Web security

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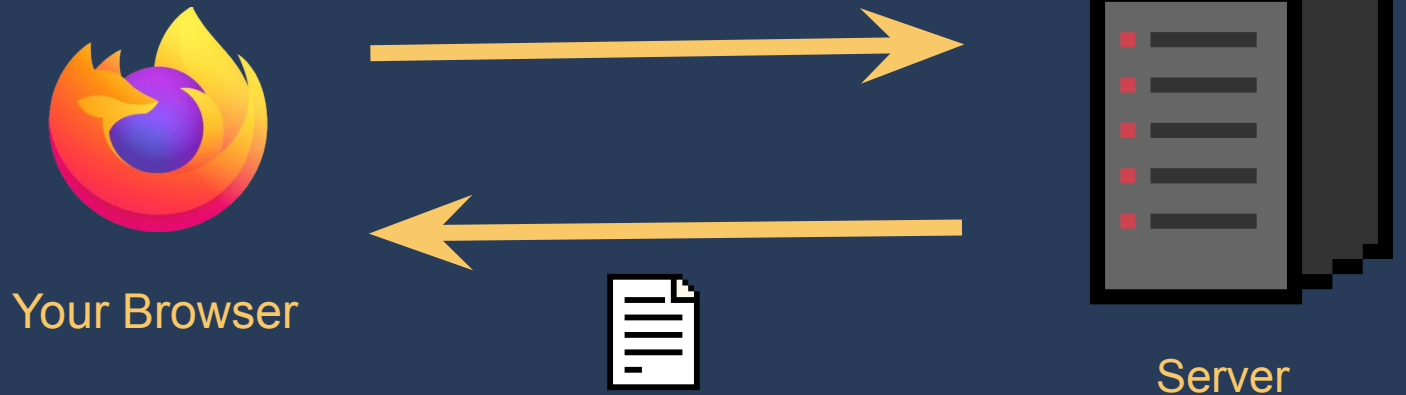
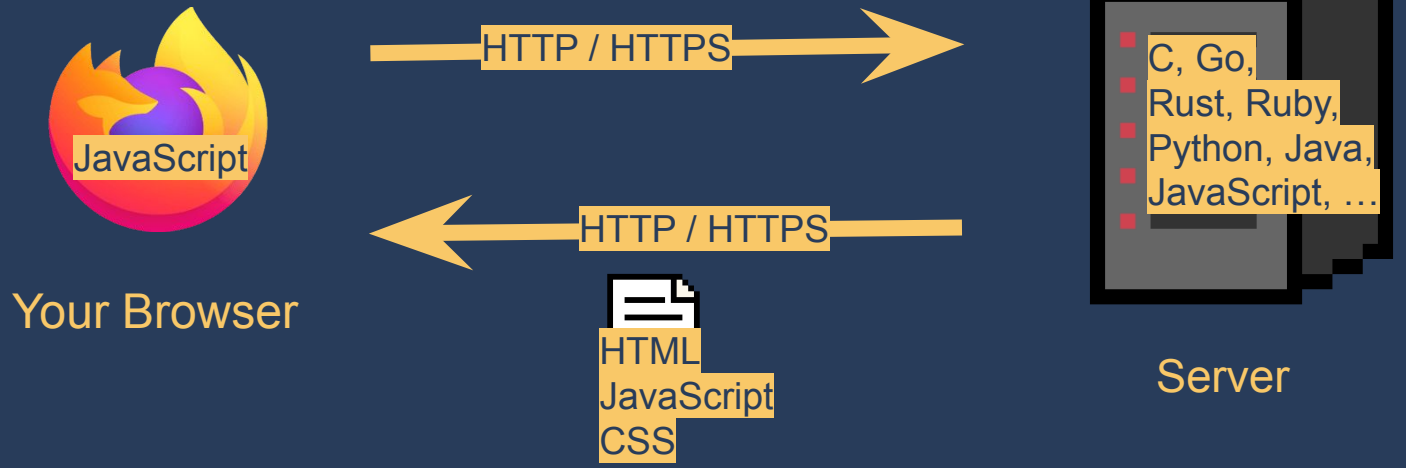
Overview

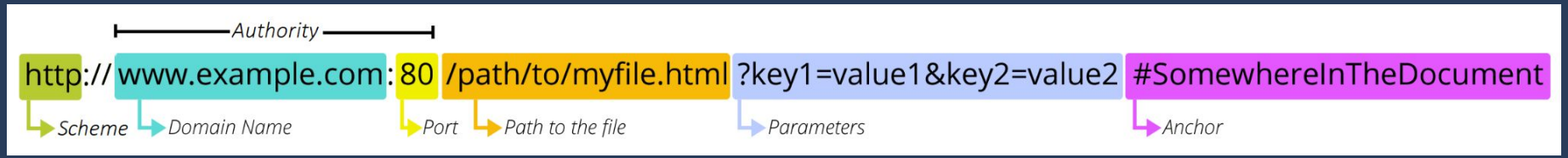


Overview


JavaScript
HTTP / HTTPS
HTTP / HTTPS
C, Go,
Rust, Ruby,
Python, Java,
JavaScript, …
Your Browser
HTML
JavaScript
CSS
Server

URL

- Protocol (scheme)
- Domain name / IP
- Port (usually 80 or 443)
- Path to file
- Parameters (query)
- Anchor (client-side)



HTTP (HyperText Transfer Protocol)

- Request-response protocol
  - Send request
  - Get response

Requests

Request

```
GET /hello.html?q=something HTTP/1.1
Host: example.com
Content-Length: 5
Content-Type: application/x-www-form-urlencoded
Accept-Language: en-us
Accept-Encoding: gzip, deflate

hello
```

Request Line

- Method - GET
- Request URI - /hello.html?q=something
- HTTP version - HTTP/1.1

HTTP Methods

- GET, HEAD, POST, PUT, DELETE, CONNECT, OPTIONS, TRACE, PATCH…
- GET and POST most used
- GET
  - Used to request data
  - Content can be cached by browser and proxy
  - Should not be used for sensitive data
- POST
  - Content is not cached
  - Used for handling sensitive data
  - Your password is sent using POST request

Requests

Request

```
GET /hello.html?q=something HTTP/1.1
Host: example.com
Content-Length: 5
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hello
```

Headers

- Key-Value pairs

Requests

Request

```
GET /hello.html?q=something HTTP/1.1
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Content-Length: 5
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Accept-Language: en-us
Accept-Encoding: gzip, deflate

hello
```

Body

- Extra data
- Example: POST requests can contain password here

Responses

Response

```
HTTP/1.1 200 OK
Date: Mon, 27 Jul 2009 12:28:53 GMT
Server: Apache/2.2.14 (Win32)
Last-Modified: Wed, 22 Jul 2009 19:15:56 GMT
Content-Length: 88
Content-Type: text/html
Connection: Closed

<html>
<body>
<h1>Hello, World!</h1>
</body>
</html>
```

Status Line

- HTTP version + status code
- Contains a status code
  - 1xx - Information
  - 2xx - OK (success)
  - 3xx - Redirection
  - 4xx - Client side error
  - 5xx - Server side error

Full List

Responses

Response

```
HTTP/1.1 200 OK
Date: Mon, 27 Jul 2009 12:28:53 GMT
Server: Apache/2.2.14 (Win32)
Last-Modified: Wed, 22 Jul 2009 19:15:56 GMT
Content-Length: 88
Content-Type: text/html
Connection: Closed

<html>
<body>
<h1>Hello!</h1>
</body>
</html>
```

Headers

- Same as for requests
- Responses and Requests share some headers
- There are request-unique headers and response-unique headers

Problems
GET aHEAD

Responses

Response

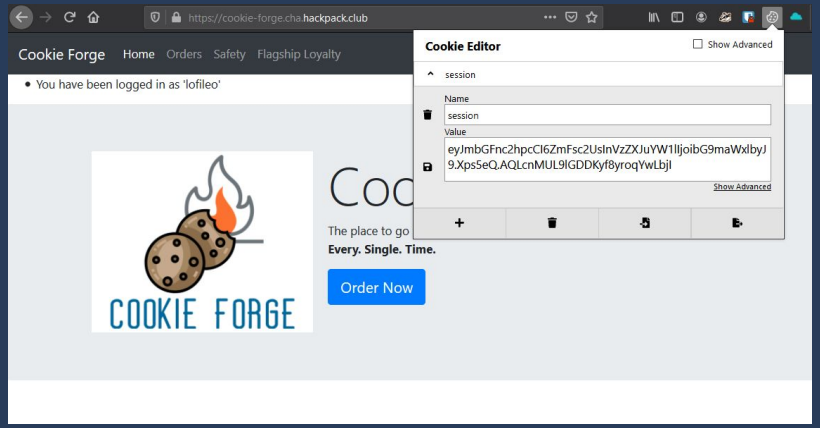
```
HTTP/1.1 200 OK
Date: Mon, 27 Jul 2009 12:28:53 GMT
Server: Apache/2.2.14 (Win32)
Last-Modified: Wed, 22 Jul 2009 19:15:56 GMT
Content-Length: 88
Content-Type: text/html
Connection: Closed

<html>
<body>
<h1>Hello!</h1>
</body>
</html>
```

Body

- Same as for requests - contains data
- In this case, HTML data for browser to display!

HTTP Cookies

- Stores information about a user
- Authentication cookies
- Tracking cookies
- Cookie Headers
  - Response: Set-Cookie: session=secret
  - Request: Cookie: session=secret



Problems

[Cookies]
[Logon]
[Power Cookie]

HTML (HyperText Markup Language)

```
<html>
    <body>
        <h1>Hello!</h1>
    </body>
</html>
```

HTML Code

Browser

- Consists of tags
- Tags can have attributes

```
<img src="cat.png" width="200" height="300">
```

- Usually a tag has an opening and a closing tag, but some does not.

Problems
[Insp3ct0r](#)
[Scavenger Hunt](#)

HTML (HyperText Markup Language)

- CSS (Cascading Style Sheets) - makes the HTML beautiful

Without CSS

With CSS

Can also be used to exfiltrate data!

Vulnerabilities - Injections

- General type of vulnerability
- Can appear in many different contexts

Vulnerabilities - Injections

- When code and data are mixed, injections can happen
- Command injection example:

```
os.system("convert " + path + " profile.png")
```

- Data can be treated as code:

```
os.system("convert --help; evil-cmd; # profile.png")
```

- Separate code and data
- Be very strict about the data

```
if not safePath(path):
    throw Exception("bad")
os.system("convert %s profile.png" % path)
```

Vulnerabilities

- There are many types of vulnerabilities
- Too many to go through them all in detail
- Links so you can read more on your own

Vulnerabilities

- Client Side
  - XSS - Cross Site Scripting
  - CSRF - Cross Site Request Forgery
  - …
- Server side
  - SQL injection
  - Command Injection
  - Deserialization
  - Path Traversal
  - SSRF - Server Side Request Forgery
  - SSTI - Server Side Template Injection
  - XXE - XML External Entity
  - …
- Conclusion: user input is dangerous!

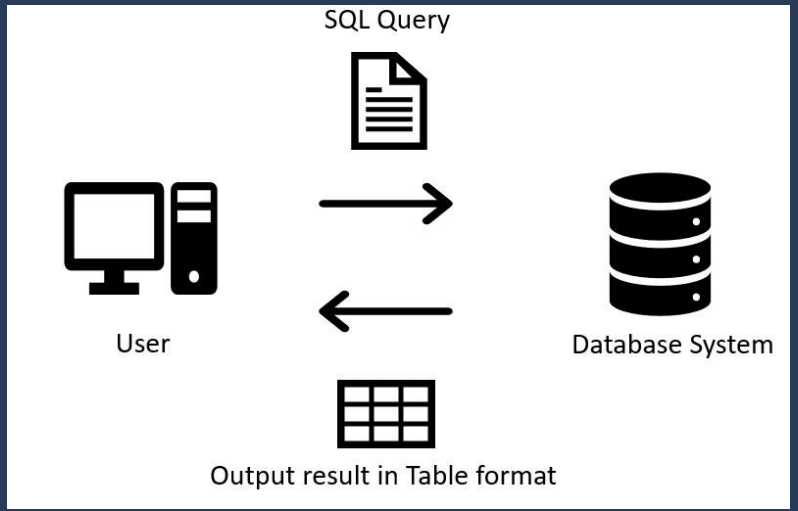
Tooling

- Burp Suite / Caido
- Python `requests`
- curl
- Developer console (CTRL + SHIFT + i or F12)
- Ngrok
- webhook.io / requestrepo.com
- SQLMap

Caido Demo

SQL

- SQL - language used to access and manipulate databases
- DML - Data Manipulation statements
  - SELECT, INSERT, UPDATE, DELETE
  - Ex: SELECT * FROM MyTable
- DDL - Data Definition statements
  - CREATE, ALTER, DROP, TRUNCATE
  - Ex: CREATE TABLE Persons (ID int, Name varchar(255));



Problems
[SQL Direct]

SQL Injections (SQLi)

- Execute SQL scripts on the server that steals information from the server
- Examples
  - Authentication forms
  - Search engines
  - E-Commerce sites
  - Blog
  - Anything with SQL database

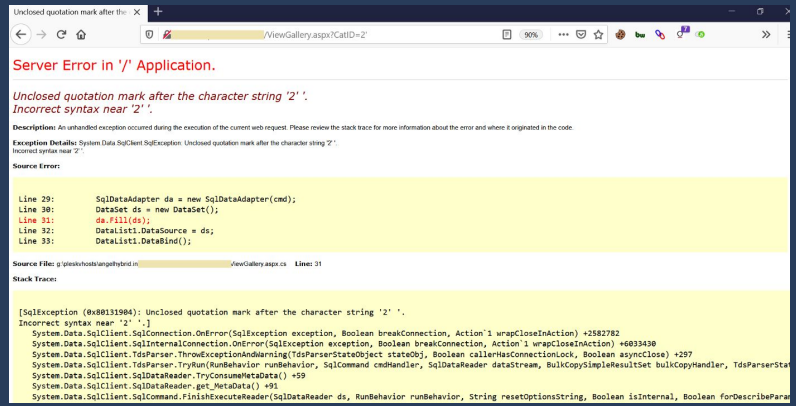

```
sqlQuery("SELECT info FROM products WHERE name='"+input+"'")
```

Approach

- Detect
- Fingerprint
- Enumerate
- Exploit

Error based SQLi

- Utilizes the error output
- Verification and exploitation
  - Break out of SQL query statements using for example single-quotes, double-quotes, backticks or semi-colons in the input field
  - Look for any error-messages or misbehavior in the application



How to detect SQLi

- Different injection points

```
SELECT info FROM products WHERE name='text'
```

```
SELECT info FROM products WHERE name="text"
```

- Detect with `'te'||'xt'`

```
SELECT info FROM products WHERE id=number
```

- Detect with `2+2`

Logic based SQLi

- Input field is **LOGIN** and query is **SELECT * FROM Table WHERE username = '';**
  - **' OR '1**
  - **' OR 1 --**
  - **" OR "" = "**
  - **'LIKE'**
  - **'='**

Union based SQLi

```
SELECT title, text FROM news WHERE id=0
```

Breaking News
Something something

```
SELECT title, text FROM news WHERE id=0 UNION SELECT 'a', 'b'
```

Breaking News
Something something

a
b

Union based SQLi

```
SELECT title, text FROM news WHERE id=0
UNION SELECT username, password FROM users
```

Breaking News
Something something

alice
password123

bob
coolcool

Very powerful type of SQLi!

Blind SQLi

- No error message is displayed by the application but its behaviour changes
- Boolean-based
  - Result varies depending on whether the sql-query is true or false
  - Ex. error message when login in disappear when we inject our payload
- Time-based
  - Sql-query that makes the database wait before returning the result. The difference in time can be used to leak data.

SQLi problems

- SQLiLite - PicoCTF
- Irish-Name-Repo 1 - PicoCTF
- Irish-Name-Repo 2 - PicoCTF
- Irish-Name-Repo 3 - PicoCTF
- https://www.wechall.net/challs/MySQL/by/chall_score/ASC/page-1

Cross Site Scripting (XSS)

- XSS happens when a user of an application can send JavaScript that is executed by the browser of another user of the same application
- JavaScript can
  - Modify the page (DOM)
  - Send HTTP requests
  - Access cookies
- This can be combined to form an XSS attack. Ex. extract cookies, send to server of attacker

Reflected XSS

- XSS through URL parameters
- https://example.com?data=<script>alert(1)</script>
  - <html>
  - <body>
  - <script>alert(1)</script>
  - </body>
  - </html>

Stored XSS

- The XSS payload is provided from the website itself
- Ex. posting a XSS payload as a comment or blog post that is displayed to other users

DOM XSS

- The browser itself is injecting an XSS payload into the DOM
- The server might not be injectable but the client side javascript files are causing the issue
- Ex. dynamic javascript code such as eval() or innerHTML
- Exploit in URL which is accessed with the window.location object

http://www.example.com/userdashboard.html#context=<script>SomeFunction(somevariable)</script>.

XSS Problems

- https://xss.challenge.training.hacq.me/
- https://xss-game.appspot.com/

Link to these slides:

royalroppers.team/meetups/web_2025-10-30.pdf