

HTTP Security Headers You Need To Have On Your Web Apps

Audience

- Anyone with a web app



Agenda

- What are HTTP Security Headers?
- Why do they matter?
- HSTS, XFO, XSS, CSP, CTO, RH, FP
 - What are they
 - What do they do
 - Demo
 - Impact on existing apps

Goals


- Expose you to security headers that are out there
- Why they are needed
- Write down ones you need to look into when you're back at work

Who am I?

- Director of Engineering at [Lean TECHniques](#)
- Co-organizer of [Iowa .NET User Group](#)
- [Friend of Redgate](#)
- Blog at [scottsauer.com](#)
- Not a security expert... but...



What are HTTP Headers?

- Allows both the client and server to pass additional data along to the request or response to exchange information and inform the other party.
- Request header examples:
 - Cookies
 - Accept-language: en-us
- Response header examples:
 - Date
 - Content-type: text/html or application/json
 - ***Security-related headers*** 

What are HTTP Security Headers?

- Response headers that the server responds with to instruct the browser what security rules to enforce when it handles your website's content.
- Key value pairs
- In general, the more security headers you opt-in to sending, the more secure your website is.
- Most security headers come with multiple options you can configure to tweak the behavior to what you want.

The screenshot shows the Chrome DevTools Network tab. The top toolbar includes tabs for Elements, Console, Sources, Network, Performance, Memory, Application, Security, Audits, and React. The Network tab is active, displaying a list of requests on the left and a detailed view of a selected request on the right. The selected request is from 'facebook.com' to 'www.facebook.com'. The response headers are expanded, showing various HTTP headers. Red arrows are drawn on the image: arrow 1 points to the 'All' filter button in the Network tab toolbar; arrow 2 points to the 'www.facebook.com' entry in the request list; arrow 3 points to the 'Response Headers' section in the detailed view.

Network tab toolbar: View: [Group by frame] [Preserve log] [Disable cache] [Offline] [Online]

Request list (left):

- facebook.com
- www.facebook.com
- MQadQzJY5-0.css
- B9wZdYhoLBh.js
- CZDXNrhczNR.js
- 26UbA3YYkTW.js
- IWpoemjeclb.css
- o1ucC237c08.js
- zm0CIAy-gWw.js
- ixjARbyUKEH.css
- jILuFtmBjCq.css
- IV5UITSC1cY.css
- fOTwljApvzr.css
- hKcmd-vLZZ.js
- ongZGhr48M.css
- ewdB3k4d_m3.css
- R-Vbjiv5u5v.js
- nzraUlbnMyJ.js
- u2_4BeXCIeg.js
- C73kA04iOeL...

Response Headers (right):

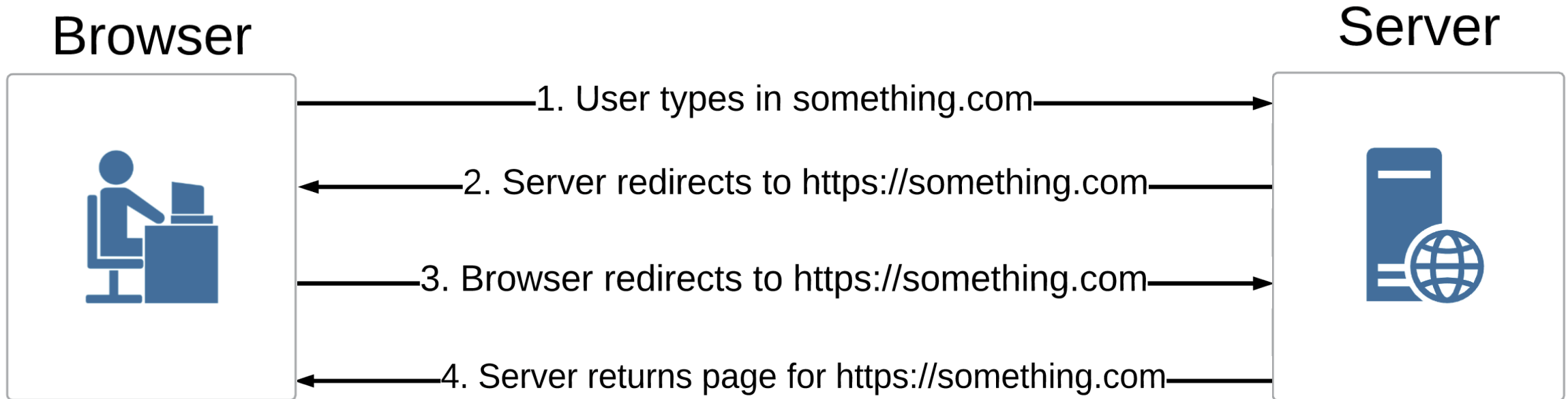
- General**
- Response Headers**
 - cache-control: private, no-cache, no-store, must-revalidate
 - content-encoding: br
 - content-security-policy: default-src * data: blob;;script-src *.facebook.com *.fbcdn.net *.facebook.net *.google-analytics.com *.virtualearth.net *.google.com 127.0.0.1:* *.spotilocal.com:* 'unsafe-inline' 'unsafe-eval' *.atla
 - olutions.com blob: data: 'self';style-src data: blob: 'unsafe-inline' *;connect-src *.facebook.com facebook.com *.fbcdn.net *.facebook.net *.spotilocal.com:* wss://*.facebook.com:* https://fb.scanandcleanlocal.com:* *.atla
 - olutions.com attachment.fbsbx.com ws://localhost:* blob: *.cdninstagram.com 'self' chrome-extension://boadgeojelhgndaghljhdicfkmllpaf chrome-extension://dlio chdbjfkdbacpmhlcpmleaejiddm;
 - content-type: text/html; charset="utf-8"
 - date: Thu, 15 Nov 2018 21:15:41 GMT
 - expect-ct: max-age=86400, report-uri="http://reports.fb.com/expectct/"
 - expires: Sat, 01 Jan 2000 00:00:00 GMT
 - pragma: no-cache
 - status: 200
 - strict-transport-security: max-age=15552000; preload
 - vary: Accept-Encoding
 - x-content-type-options: nosniff
 - x-fb-debug: KkqYDI+lC5qzp2+H01/yAWcb1I2/t3H/DmM51X5rJVZvcB+AlN9XNFaDftUb35k0Tnn4dCUT/bAizUfnv/E0yg==
 - x-frame-options: DENY
 - x-xss-protection: 0

Bottom status bar: 495 / 536 requests | 5.9 MB / 6.0 ...

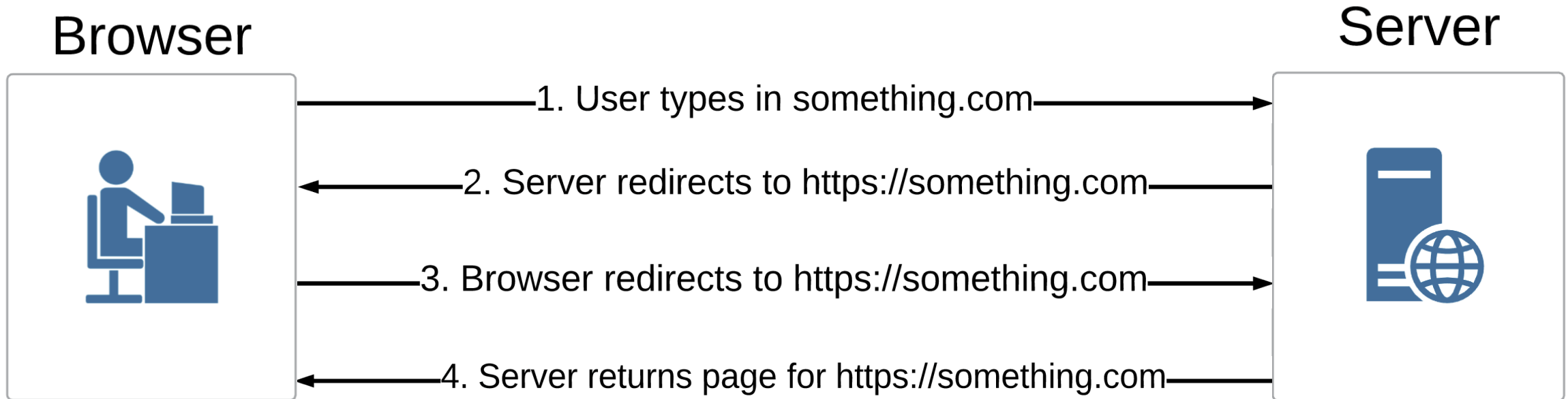
HTTP Strict Transport Security (HSTS)

- What is it?
 - It allows websites to tell web browsers to only request this site over HTTPS, not over HTTP.
- Why should I care?
 - Prevents some classes of man-in-the-middle (MITM) attacks.

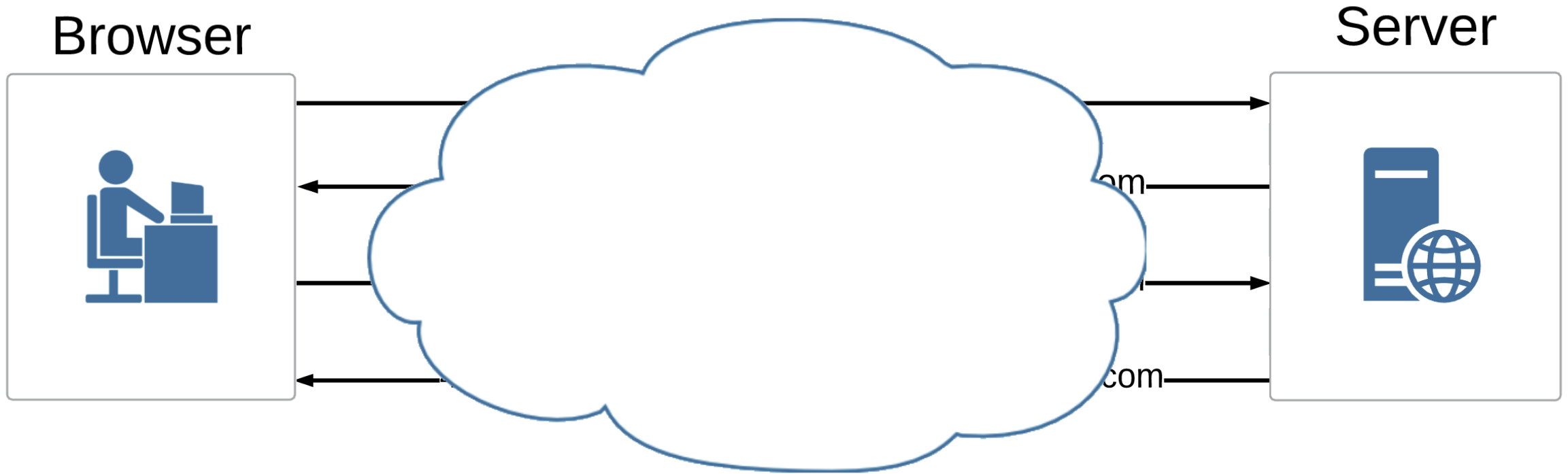
Without HSTS



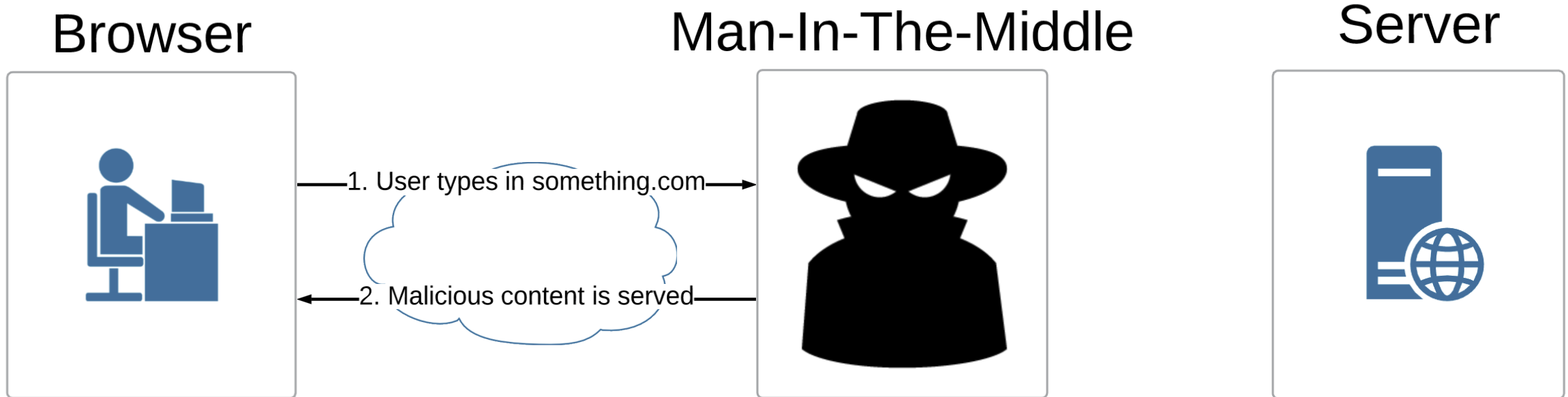
What's the issue?



What's the issue?



What can happen?

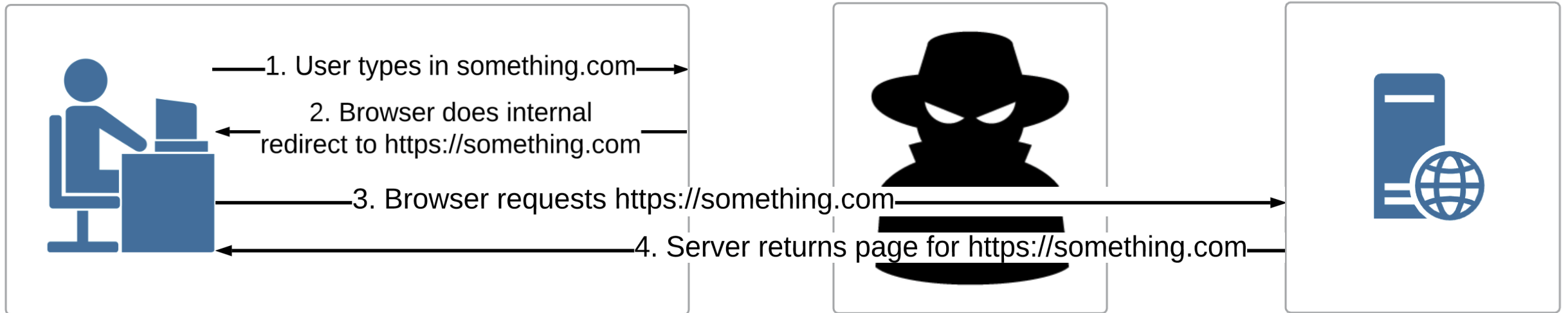


With HSTS

Browser

Man-In-The-Middle

Server



HSTS Options

Example: **strict-transport-security:** `max-age=31536000` `includeSubDomains`; `preload`

- max-age
 - The number of seconds the browser should enforce HSTS. 31,536,000 (1 year) is really common. Adds your site to its internal list for this # of seconds.
- includeSubDomains
 - Apply the HSTS policy to all subdomains.
- preload
 - Instructs the browser to be on the preload list... more on that in the next slide.
- max-age is required. The other two are not.

HSTS Preload List

- List maintained by Google, but used by all browsers.
- If you **ARE NOT** on the list, then the first HTTP request will 301 and opens up for chance of MITM
- If you **ARE** on this list, then the HTTP request will 307 internal redirect, not 301, even if you've never visited the site before
- Guarantees no chance of basic MITM attack.
- Submit your domain to the list here: <https://hstspreload.org/>
- Add the preload option to your header to confirm your submission.



HSTS Demo

HSTS Gotchas

- You probably don't want this running when running locally on localhost... unless every website you run locally is HTTPS
- HTTP and HTTPS often listen on different ports like localhost:5000 for HTTP and localhost:5001 for HTTPS.
 - If running for localhost:5000 it will redirect to <https://localhost:5000> which will not bind

HSTS Impact of Retrofitting on Existing App

- Is everything really HTTPS?
- Subdomains
- If you're planning on going from HTTPS to HTTP in the future for some reason
 - IDK why though

Quick word on HTTPS

- A good idea even if your site is internal
- Network topology may change
- Perception to users thanks to Chrome

ⓘ Not secure | www.████.com



HSTS Questions

X-Frame-Options (XFO)

- What is it?
 - Used to tell a browser whether or not a page should be rendered in a frame or iframe.
- Why should I care?
 - Prevents click-jacking attacks.

X-Frame-Options (XFO) Options

Example: **x-frame-options: DENY**

- Directives to choose from
 - DENY
 - Prevents any domain from framing your page. This is the most secure.
 - SAMEORIGIN
 - Only allows framing from the same domain.
 - ALLOW-FROM https://site1.com
 - Let's you specify a single site that can frame your page.



XFO Demo

XFO Impact of Retrofitting to Existing App

- Do you know which sites should be iframing your app?
- I imagine most could just do DENY or at least SAMEORIGIN



XFO Questions

Cross-Site Scripting (XSS)

- What is it?
 - A vulnerability in a trusted website where malicious scripts can be injected.
 - XSS can be used to harvest cookies, tokens, etc. since the script that is loaded appears to be legit.
- Often it comes from input from the user that is not validated or encoded and then re-displaying that to the user.
- Examples:
 - Taking input from user, save it in a DB and others can see (Twitter, Facebook, etc.)
 - “Contact Us” or “Feedback” form on your page
 - Can you put in `<script>//something malicious here</script>` and does it get loaded by your email client?



XSS Demo

XSS Final Note

- Most modern frameworks help you out here.
- ASP.NET Core for instance, I have to call `Html.Raw()` since it encodes by default.
- React escapes non-props characters by default



XSS Questions

Cross-Site Scripting (XSS)

- Can be prevented with Content-Security-Policy (CSP)
 - Among other attacks not just XSS
- Old X-XSS-Protection security header is no longer honored by any major browser
 - Edge in 2018
 - Chrome in 2019

Content Security Policy (CSP)

- What is it?
 - Gives the browser an allowlist of sources to load static resources like JS, CSS, images, etc. from. This allowlist can specify how the resource is loaded (i.e. disabling inline scripts) and where the resource can be loaded from.
- Why should I care?
 - It can reduce or even eliminate the ability for XSS to occur.
 - Also limits your attack surface of other kinds of attacks (more later).

Content Security Policy (CSP) Options

Example: `content-security-policy: script-src 'self' www.google-analytics.com www.google.com`

- script-src = the content type you are configuring
- self = the domain the page is being served on
- The rest are other domains that are allowed to load scripts from
- Other values:
 - unsafe-inline would mean allowing <script> tags or inline event handlers like <button onclick="clickEvent">
 - none means block any use of this content type
- report-uri = where to send JSON payload with violation information

Content Security Policy (CSP) Options

- In general, the more you allow, the greater your XSS risk.
- Not allowing inline scripts is one of the biggest wins if you can manage it.

Content Security Policy (CSP) Options

- There are other ones just like script-src that behave similarly such as:
 - style-src
 - media-src
 - frame-src
 - font-src
 - And more
- All take in domains to allow
- unsafe-inline also works with styles
- none works with all
 - i.e. if you want no one to frame your content



CSP Demo

CSP Impacting of Retrofitting to Existing App

- **HUGE**

- This is an allowlist
- You **must know what your app is doing** (inline scripts/styles or not), where it's loading from (CDN's, other sources, or not), etc.
- Configuring this wrong will break your app.
- Compromise
 - Set to report only (via Content-Security-Policy-Report-Only instead of Content-Security-Policy), collect data and what your app does, and tweak CSP to that accordingly after a certain period of time.
 - Start converting inline scripts and the like.

Content Security Policy (CSP)

- CSP can override the need for other headers
- frame-ancestors 'none' means no one can embed the page in a frame/iframe.
 - This eliminates the need for X-Frame-Options: DENY
- However, auditors probably still want to see it



CSP Questions

Browser Sniffing Protection (X-Content-Type-Options)

- What is it?
 - Tells a browser to not “sniff” the response and try and determine what’s in the response. Instead, look at the content-type header and render it according to that. So if it says it’s text/plain, render it as text/plain
- Why should I care?
 - Prevents unexpected execution from what the server thinks the response is.
 - Especially important if you take uploads from a user and re-display them.
 - Someone may upload a .txt file, but it’s really JavaScript and without this option set, the browser may execute the JavaScript.

Browser Sniffing Protection (X-Content-Type-Options)

Example: **x-content-type-options:** nosniff

- nosniff
 - Does not have the browser sniff the contents of the response to try and determine what to display
 - Instead, it just looks at the content-type header and renders it as that.

XCTO Impact of Retrofitting to Existing App

- Very minimal
- Note: most modern browsers will not sniff by default now.
- IE in compatibility view will still sniff
- Still shows up on audits



XCTO Questions

Referer Header background

- When a link is clicked, the browser will send the previous page's URL in the Referer Request Header. Allows the server to do something with that data.
- Useful for tracking a user's flow through an app
- Yes it's misspelled
- Yes that's actually how it shows up in the browser

I've seen this on my blog

Stats for 2020		
Referrers		>
Referrer		Views
✓ 🔍 Search Engines		94,142
✓ github.com	...	1,385
✓ forums.asp.net	...	1,372
✓ codeopinion.com	...	765
✓ ayende.com	...	240
✓ testing-library.com	...	214
🔗 🐦 Twitter		176
✓ WordPress Android App		173
✓ ecosia.org	...	154
✓ blog.georgekosmidis.net	...	114
View all		

...and even JIRA/Confluence/OWA

webmail.██████████.owa/	...	2
██████████	...	2
██████████tech/entity-framework-core/	...	2
██████████	...	2
██████████issues/8879	...	2
kb.██████████h/pages/viewpage.action?pagelId=17694924	...	2
██████████confluence/display/PLATTFORM/Monitoring	...	2
jira.██████████browse/HOSD-1080	...	2
scottsauer.com/2017/04/03/adding-global-error-handling-and-logging-in-asp-net-core/	...	2
██████████.com	...	2
██	...	2
▼ evernote.com	...	2
██	...	2
confluence/display/EX/Health+Checks	...	2
██████████hipchat.com/chat/room/4001051	...	2

Referrer-Policy

- What is it?
 - Tells a browser what should be sent in the Referer header
- Why should I care?
 - It helps protect the identity of the source of a page's visit.

Referrer-Policy

Example: `referrer-policy: no-referrer`

- no-referrer
 - Referrer header is omitted entirely. **Most secure.**
- origin
 - Only send the domain (i.e. sends example.com instead of example.com/index.html)
- same-origin
 - Only send when going to the same domain
- [And more](#)

RP Impact of Retrofitting to Existing App

- Minimal with the right config



RP Questions

Feature-Policy (Working Draft)

- What is it?
 - Tells a browser to allow or deny the use of browser features, and allowing granularity of being able to specify specific domains
 - Think – 3rd party code you embed.
- Why should I care?
 - Allows you to restrict what your own app can do
 - In case of a XSS vulnerability
 - Allows you to restrict what 3rd party code can do
 - Block geolocation, camera, microphone, etc.
- Limited browser support – rename coming to “Permissions Policy”

Feature-Policy Is Experimental

IE	Edge [*]	Firefox	Chrome	Safari	Opera	Safari on iOS [*]	Opera Mini [*]	Android Browser [*]
			4-59					
	12-18		¹ 60-73		10-46			
	79-87	2-73	74-87	3.1-11	¹ 47-60	3.2-11.2		
6-10	⁴ 88-89	² 74-87	⁴ 88-89	^{2 3} 11.1-14	62-74	^{2 3} 11.3-14.4		2.1-4.4.4
11	⁴ 90	² 88	⁴ 90	^{2 3} 14.1	⁴ 75	^{2 3} 14.5	all	90
		² 89-90	⁴ 91-93	^{2 3} TP				

Feature-Policy

Example: **feature-policy:** camera 'self'; geolocation 'none'

- The feature you are locking down
 - camera, geolocation, microphone, payment, autoplay, etc.
- The allow list of who can use this feature
 - *
 - self
 - none
 - <https://example.com>



FP Demo

FP Impact of Retrofitting to Existing App

- Pretty big
- Know what your site is doing

Permissions-Policy

Example: **permissions-policy:** camera=(self "https://google.com"), geolocation()
feature-policy: camera 'self' https://google.com; geolocation 'none'

- Same idea as Feature-Policy but slightly different syntax
- The feature you are locking down
- The allow list of who can use this feature
- PP will (likely) replace FP, but it has almost zero support today unlike FP

Permissions-Policy is a Working Draft

Permissions Policy - WD

A security mechanism that allows developers to explicitly enable or disable various powerful browser features for a given site.
Similar to [Document Policy](#).

Current aligned

Usage relative

Date relative

Filtered

All



IE	Edge [*]	Firefox	Chrome	Safari	Opera	Safari on iOS [*]	Opera Mini [*]	Android Browser [*]
	12-18		4-59					
	² 79-85		² 60-85		10-46			
	² 86-87	2-73	² 86-87	3.1-11	² 47-71	3.2-11.2		
6-10	^{1 2} 88-89	² 74-87	^{1 2} 88-89	² 11.1-14	² 72-74	² 11.3-14.4		2.1-4.4.4
11	^{1 2} 90	² 88	^{1 2} 90	² 14.1	² 75	² 14.5	all	² 90
		² 89-90	^{1 2} 91-93	² TP				



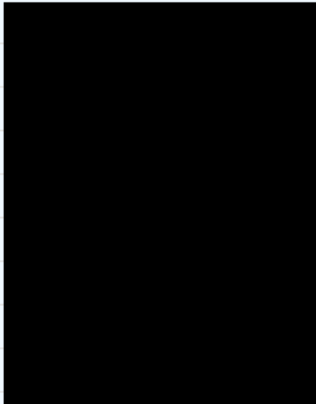
FP/PP Questions

How do I test my website?

- <https://securityheaders.com>
- Run by security expert [Scott Helme](#)

The image shows the top section of the Security Headers website. It has a blue header with the text "Security Headers" in white. Below it, on the left, is the text "Sponsored by" followed by the Probely logo. On the right side of the header are three white links: "Home", "About", and "Donate". The main content area has a blue background with the text "Scan your site now" in large white font. Below this is a white input field containing "facebook.com" and a dark blue "Scan" button. At the bottom of the input field area, there are two blue checkmarks followed by the text "Hide results" and "Follow redirects".

Recent Scans

	F
	F
	F
	F
	F
	F
	F
	D
	B
	F

[illegible]

SecurityHeaders.com

Scan your site now

Scan

☒ Hide results ☒ Follow redirects

Security Report Summary



Site: <https://www.facebook.com/>

IP Address: 2a03:2880:f131:83:face:b00c:0:25de

Report Time: 26 Jan 2021 04:12:00 UTC

Headers:

✓ X-Frame-Options

✓ Strict-Transport-Security

✓ Content-Security-Policy

✓ X-Content-Type-Options

✗ Referrer-Policy

✗ Permissions-Policy

Warning:

Grade capped at A, please see warnings below.

SecurityHeaders.com

Missing Headers

Referrer-Policy

[Referrer Policy](#) is a new header that allows a site to control how much information the browser includes with navigations away from a document and should be set by all sites.

Permissions-Policy

[Permissions Policy](#) is a new header that allows a site to control which features and APIs can be used in the browser.

Warnings

Content-Security-Policy

This policy contains 'unsafe-inline' which is dangerous in the script-src directive. This policy contains 'unsafe-eval' which is dangerous in the script-src directive. This policy contains 'unsafe-inline' which is dangerous in the style-src directive.

Upcoming Headers

Expect-CT

[Expect-CT](#) allows a site to determine if they are ready for the upcoming Chrome requirements and/or enforce their CT policy.

Cross-Origin-Embedder-Policy

[Cross-Origin Embedder Policy](#) allows a site to prevent assets being loaded that do not grant permission to load them via CORS or CORP.

Cross-Origin-Opener-Policy

[Cross-Origin Opener Policy](#) allows a site to opt-in to Cross-Origin Isolation in the browser.

Cross-Origin-Resource-Policy

[Cross-Origin Resource Policy](#) allows a resource owner to specify who can load the resource.

SecurityHeaders.com

Additional Information

X-Frame-Options

[X-Frame-Options](#) tells the browser whether you want to allow your site to be framed or not. By preventing a browser from framing your site you can defend against attacks like clickjacking.

X-XSS-Protection

[X-XSS-Protection](#) sets the configuration for the XSS Auditor built into older browsers. The recommended value was "X-XSS-Protection: 1; mode=block" but you should now look at [Content Security Policy](#) instead.

Strict-Transport-Security

[HTTP Strict Transport Security](#) is an excellent feature to support on your site and strengthens your implementation of TLS by getting the User Agent to enforce the use of HTTPS.

content-security-policy

[Content Security Policy](#) is an effective measure to protect your site from XSS attacks. By whitelisting sources of approved content, you can prevent the browser from loading malicious assets. [Analyse](#) this policy in more detail. You can sign up for a free account on [Report URI](#) to collect reports about problems on your site.

X-Content-Type-Options

[X-Content-Type-Options](#) stops a browser from trying to MIME-sniff the content type and forces it to stick with the declared content-type. The only valid value for this header is "X-Content-Type-Options: nosniff".

Note

- If you're using a WAF (Cloudflare, Incapsula, etc.) they may be adding these for you.
- Personally, I'd rather let the app add them, avoid vendor-lock in, and get localhost running as close to prod as possible.
- Sometimes this is hard to do if doing JAM stack
 - Lambda@Edge

Takeaways

- HTTP Security Header Awareness
- At least one HTTP Header or option written down to look into at work
- There are more Security Headers out there and more coming
- SecurityHeaders.com
- The web is a scary place



Resources

- <https://securityheaders.com/>
- MDN: <https://developer.mozilla.org/en-US/docs/Web/HTTP/>
 - Http Security on the left
- Code from demos: <https://github.com/scottsauber/talks>
- [Troy Hunt Pluralsight on Security Headers](#)
- This slide deck is intentionally left detailed

Questions?

Thanks!