Protect against Cross-Site Request Forgery (CSRF)

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What is CSRF

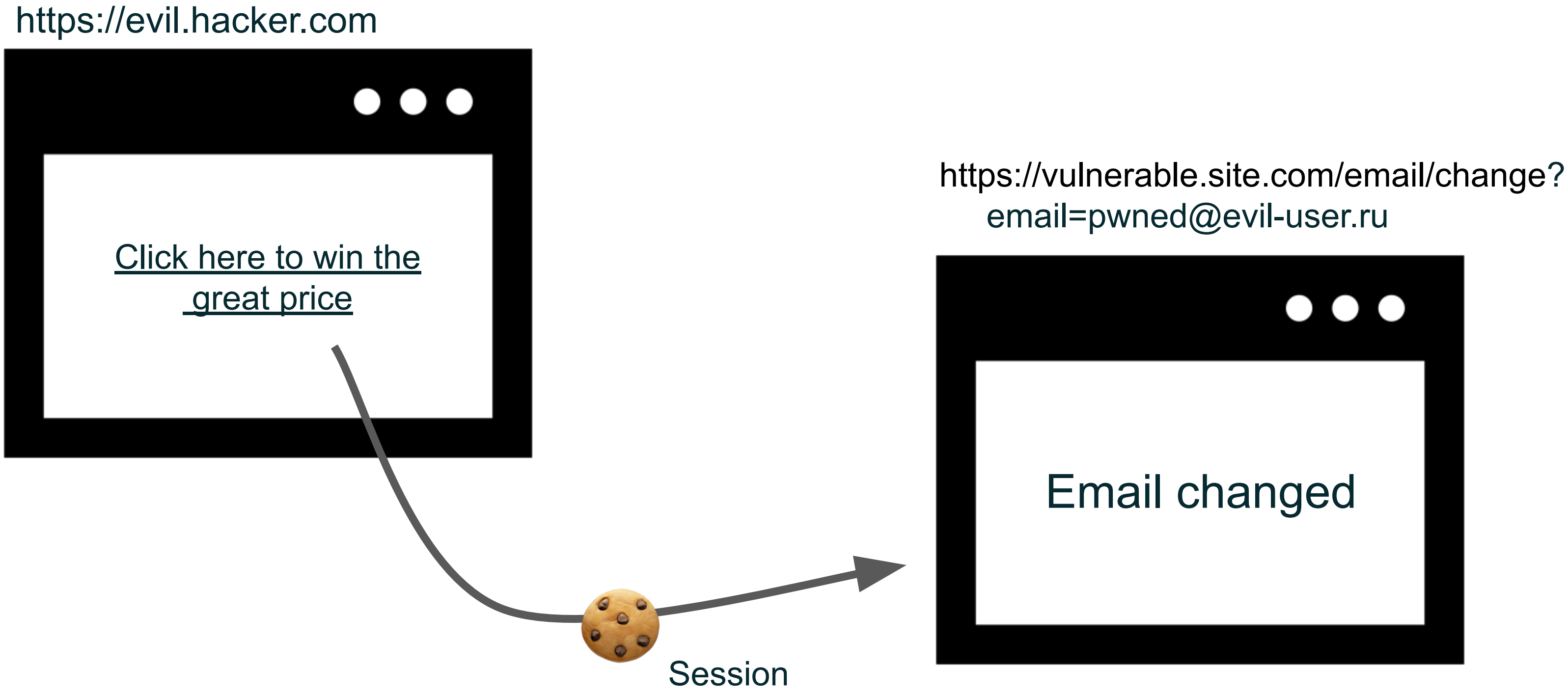
What is CSRF

CSRF stands for Cross-Site Request Forgery. It's a type of malicious exploit of a website where unauthorized commands are transmitted from a user that the website trusts. In a CSRF attack, an innocent end user is tricked by an attacker into submitting a web request that they did not intend.

```
https://vulnerable.site.com/email/change?email=pwned@evil-user.net
```

What is CSRF

The user was previous logged in to the vulnerable site, so the session cookie is send with the request



https://evil.hacker.com

Click here to win the great price

Session

https://vulnerable.site.com/email/change?
email=pwned@evil-user.ru

Email changed

In a CSRF attack, an innocent end user is tricked by an attacker into submitting a web request that they did not intend.

Cross-Site Request Forgery In Action

What is CSRF

For example, suppose an application contains a function that lets the user change the email address on their account. When a user performs this action, they make an HTTP request like the following:

```
POST /email/change HTTP/1.1
Host: vulnerable-website.com
Content-Type: application/x-www-form-urlencoded
Content-Length: 30
Cookie: session=yvthwsztyeQkAPzeQ5gHgTvlyxHfsAfE

email=peter@mysite.com
```

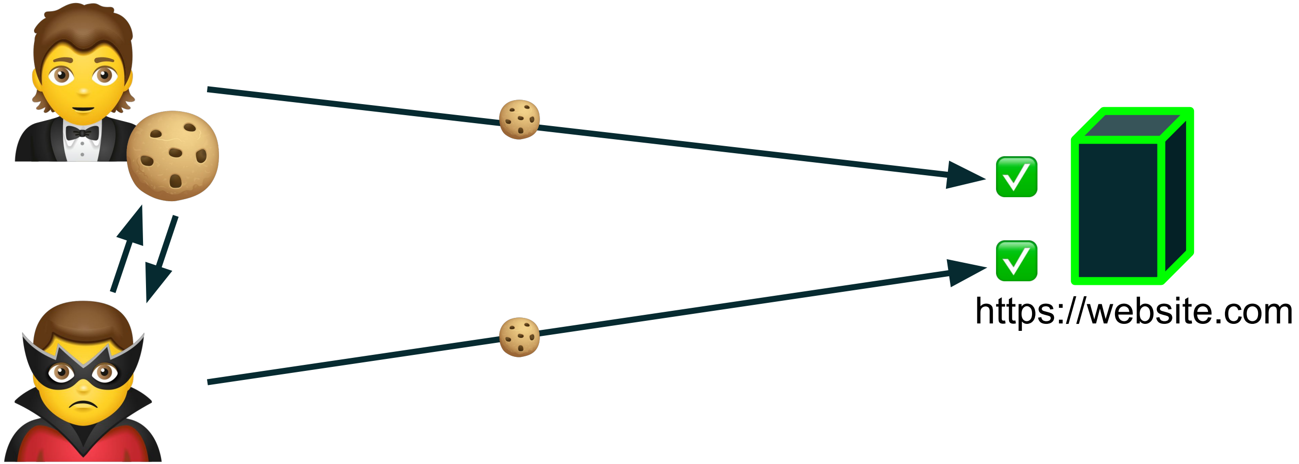
What is CSRF

With these conditions in place, the attacker can construct a web page containing the following HTML

```
<html>
    <body>
        <form action="https://vulnerable-website.com/email/change" method="POST">
            <input type="hidden" name="email" value="pwned@evil-user.ru" />
        </form>
        <script>
            document.forms[0].submit();
        </script>
    </body>
</html>
```

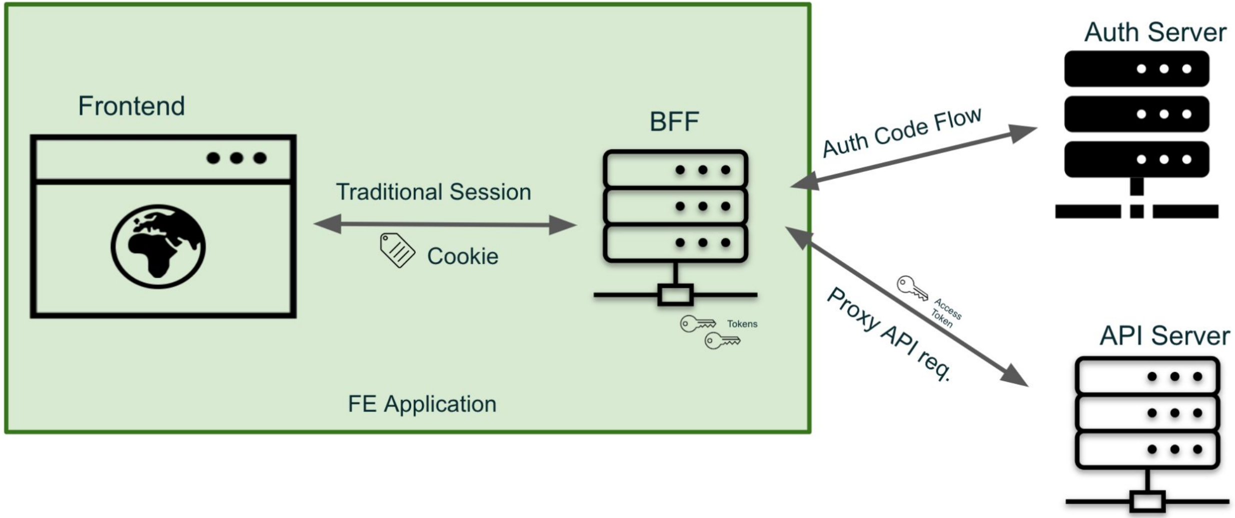
Why does a CSRF attack work?

- Browsers automatically send cookies
  - Also session cookies
- When user is authenticated
  - Site cannot distinguish between legitimate requests and forged requests



https://cheatsheetseries.owasp.org/cheatsheets/Cross-Site_Request_Forgery_Prevention_Cheat_Sheet.html

Remember our Backend for Frontend (BFF)



Cookies are used to handle the session management,
so inherently a naive BFF its vulnerable to CSRF attacks.

Real life attack examples

- **ING direct (2008)**: allowed elicit money transfers
- Paypal (2016): attacker can change a users profile without permission (more)
- **Moodle (2020)**: A popular open-source Learning Management System, was found to have a CSRF vulnerability that could allow an attacker to change a user's password.
- **Fortinet FortiOS (2021)**: A CSRF vulnerability was discovered that could allow an attacker to perform administrative operations without the user's consent.
- **OkCupid (2021):** Vulnerability in dating site OkCupid could be used to trick users into ‘liking’ or messaging other profiles (more)
- **Grafana (2022):** Vulnerability which allows anonymous attackers to elevate their privileges (more)

How can we stop CSRF attacks

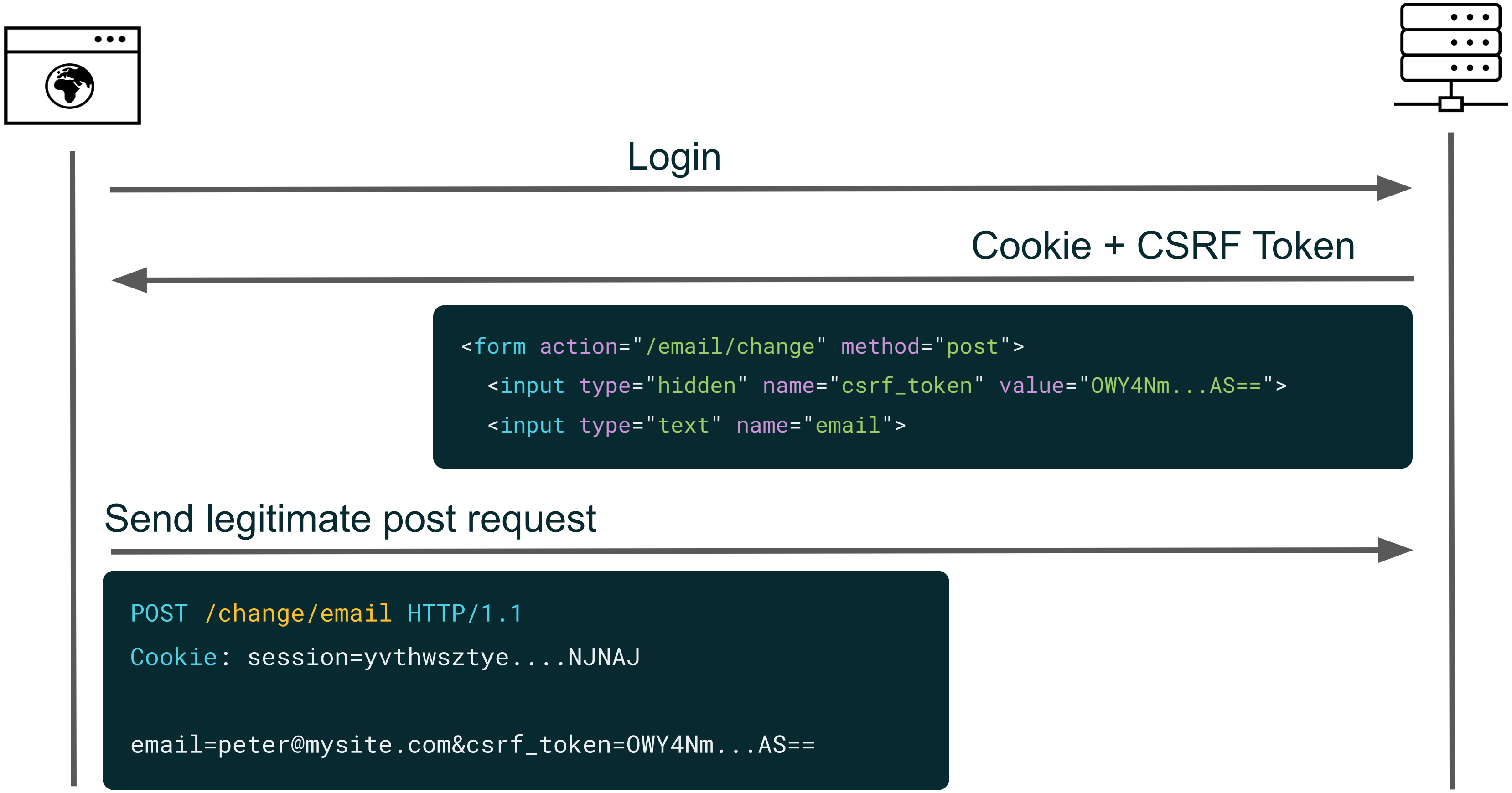
Defences for CSRF

- Logging off web applications when not in use (logoff after inactivity)
- Traditional Applications (php, webforms, mvc)
  - Synchronizer Token Pattern
  - Double-Submit Cookie Pattern
- SameSite Cookie
- SOP & Cross-Origin Resource Sharing (CORS)

CSRF Defences

Synchronizer Token

CSRF Defence - Synchronizer Token



Login

Cookie + CSRF Token

```
<form action="/email/change" method="post">
  <input type="hidden" name="csrf_token" value="OWY4Nm...AS==">
  <input type="text" name="email">
```

Send legitimate post request

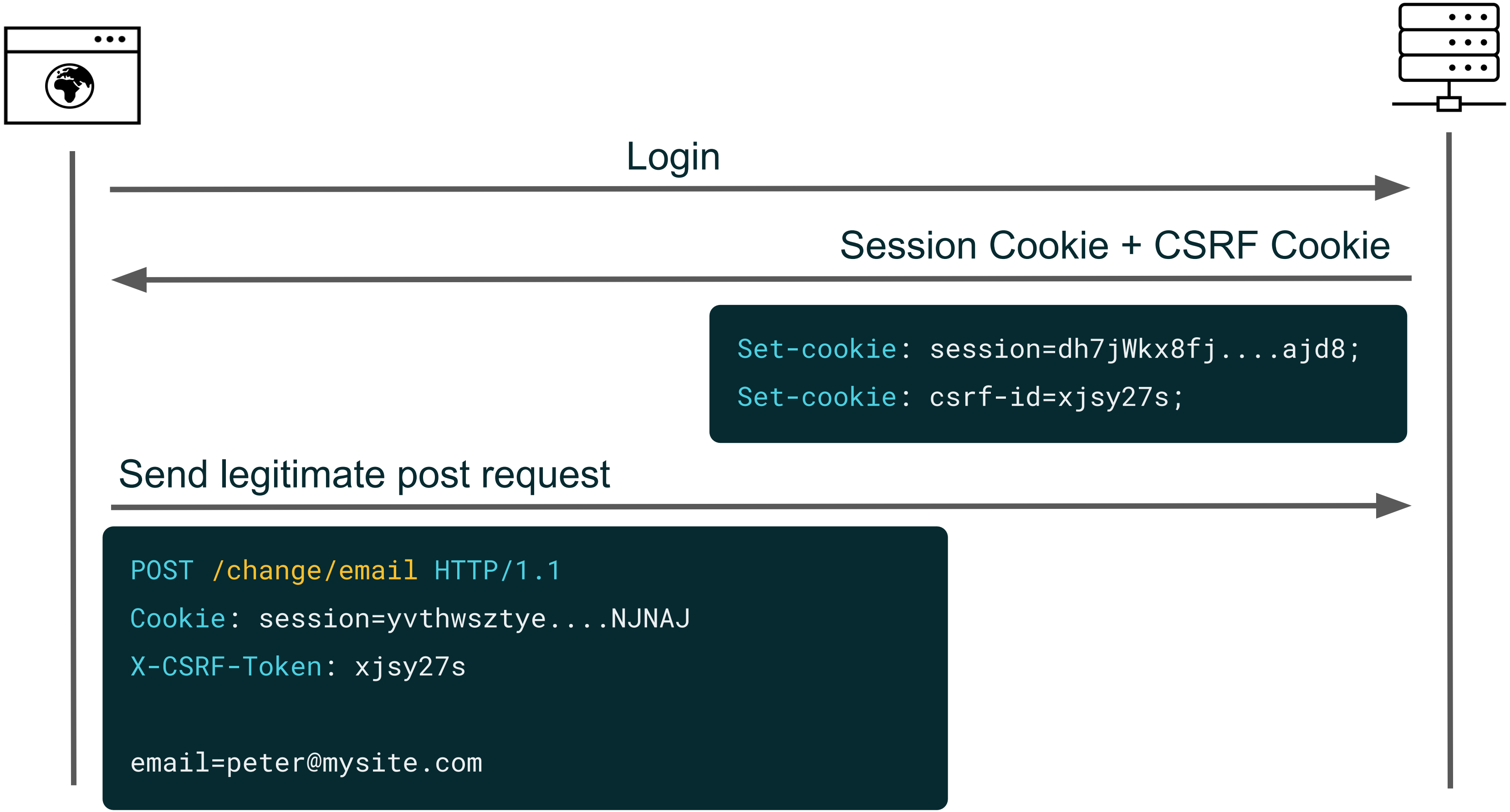
```
POST /change/email HTTP/1.1
Cookie: session=yvthwsztye....NJNAJ

email=peter@mysite.com&csrf_token=OWY4Nm...AS==
```

Preventing CSRF by Synchronizer token

CSRF Defences

Double-Submit Cookie

CSRF Defence - Double-Submit Cookie



Login

Session Cookie + CSRF Cookie

```
Set-cookie: session=dh7jWkx8fj....ajd8;
Set-cookie: csrf-id=xjsy27s;
```

Send legitimate post request

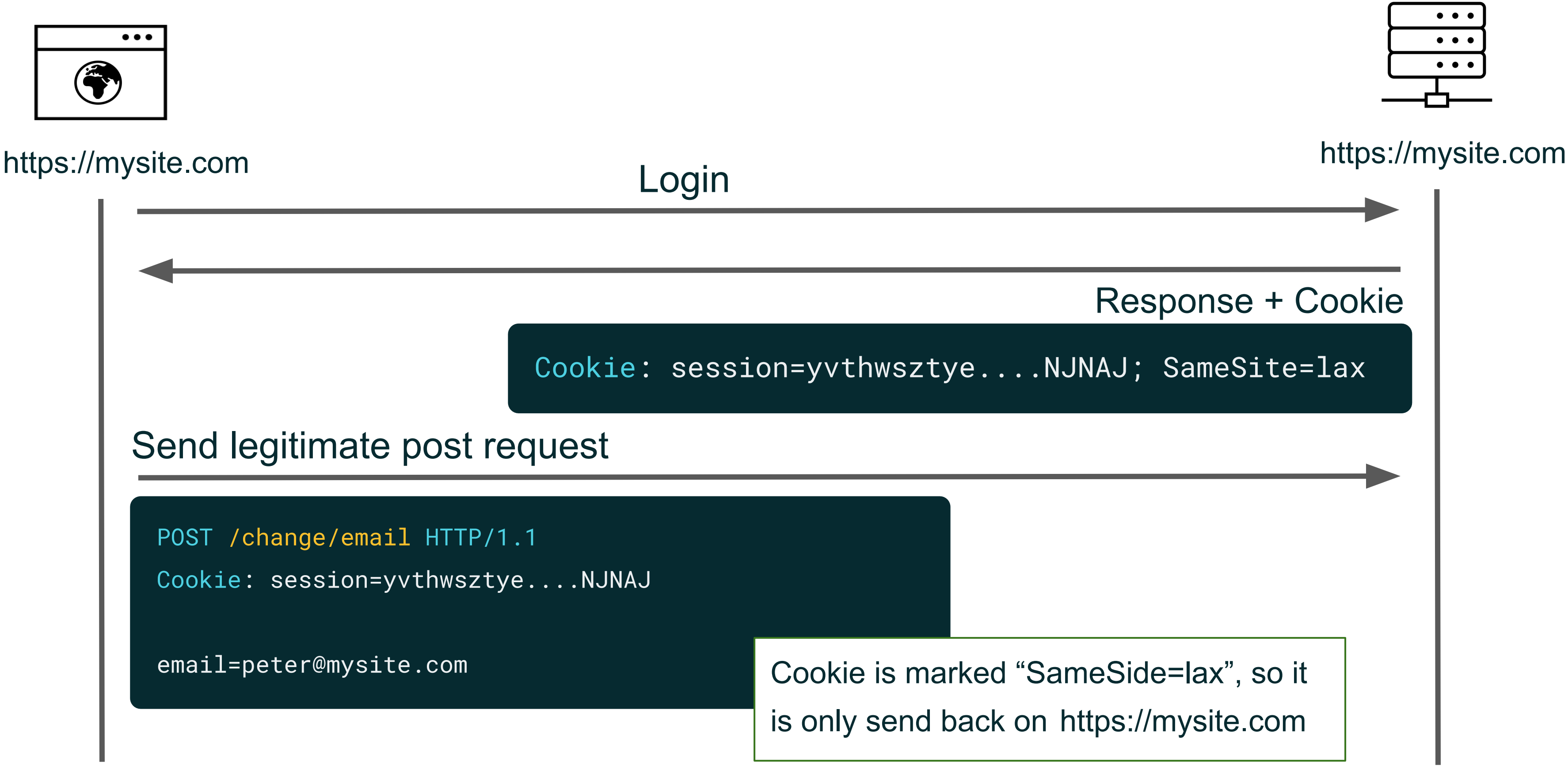
```
POST /change/email HTTP/1.1
Cookie: session=yvthwsztye....NJNAJ
X-CSRF-Token: xjsy27s

email=peter@mysite.com
```

Preventing CSRF by Double-Submit Cookie

CSRF Defences

SameSite Cookie

CSRF Defence - SameSite cookie

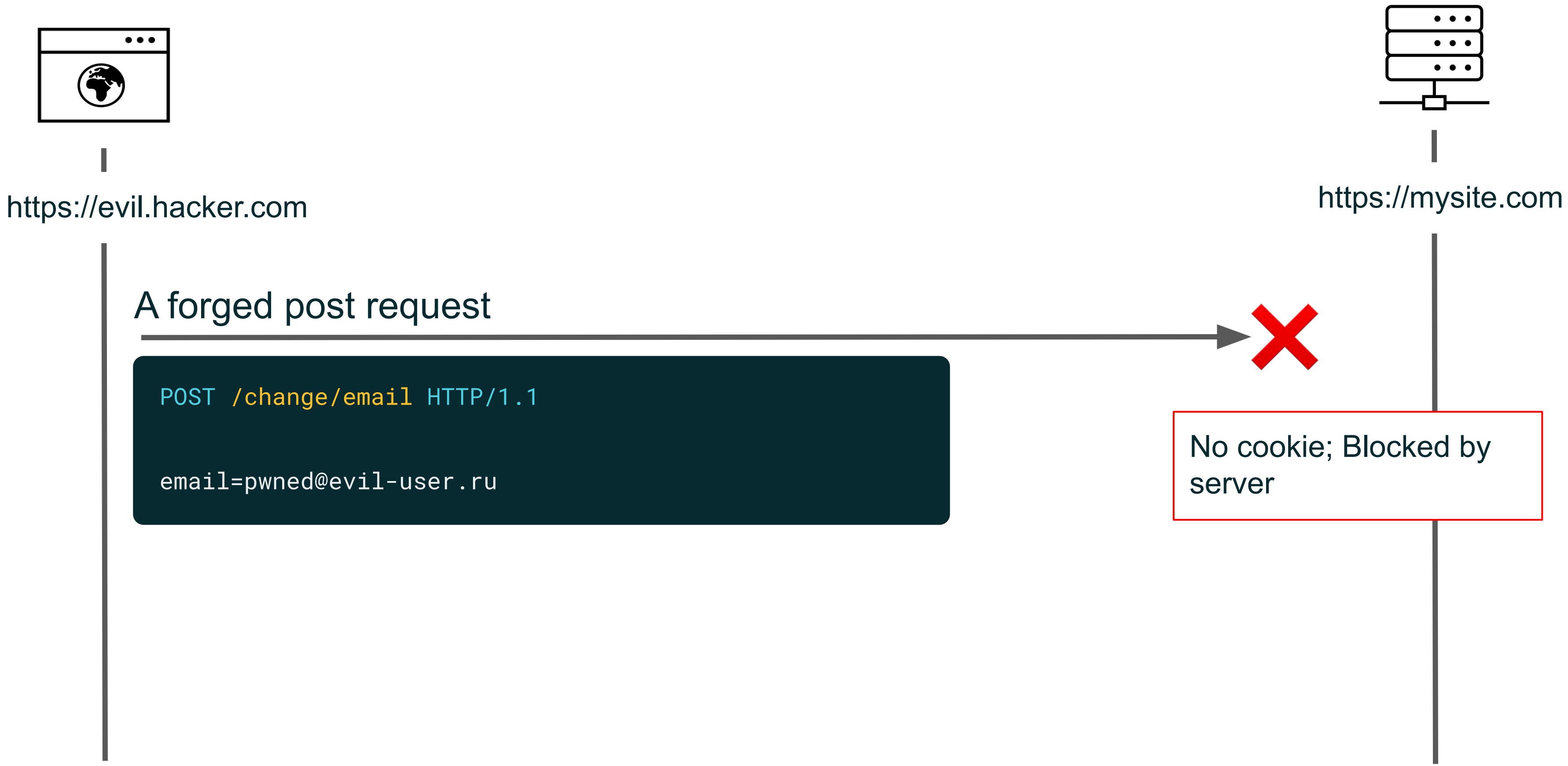


```
Cookie: session=yvthwsztye....NJNAJ; SameSite=lax
```

```
POST /change/email HTTP/1.1
Cookie: session=yvthwsztye....NJNAJ

email=peter@mysite.com
```

Cookie is marked “SameSide=lax”, so it is only send back on https://mysite.com

CSRF Defence - SameSite cookie



https://evil.hacker.com

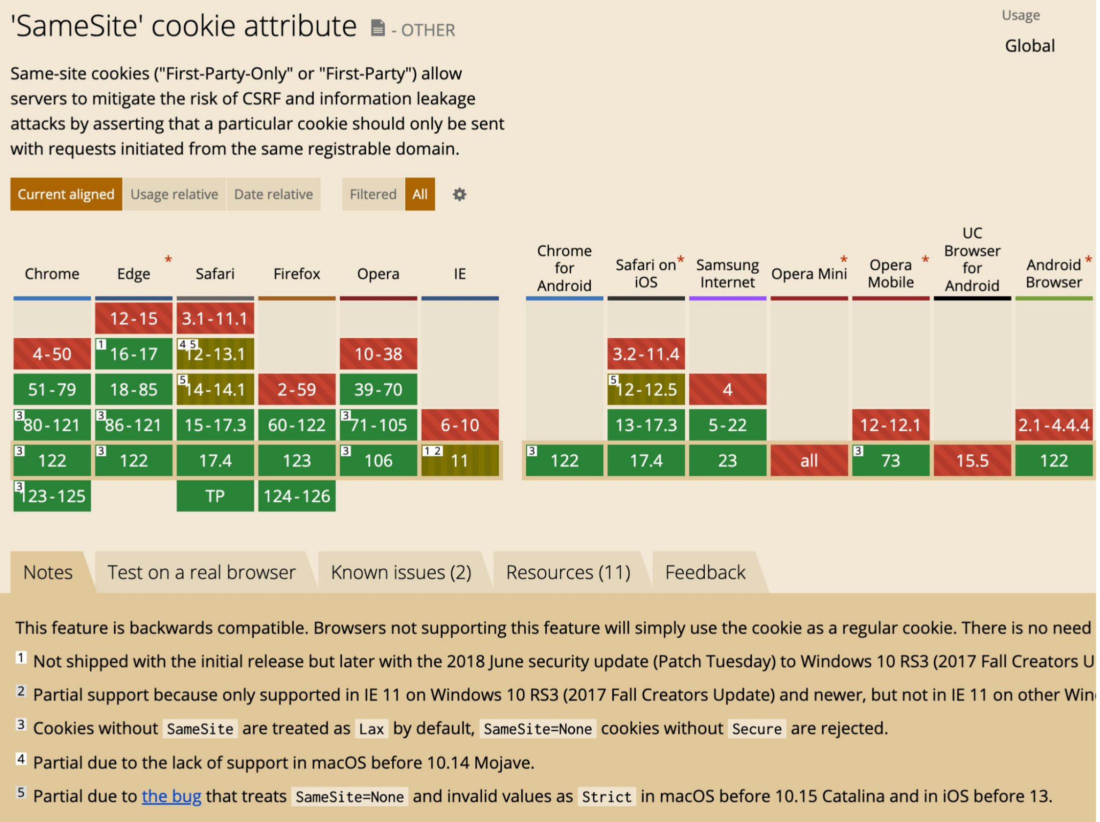
https://mysite.com

A forged post request

```
POST /change/email HTTP/1.1

email=pwned@evil-user.ru
```

No cookie; Blocked by server

SameSite cookie support



'SameSite' cookie attribute - OTHER

Usage

Global

Same-site cookies ("First-Party-Only" or "First-Party") allow servers to mitigate the risk of CSRF and information leakage attacks by asserting that a particular cookie should only be sent with requests initiated from the same registrable domain.

Chrome	Edge *	Safari	Firefox	Opera	IE	Chrome for Android	Safari on iOS *	Samsung Internet	Opera Mini *	Opera Mobile *	UC Browser for Android	Android Browser *
	12-15	3.1-11.1										
4-50	[1] 16-17	[4 5] 12-13.1		10-38			3.2-11.4					
51-79	18-85	[5] 14-14.1	2-59	39-70			[5] 12-12.5	4				
[3] 80-121	[3] 86-121	15-17.3	60-122	[3] 71-105	6-10		13-17.3	5-22		12-12.1		2.1-4.4.4
[3] 122	[3] 122	17.4	123	[3] 106	[1 2] 11	[3] 122	17.4	23	all	[3] 73	15.5	122
[3] 123-125		TP	124-126									

This feature is backwards compatible. Browsers not supporting this feature will simply use the cookie as a regular cookie. There is no need

[1] Not shipped with the initial release but later with the 2018 June security update (Patch Tuesday) to Windows 10 RS3 (2017 Fall Creators U

[2] Partial support because only supported in IE 11 on Windows 10 RS3 (2017 Fall Creators Update) and newer, but not in IE 11 on other Win

[3] Cookies without `SameSite` are treated as `Lax` by default, `SameSite=None` cookies without `Secure` are rejected.

[4] Partial due to the lack of support in macOS before 10.14 Mojave.

[5] Partial due to the bug that treats `SameSite=None` and invalid values as `Strict` in macOS before 10.15 Catalina and in iOS before 13.

Preventing CSRF by SameSite Cookie

CSRF Defences

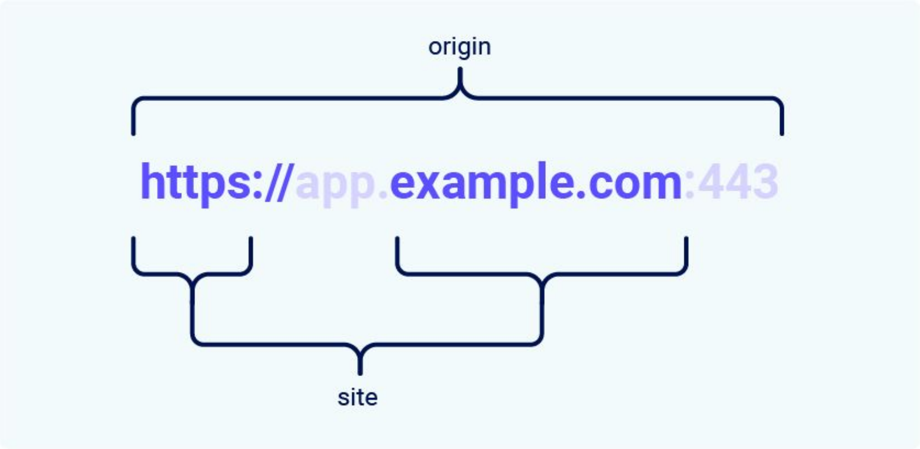
SOP & Preflight

Origin, SOP & CORS

- **Origin**: Web content's origin is defined by the scheme (protocol), hostname (domain), and port of the URL used to access it.

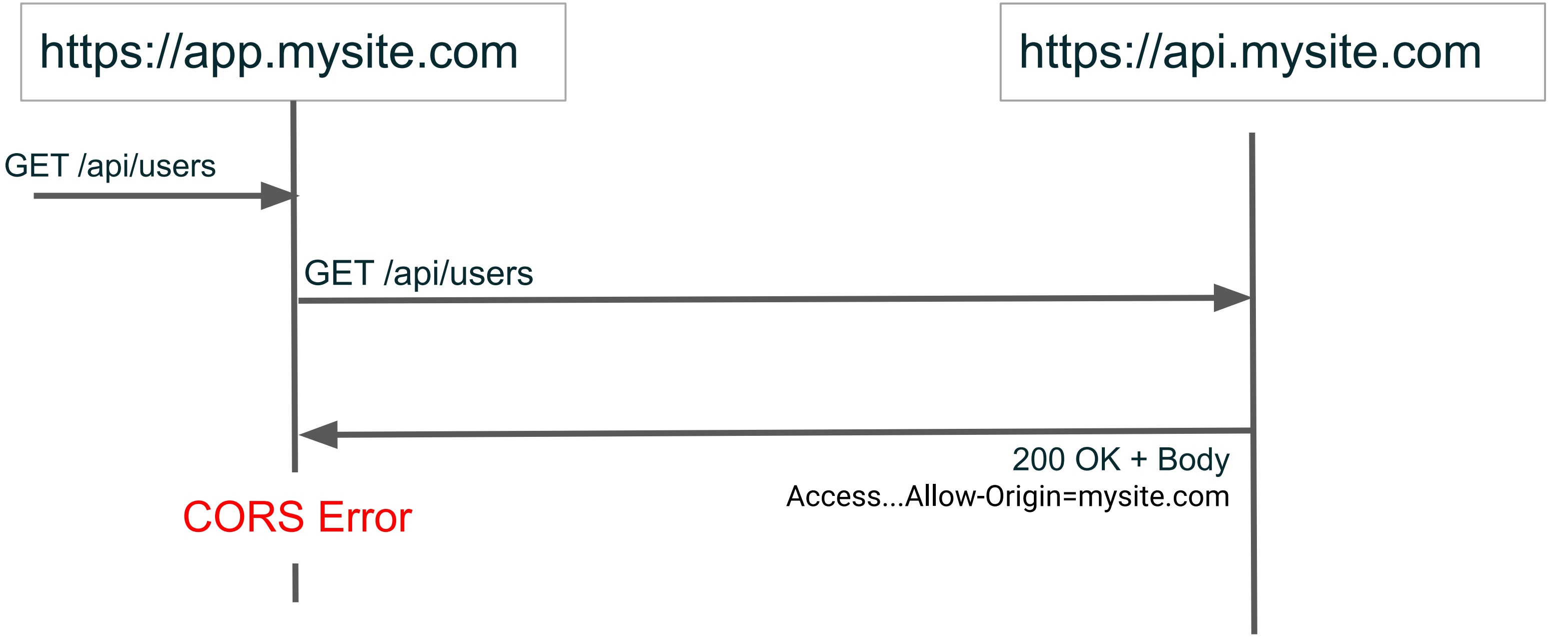
- **SOP**: Same Origin Policy : SOP restricts web resources from being accessed across different origins

- **CORS**: Cross Origin Resources Sharing : Allows web resources to be accessed across different origins with appropriate permissions



https://portswigger.net/web-security/csrf/bypassing-samesite-restrictions

Simple Request



https://app.mysite.com

https://api.mysite.com

GET /api/users

GET /api/users

200 OK + Body
Access...Allow-Origin=mysite.com

CORS Error

SOP doesn’t block simple requests (GET, HEAD) but the browser reject reading of the response body.

Simple Request

In the context of Same Site Origin, simple requests refer to certain types of HTTP requests that are considered "**safe**" and do not trigger a preflight request when they're made across origins. Simple requests must meet the following criteria:

- **They use only GET, HEAD, or POST methods**

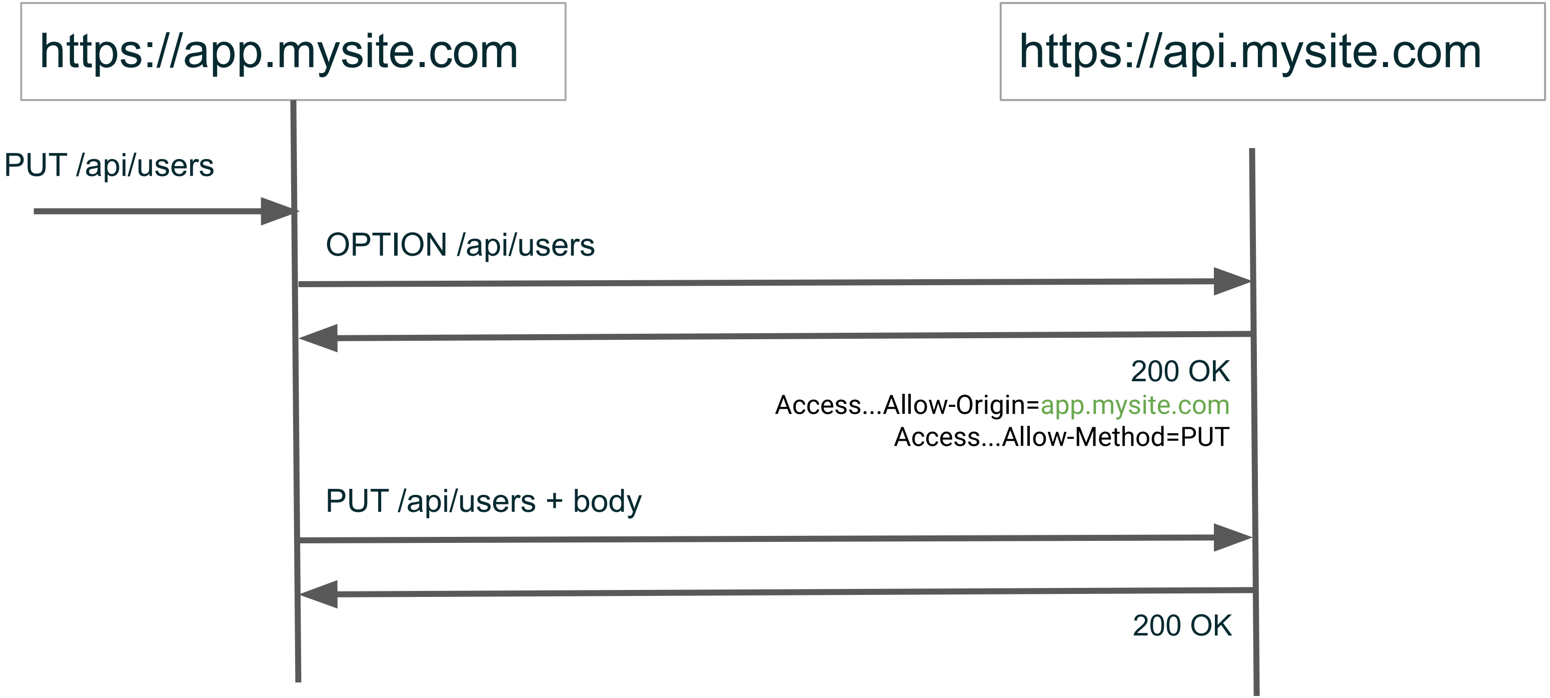
- **If the POST method is used, then the `Content-Type` should be one of the following: `` `application/x-www-form-urlencoded’ ``, `` `multipart/form-data’ ``, or `‘text/plain’`**

- **Only using simple headers (content-type, accept, …)**

- **Not using content type `application/json`**

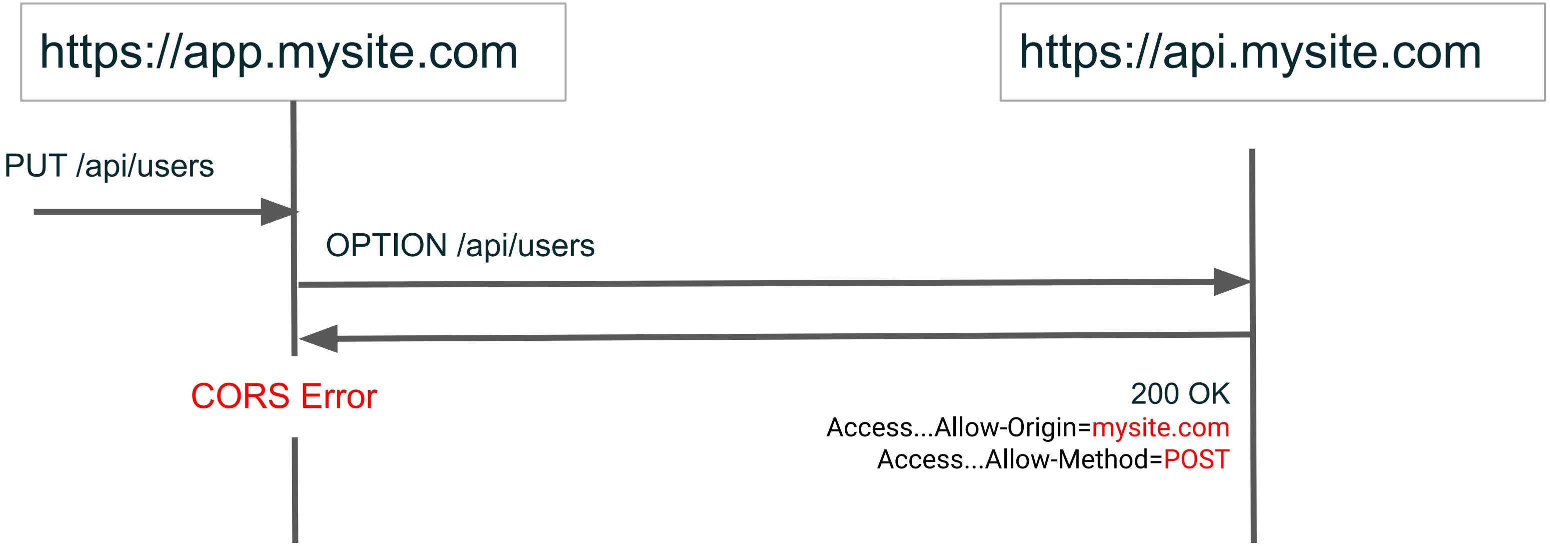
Simple requests are considered “safe”

None Simple Request (success)



The browser sends a preflight request to understand what (non-simple/unsafe) requests the source allows. If the server allows it the browser continues with the actual request.

None Simple Request (failed)



https://app.mysite.com

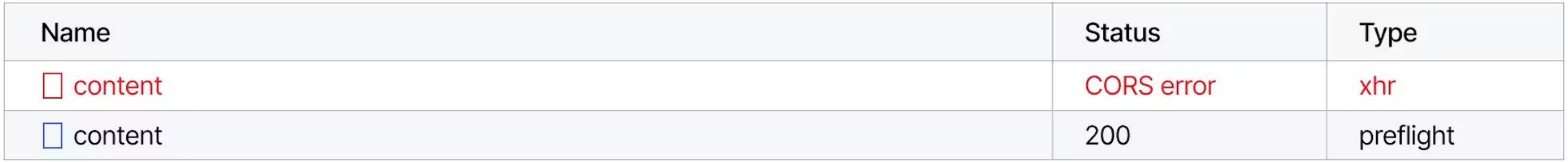
https://api.mysite.com

PUT /api/users

OPTION /api/users

CORS Error

200 OK
Access...Allow-Origin=mysite.com
Access...Allow-Method=POST



Name	Status	Type
□ content	CORS error	xhr
□ content	200	preflight

The browser sends a preflight request to understand what (non-simple/unsafe) requests the source allows.

None Simple Request

Non simple requests refer to certain types of HTTP requests that are considered "**unsafe**" and **trigger a preflight** request when they're made across origins.

- **They use PUT, DELETE, or POST methods.**
- **Requests with custom headers (none simple headers)**
- **Requests with content type `application/json`.**

Preventing CSRF by Same Origin Policy (SOP)

Mitigation for CSRF

- **Synchronizer Tokens** and **Double Submit Cookie** are a good CSRF defence. By requiring the browser to submit a secret token alone with the requested data the backend can identify and reject illegal requests.
- **Same-site** cookies neutralize CSRF. SiteSite cookies are not included in cross-site requests. But they do not protect against Cross Origin Request Forgery.
- If you set your **CORS** policy to only accept requests from trusted domains, it can prevent CSRF attacks originating from malicious websites.

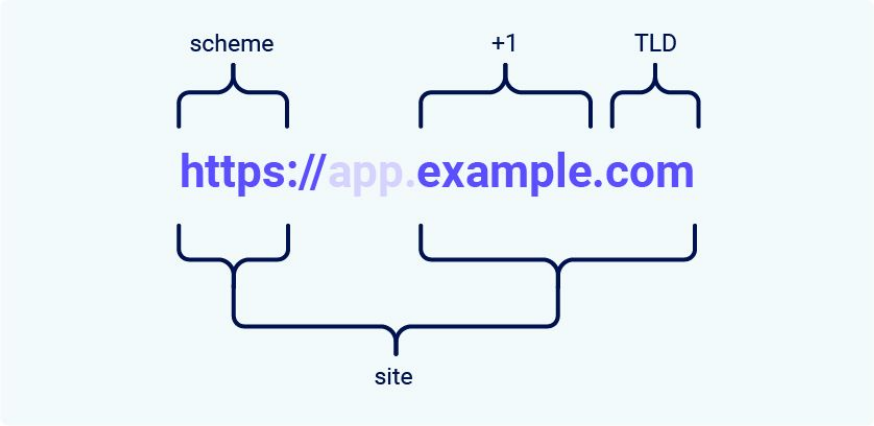
So are we safe now?

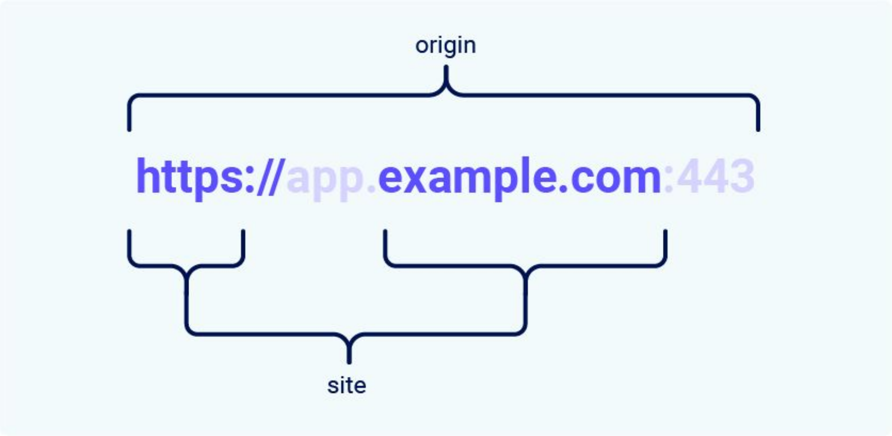
Not yet, sorry

CSRF Defences

Block FORM posting
&
Strict Content-type

Same Site cs Same Origin





The **SameSite cookie** restrictions relates to the **site.** Multiple sub domains are considered as the same site.

Do we trust all subdomains? 🤔

https://portswigger.net/web-security/csrf/bypassing-samesite-restrictions

Same Site != Same Origin

Is SOP not handling this?

Yes, Same Origin Policy (SOP) is blocking all Cross Origin resource requests.

But …

Submitting data FORM post

Form POST Request

```
POST /email/change HTTP/1.1
Host: vulnerable-website.com
Content-Type: application/x-www-form-urlencoded
Content-Length: 30
Cookie: session=yvthwsztye

email=peter@mysite.com
```

Empty POST Request

```
POST /passw/reset HTTP/1.1
Host: vulnerable-website.com
Cookie: session=yvthwsztye
```

SOP is not helping here 🙄

Submitting data fetch - nocors

Fetch with mode=”no-cors”

```
fetch('https://mysite.com/api/change', {
  mode:  'no-cors'
  method: 'POST',
  headers: {
    'Content-Type': 'application/json'
  },
  body: JSON.stringify({
    email: 'peter@mysite.com'
  })
})
```

SOP is not helping here, either 🙄

Improper Content-Type validation == a vulnerability

Accept Form URL Encoded values

```
const app = express();
app.use(express.urlencoded());
app.use(express.json());
```

Accept all content types

```
const app = express();
app.use(express.json({ type: "*/*" })
```

SOP is for scripts, so make sure you block form post 🤔

Strict Content-Type verification

CSRF Defences

CORS
&
Custom Header

An empty POST request is a simple request!

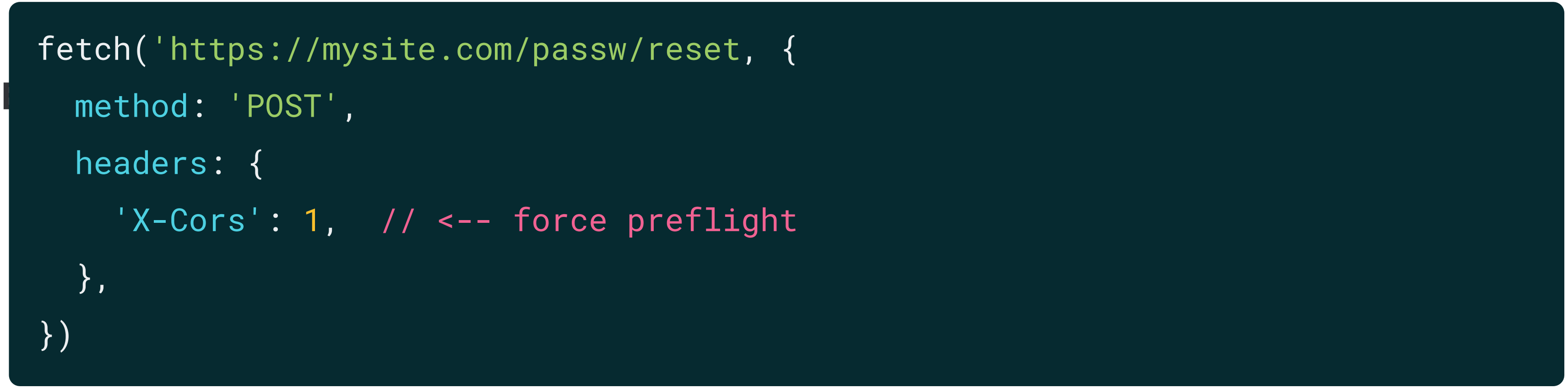
Empty POST Request

```
POST /passw/reset HTTP/1.1
Host: vulnerable-website.com
Cookie: session=yvthwsztye
```

An empty post is simple request, so no preflight. 🙄

Block all simple requests

Enforcing CORS (preflight) for all API routes



```
fetch('https://mysite.com/passw/reset, {
  method: 'POST',
  headers: {
    'X-Cors': 1,  // <-- force preflight
  },
})
```

- Add a custom header (any header)
- This triggers a pre-flight for any cors origin request
- Enforce at the server for every endpoint

NextJS & the Duende BFF framework using this techniek to protect local endpoints

So are we safe now?

🥳 Yes, thats it 🎉

Key takeaways

Key takeaways

Cross-Site Scripting (XSS) can defeat all CSRF mitigation techniques!

CSRF Matters when you rely on cookies for authentication

SameSite cookie mitigate CSRF, but not Cross **Origin** Request Forgery (CORF)

API can rely on CORS as a defence against Cross Origin Request Forgery

Further reading

- Robust defenses for cross-site request forgery.
- Portswigger - Cross-site request forgery (CSRF)
- HackTricks - Cross Site Request Forgery
- NCC group - Common CSRF prevention misconceptions
- The Past, Present, and Future of Cross-Site/Cross-Origin Request Forgery by Dr Philippe De Ryck
- Comparing the BFF Security architecture with an SPA using a public API by damienbod.
- Common no-cors misconceptions