics.com https://graph.facebook.com 'nonce-eYyW3aaTY/WRlhD2P/SGBQ==' https://twitter.com 'unsafe-eval' https://*.twimg.com https://api.twitter.com https://analytics.twitter.com https://publish.twitter.com https://ton.twitter.com https://syndication.twitter.com https://www.google.com https://t.tellapart.com https://platform.twitter.com https://www.google-analytics.com blob: 'self'; frame-ancestors 'self'; font-src https://twitter.com https://*.twimg.com data: https://ton.twitter.com https://fonts.gstatic.com https://maxcdn.bootstrapcdn.com https://netdna.bootstrapcdn.com 'self'; media-src https://rmpdhdsnappytv-vh.akamaihd.net https://prod-video-eu-central-1.pscp.tv https://prod-video-ap-south-1.pscp.tv https://v.cdn.vine.co https://dwo3ckksxlb0v.cloudfront.net https://twitter.com https://prod-video-us-east-2.pscp.tv https://prod-video-cn-north-1.pscp.tv https://amp.twimg.com https://smmdhdsnappytv-vh.akamaihd.net https://*.twimg.com https://prod-video-eu-west-1.pscp.tv https://*.video.pscp.tv https://rmmdhdsnappytv-vh.akamaihd.net https://clips-media-assets.twitch.tv https://prod-video-ap-northeast-2.pscp.tv https://prod-video-us-west-2.pscp.tv https://prod-video-us-west-1.pscp.tv https://prod-video-ap-northeast-1.pscp.tv https://smdhdsnappytv-vh.akamaihd.net https://ton.twitter.com https://prod-video-eu-west-3.pscp.tv https://rmdhdsnappytv-vh.akamaihd.net https://mmdhdsnappytv-vh.akamaihd.net https://prod-video-ca-central-1.pscp.tv https://smpdhdsnappytv-vh.akamaihd.net https://prod-video-sa-east-1.pscp.tv https://mdhdsnappytv-vh.akamaihd.net https://prod-video-ap-southeast-2.pscp.tv https://mtc.cdn.vine.co https://prod-video-cn-northwest-1.pscp.tv https://prod-video-eu-west-2.pscp.tv https://dev-video-us-west-2.pscp.tv https://prod-video-us-east-1.pscp.tv blob: 'self' https://prod-video-ap-northeast-3.pscp.tv https://prod-video-ap-southeast-1.pscp.tv https://mpdhdsnappytv-vh.akamaihd.net https://dev-video-eu-west-1.pscp.tv; 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style-src https://fonts.googleapis.com https://twitter.com https://*.twimg.com https://translate.googleapis.com https://ton.twitter.com 'unsafe-inline' https://platform.twitter.com https://maxcdn.bootstrapcdn.com https://netdna.bootstrapcdn.com 'self'; object-src https://twitter.com https://pbs.twimg.com; default-src 'self' blob:; frame-src https://staticxx.facebook.com https://twitter.com https://*.twimg.com https://5415703.fls.doubleclick.net https://player.vimeo.com https://pay.twitter.com https://www.facebook.com https://ton.twitter.com https://syndication.twitter.com https://vine.co twitter: https://www.youtube.com https://platform.twitter.com https://upload.twitter.com https://s-static.ak.facebook.com https://4337974.fls.doubleclick.net https://8122179.fls.doubleclick.net 'self' https://donate.twitter.com; img-src https://graph.facebook.com https://*.giphy.com https://*.pscp.tv https://twitter.com https://*.twimg.com https://ad.doubleclick.net data: https://clips-media-assets.twitch.tv https://lumiere-a.akamaihd.net https://fbcdn-profile-a.akamaihd.net https://www.facebook.com https://ton.twitter.com https://*.fbcdn.net https://syndication.twitter.com https://media.riffsy.com https://www.google.com https://stats.g.doubleclick.net https://platform.twitter.com https://api.mapbox.com https://www.google-analytics.com blob: https://*.periscope.tv 'self'; report-uri https://twitter.com/i/csp_report?a=NVQWGYLXFVZXO2LGOQ%3D%3D%3D%3D%3D%3D%3D&ro=false;

Managing `content-security-policy` at LendingClub

- Empowering developers through a layered hierarchy of control
- Setting global fallbacks for legacy applications
- Leveraging `content-security-policy-report-only`

Developer led CSPs

Real time config

- Can overwrite both app specific and global values
- Requires change control approval to differ from static

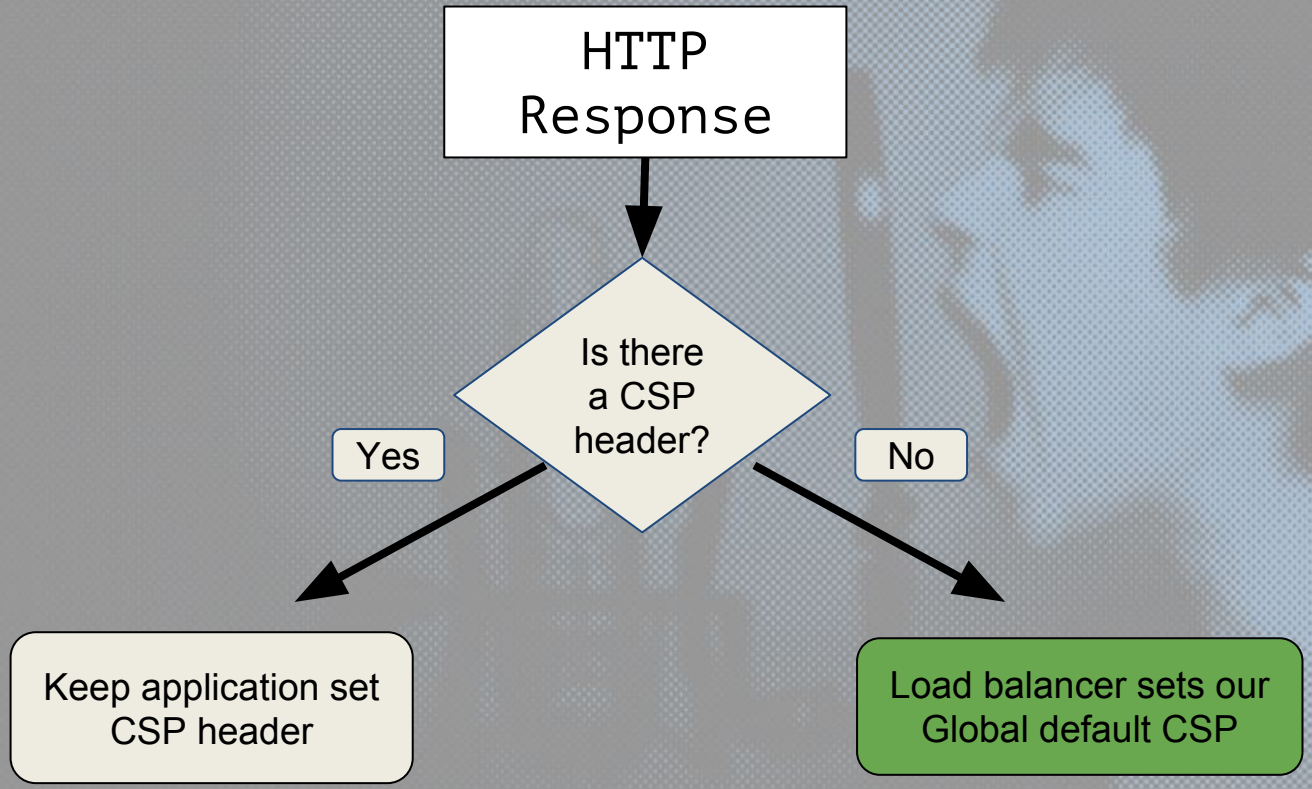
Application static config

- Only application specific additions (loosening)
- Standard code review and security team informed

Global defaults

- reporting uri
- analytics, A/B test vendor, etc
- Requires committee approval to change

What about legacy stuff?



`content-security-policy-report-only`

- Basically “audit mode” for `content-security-policy`
- Displays violations in the browser console, but won’t block functionality
- Syntax is identical; only appending `-report-only`
- Reports violations via report-uri
  - Can be helpful to have a different reporting URI for each

Example Report

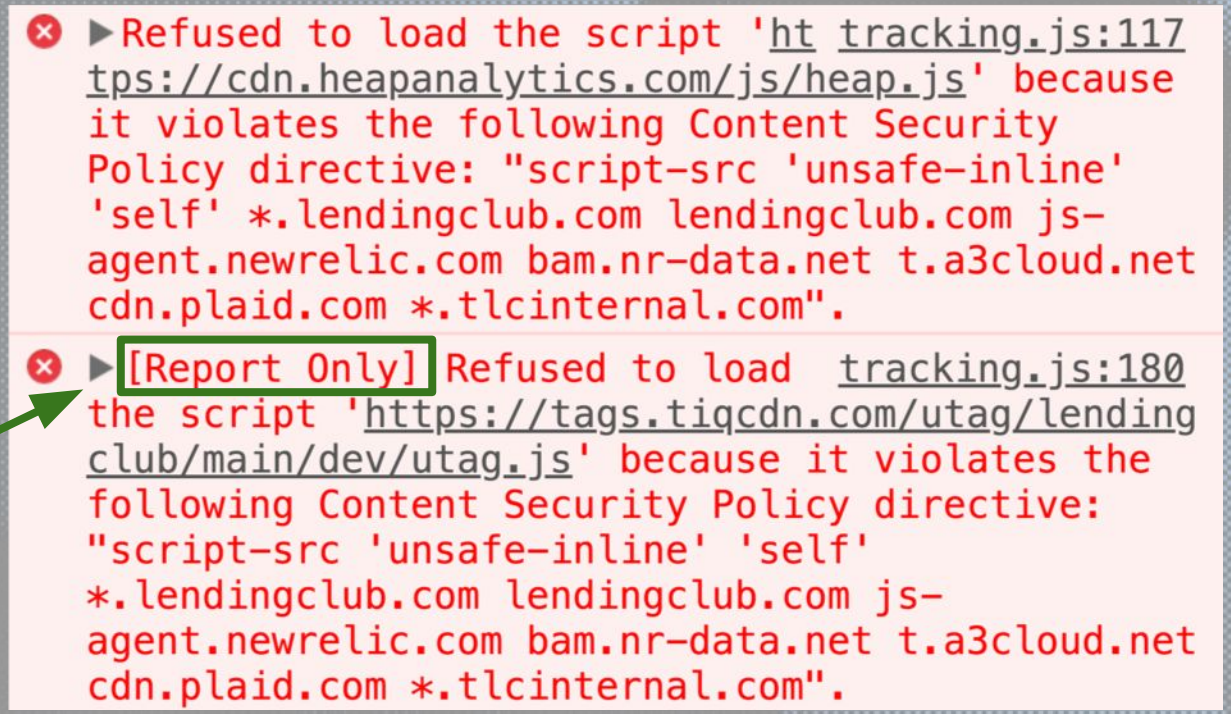
JSON formatted POST to your report URI

```
{
  "csp-report": {
    "document-uri": "http://example.com/signup.html",
    "referrer": "",
    "blocked-uri": "http://example.com/css/style.css",
    "violated-directive": "style-src cdn.example.com",
    "original-policy": "default-src 'none'; style-src
cdn.example.com; report-uri /_/csp-reports",
    "disposition": "report/enforce"
  }
}
```

Example Console Errors

A blocked CSP violation

A non-blocking CSP-RO violation



Takeaways from LendingClub

- Make the lowest friction way to change CSPs your normal path to test and push code to production
  - Still have an emergency break for real-time changes
  - Still have a consensus global baseline for legacy apps
- Use the `-report-only` header to sanity check changes
- DevOps & Developer led CSP settings are faster, safer and stronger than top-down security mandates

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Server by Mister Pixel from the Noun Project
Phishing attack by ProSymbols from the Noun Project

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October 17, 2018 - @SecTinkerer