Report URI

Penetration Testing Report

3190

Web Application Test

16/11/2023

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1 Document Revision History

Name	Date	Version	Comment
Max de Dumast	14/11/2023	0.1	Initial Document
Dan Turner	16/11/2023	0.2	QA by senior consultant
Max de Dumast	16/11/2023	1.0	Final Draft

2 Introduction

Report URI (Report URI) engaged Pentest Limited to undertake this project. This was to gain independent assurance that security controls are in-line with industry best practices.

Report URI was founded to take the pain out of monitoring security policies like CSP and other modern security features. Report URI are the best real-time monitoring platform for cutting edge web standards. Their experience, focus, and exposure allow them to take the hassle out of collecting, processing, and understanding reports, giving customers just the information they need.

Report URI have indicated the need for a repeat security test of their 'Report URI' application in order to identify vulnerabilities to attacks that could be launched across a computer network, and to provide security assurances regarding their systems. Such a test will allow Report URI to undertake remediation efforts and increase their overall security posture.

2.1 Scope & Duration

This assessment included the following phases of work:

- Phase 1 – Web application assessment of the "Report URI" application and API endpoint

The duration included 5 days effort (including reporting). Work commenced on 30/10/2023 and concluded on 03/11/2023.

2.2 Scenarios Included

The target was assessed using a white-box assessment methodology, whereby access to all source-code as well as Enterprise accounts were provided. Furthermore, constant communications with Scott Helme facilitated investigation of potential vulnerabilities.

2.3 Target(s)

- https://report-uri.com
- API Endpoint

3 Executive Summary

Pentest performed a security assessment of the Report URI website and supporting API endpoint, from October 30 to November 3. The test's aim was to allow Report URI to identify and undertake remediation efforts for any vulnerabilities discovered.

The test uncovered only one low impact vulnerability and another two were raised informationally.

The first related to the use of two third-party JavaScript libraries which were out-of-date. One of them was affected by a Cross-Site Scripting vulnerability, but due to the site's stringent encoding of user-supplied data, the application was not vulnerable. The second library did not have any publicly disclosed vulnerabilities but is considered EOL by the vendor.

The other two issues, mentioned only for informational reasons due to mitigating factors, were raised to further reinforce the application's already robust security posture.

Finally, the appendix of this report has findings that, owing to robust coding practices and multi-layered verification and defences, posed no security risk. These findings were related to race-conditions, a potential path restriction bypass, and a suspected remote-code execution vulnerability. Their inclusion in this report serves to highlight Report URI's efforts to protect their environment and clients' personal data.

3.1 Next Steps

A complete writeup of every issue is available in the body of this report. It includes required steps to confirm and replicate each issue, along with recommended remedial actions. Pentest recommend taking time to review the findings before arranging a triage meeting to determine the order of priority for remedial work. As a rule of thumb:

- **Critical Risk Items** – Address these immediately.
- **High Risk Items** – Address these as soon as possible after any Critical Risks.
- **Medium Risk Items** – Plan to address these within 3 months of discovery.
- **Low and Info Risk Items** – Track these within a risk register and discuss remediation versus acceptance.

If recommendations within this report are followed Pentest believe that the target's security posture will improve.

3.2 Caveats

Pentest provides no warranty that the target(s) are now free from other defects. Security is an ever-evolving field and consultancy is based on the opinions of the consultant, their understanding of the goals of Report URI as well as their individual experience.

The findings of this project are based on a time-limited assessment and by necessity can only focus on approved targets which are in scope. An attacker would not be constrained by either time or scope limits and could circumvent controls which are impractical to assess via structured penetration testing.

To appropriately secure assets Pentest encourage a cyclical approach to assessment. Each cycle should include:

- **Comprehensive Assessment** – where a full list of findings is produced with the widest scope possible.
- **Focused Verification Testing** – where solutions to the initial assessment's findings are verified.

Depending on how important the target is to the concerns of Report URI, Pentest recommend repeating the cycle every 6-months or 12-months at least.

3.3   Risk Categories & Rationales

Pentest use a simple risk categorisation of each vulnerability to focus the triage process at the risks which truly matter. The Common Vulnerability Scoring System (CVSS) is an industry standard formula. It generates a risk score between 0.0 and 10.0.

The table below explains the risk categories and demonstrates rule-of-thumb equivalency with CVSS scores:

Risk Category	CVSS Score	Rationales
Critical	8.1 – 10.0	Poses a severe risk which is easy to exploit. Begin the process of remediating immediately after the issue has been presented.
High	6.1 – 8.0	Poses a significant risk and can be exploited. Address these as soon as possible after any critical risks have been remediated.
Medium	4.1 – 6.0	Poses an important risk but may be difficult to exploit. Pentest recommends remedial work within 3 months of discovery.
Low	2.1 – 4.0	Poses a minor risk or may be exceedingly difficult to exploit. Address these over the long-term during testing cycles.
Info	0.0 – 2.0	Loss of sensitive information, or a discussion point. These are not directly exploitable but may aid an attacker. Remediate these to create a true defence-in-depth security posture.

CVSS is not applicable to all risks. For example, it is incapable of capturing the risk of a "flat network design". Experience has told us that this is a "high" risk in most cases.

For this reason, the reader may find vulnerabilities which have no CVSS rating in our reports.

We endeavour to provide the reason for omitting the risk score when that is the case, and to provide CVSS by default in all applicable cases.

3.4 Visual Summary

	Info	Low	Medium	High	Critical
Count	2	1	0	0	0
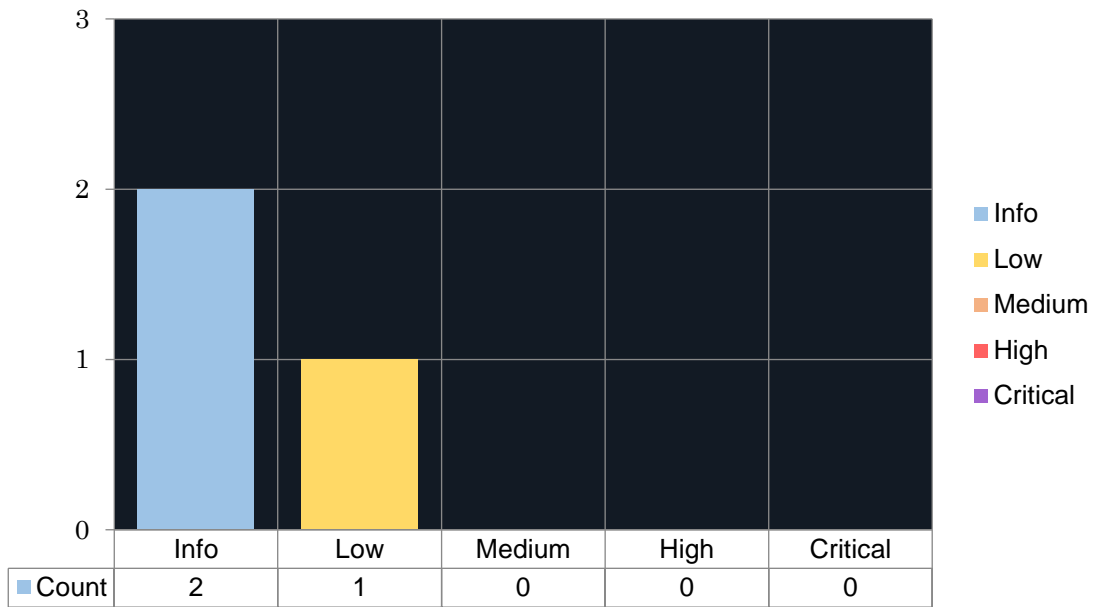
4 Recommended Actions

ID	Vulnerability	Recommendation	Risk	CVSSv3
1	**Vulnerabilities in Outdated Dependencies Detected**	Upgrade the affected libraries to the latest supported version.	Low	3.1/Low
2	**Insecure TLS/SSL Configuration**	Consider disabling support for CBC mode, non-ephemeral DH, and SHA HMAC.	Info	3.7/Low
3	**CSP configured without 'base-uri' directive**	Implement the 'base-uri' directive.	Info	N/A

5 Technical Findings

5.1 Vulnerabilities in Outdated Dependencies Detected

5.1.1 Background

Most software products are developed using APIs or libraries provided by third-parties. Doing so reduces development time and cost and feeds into the "why re-invent the wheel?" philosophy. Once a component has been integrated into an application it must be upgraded regularly to guard against bugs and remove publicly known vulnerabilities.

Failure to do so can mean that the application itself is at risk of exploitation due to weaknesses that exist in the supporting dependencies. This risk has been captured by the OWASP top 10 2021 project as category A06 labelled "Vulnerable and Outdated Components" defined at reference [1].

5.1.2 Details

The website included two outdated JavaScript libraries, one of which had publicly disclosed vulnerabilities.

Pentest did not review the site's JavaScript files to confirm exploitability. This is because auditing the JavaScript is time consuming and, though it may prove the site was secure at this time, would not prevent additions to the site making it vulnerable in the future. The only way to remove all residual risk is to apply the relevant updates.

Moreover, Report URI implemented a strict CSP, which would have extended the required effort to exploit the vulnerabilities, should it be possible.

The affected libraries are below.

5.1.2.1 jQuery DataTables

jQuery DataTables version 1.10.16 was included on the target, which was vulnerable to Cross-Site Scripting (XSS) if an array containing untrusted data was reflected without sanitisation.

The library was included in several locations throughout the website, an example of which is shown below.

```
GET /account/reports/crash/ HTTP/2
Host: report-uri.com
                    ▲Request                ▼Response
HTTP/2 200 OK
Content-Type: text/html; charset=utf-8

<!DOCTYPE html>
<html lang="en">
<head>
<link rel="dns-prefetch" href="https://cdn.report-uri.com/">
<link rel="preconnect" href="https://cdn.report-uri.com/" crossorigin>
<meta charset="utf-8">
<title>Report URI: Crash Reports</title>
```

```
[snip]
<script src="https://cdn.report-
uri.com/libs/datatables/1.10.16/js/jquery.dataTables.min.js"
nonce="7cPbnUg7NxiKWldnDRsbPF5O"></script>
<script src="https://cdn.report-uri.com/js/dataTables.bootstrap.min.js"
nonce="7cPbnUg7NxiKWldnDRsbPF5O"></script>
<script src="https://cdn.report-uri.com/js/datatable.min.js?v=1.0.1"
nonce="7cPbnUg7NxiKWldnDRsbPF5O"></script>
<script src="https://cdn.report-uri.com/js/bootstrap-
datetimepicker.min.js" nonce="7cPbnUg7NxiKWldnDRsbPF5O"></script>
<script src="https://cdn.report-uri.com/js/reports-page.min.js?v=24"
nonce="7cPbnUg7NxiKWldnDRsbPF5O"></script></div>
[snip]
</body>
</html>
```

Figure 1 - Partial response for /account/reports/crash, highlighting the inclusion of the outdated jquery.datatables.

More information about the library and associated vulnerability is available in reference [4].

5.1.2.2   Bootstrap

Bootstrap version 3.4.1 was in use on the target. The vendors of Bootstrap have marked this version as EOL (End of Life). Any vulnerabilities found to affect it will not be patched, potentially exposing users to attacks.

However, no public vulnerabilities have been reported at the time of writing.

A partial response highlighting the inclusion of Bootstrap, along with the version, is shown below.

```
GET /account/teams/ HTTP/2
Host: report-uri.com
----------------▲Request----------------▼Response----------------
HTTP/2 200 OK
Content-Type: text/html; charset=utf-8

<!DOCTYPE html>
<html lang="en">
<head>
<link rel="dns-prefetch" href="https://cdn.report-uri.com/">
<link rel="preconnect" href="https://cdn.report-uri.com/" crossorigin>
<meta charset="utf-8">
<title>Report URI: Teams</title>
[snip]
<script src="https://cdn.report-uri.com/libs/twitter-
bootstrap/3.4.1/js/bootstrap.min.js" integrity="sha256-
nuL8/2cJ5NDSSwnKD8VqreErSWHtnEP9E7AySL+1ev4= sha384-
aJ21OjlMXNL5UyIl/XNwTMqvzeRMZH2w8c5cRVpzpU8Y5bApTppSuUkhZXN0VxHd sha512-
oBTprMeNEKCnqfuqKd6sbvFzmFQtlXS3e0C/RGFV0hD6QzhHV+ODfaQbAlmY6/q0ubbwlAM/n
CJjkrgA3waLzg==" crossorigin="anonymous"
nonce="7k+/HT7sM95kBwXDE1HpP/I2"></script>
[snip]
</body>
</html>
```

Figure 2 - Partial response for /account/teams/, highlighting the EoL version of Bootstrap being included.

More information about Bootstrap's version 3 reaching EOL is available in reference [5].

5.1.3   Risk Analysis

Pentest Risk Category	Low	
CVSS	3.1/Low AV:N/AC:H/PR:N/UI:R/S:U/C:L/I:N/A:N	
Explanation	The risk associated with this issue was considered low, as no areas of the application were found to reflect user inputs without appropriate HTML encoding. Moreover, the application implemented a strict CSP. The issue is raised to encourage updating the affected libraries and is not believed to constitute an immediate threat to Report URI or its users.	

5.1.4   Recommendation

The immediate recommendation is to download and integrate the latest supported versions of each outdated dependency.

Pentest understands that this would be a significant undertaking for Report URI, due to changes in the underlying APIs and updated versions of the dependencies. As such, to ensure that updated components do not affect the user experience, a full User Acceptance Testing (UAT) would need to be carried out.

The advice above would triage the initial problem only and would not prevent the situation from recurring. The long-term solution is to modify the Software Development Life Cycle (SDLC) to ensure that dependencies are regularly updated. OWASP provides a free tool called "dependency-check" (see reference [2]) which can be integrated into most build processes.

5.1.5   References

[1]	OWASP Top 10: A06_2021 - Vulnerable and Outdated Components
[2]	OWASP: OWASP Dependency Check
[3]	TaringAmberini: Ready to use Java Dependencies Vulnerability Checker
[4]	CVE.org - CVE-2021-23445
[5]	GitHub – Bootstrap version 4 issue

5.1.6   Affected Item(s)

- /account/*
- /watch/*
- /billing/payment

5.2 Insecure TLS/SSL Configuration

5.2.1 Background

Transport Layer Security (TLS) and its predecessor, Secure Sockets Layer (SSL), are cryptographic protocols providing communications security over a computer network. TLS is often used to protect web application data from unauthorised disclosure and modification. It is used both between clients (web browsers) and application servers, and between application servers and other back-end components. When establishing a connection, the server and client agree on a protocol and cipher suite to transmit with. Cipher suites are a set of instructions on how to achieve this secure transmission and consist of four elements:

- **Key exchange algorithm** - Specifies how the bulk encryption key is established in versions prior to TLS 1.3. In TLS 1.3 only pre-shared keys or Diffie-Hellman Ephemeral can be used, so this is not included.
- **Authentication algorithm** - Specifies how the client and server validate that they are communicating with the right endpoint in versions prior to TLS 1.3. In TLS 1.3 the signing algorithm is dependent on the certificate and no longer part of the cipher suite, so this is not included.
- **Bulk encryption algorithm** - Specifies what symmetric encryption algorithm is used to protect information in transit.
- **Message Authentication Code (MAC) algorithm** - Specifies what hashing algorithm is used to ensure that the message content has not been changed.

Several cipher suites suffer from publicly known issues rendering them cryptographically weak, these are detailed below.

Key Exchange/Authentication Algorithm Weaknesses:

- RSA without Diffie-Hellman Ephemeral - RSA without the use of Diffie-Hellman Ephemeral (DHE) for key exchange does not provide forward secrecy. This means that an attacker able to record communications would be able to decrypt them in the future if the client or server RSA keys were compromised.

Bulk Encryption Algorithm Weaknesses:

- Cipher Block Chaining (CBC) - While encryption using algorithms operating in CBC mode is not inherently insecure, it is difficult to implement it securely. There have been multiple vulnerabilities identified with implementations, most notably the POODLE, BEAST, and LUCKY 13 attacks, though others exist. The TLS 1.3 protocol removes support for encryption algorithms using CBC mode entirely due to these weaknesses.

HMAC Algorithm Weaknesses:

- SHA-1 - This hashing function is no longer considered secure and is deprecated as of December 2021 in TLS 1.2. This may allow an attacker to modify data in transit without detection, though implementing such an attack in real-time would be difficult.

5.2.2 Details

While the target accepted several insecure cipher suites, as detailed in **SSLScan Results for: report-uri.com:443**, simulations showed that the server never defaulted to using them, as shown below:

```
 Running client simulations (HTTP) via sockets

 Browser                      Protocol  Cipher Suite Name (OpenSSL)
Forward Secrecy
-----------------------------------------------------------------------
-----------------------
 Android 6.0                  TLSv1.2   ECDHE-ECDSA-CHACHA20-POLY1305-OLD
256 bit ECDH (P-256)
 Android 7.0 (native)         TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 Android 8.1 (native)         TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
253 bit ECDH (X25519)
 Android 9.0 (native)         TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Android 10.0 (native)        TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Android 11 (native)          TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Android 12 (native)          TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Chrome 79 (Win 10)           TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Chrome 101 (Win 10)          TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Firefox 66 (Win 8.1/10)      TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Firefox 100 (Win 10)         TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 IE 6 XP                      No connection
 IE 8 Win 7                   No connection
 IE 8 XP                      No connection
 IE 11 Win 7                  TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 IE 11 Win 8.1                TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 IE 11 Win Phone 8.1          TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 IE 11 Win 10                 TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 Edge 15 Win 10               TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
253 bit ECDH (X25519)
 Edge 101 Win 10 21H2         TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Safari 12.1 (iOS 12.2)       TLSv1.3   TLS_CHACHA20_POLY1305_SHA256
253 bit ECDH (X25519)
 Safari 13.0 (macOS 10.14.6)  TLSv1.3   TLS_CHACHA20_POLY1305_SHA256
253 bit ECDH (X25519)
 Safari 15.4 (macOS 12.3.1)   TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 Java 7u25                    No connection
```

```
 Java 8u161                      TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 Java 11.0.2 (OpenJDK)           TLSv1.3   TLS_AES_128_GCM_SHA256
256 bit ECDH (P-256)
 Java 17.0.3 (OpenJDK)           TLSv1.3   TLS_AES_256_GCM_SHA384
253 bit ECDH (X25519)
 go 1.17.8                       TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
 LibreSSL 2.8.3 (Apple)          TLSv1.2   ECDHE-ECDSA-CHACHA20-POLY1305
253 bit ECDH (X25519)
 OpenSSL 1.0.2e                  TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 OpenSSL 1.1.0l (Debian)         TLSv1.2   ECDHE-ECDSA-CHACHA20-POLY1305
253 bit ECDH (X25519)
 OpenSSL 1.1.1d (Debian)         TLSv1.3   TLS_AES_256_GCM_SHA384
253 bit ECDH (X25519)
 OpenSSL 3.0.3 (git)             TLSv1.3   TLS_AES_256_GCM_SHA384
253 bit ECDH (X25519)
 Apple Mail (16.0)               TLSv1.2   ECDHE-ECDSA-AES128-GCM-SHA256
256 bit ECDH (P-256)
 Thunderbird (91.9)              TLSv1.3   TLS_AES_128_GCM_SHA256
253 bit ECDH (X25519)
```

Figure 3 - testssl report-uri.com output, "Client Simulations" section.

A suitably well-placed attacker would therefore need significant resources to exploit this issue, as they would not only need to computing power which would be unaffordable to most but also need the ability to downgrade the negotiated cipher suite.

5.2.3   Risk Analysis

Pentest Risk Category	Info
CVSS	3.7/Low AV:A/AC:H/PR:N/UI:R/S:U/C:L/I:L/A:N
Explanation	Given the significant processing power required to break the affected cipher suite's encryption, as well as the need for the attacker to be placed such that they are able to forcefully downgrade the chosen cipher suite, this vulnerability is unlikely to be exploited successfully. As a result, it is raised informationally.

5.2.4   Recommendation

To protect against the cryptographic vulnerabilities discussed above, Pentest recommends the following configuration changes be made to the TLS/SSL service. This configuration should be reviewed carefully as resolving TLS/SSL issues can be a difficult task, and incorrect configuration can introduce more problems. However, following the recommendations as laid out below will result in a minimal attack surface being presented.

Key Exchange/Authentication Algorithm Recommendations:

- RSA without Diffie-Hellman Ephemeral - Disable any cipher suites using RSA without the use of Diffie-Hellman Ephemeral for key exchange.
- Enable and prefer cipher suites using ephemeral key exchange, ideally using elliptic curve cryptography (e.g., ECDHE_ECDSA, ECDHE_RSA).

Bulk Encryption Algorithm Recommendations:

- Disable any encryption algorithms operating in CBC mode.

HMAC Algorithm Recommendations:

- Disable the following hashing algorithm: SHA1.

Mozilla provides a tool [1] for generating secure configurations for the most common web servers. Use of this tool is highly recommended to prevent implementation errors and the 'Intermediate' configuration is recommended for most publicly accessible websites.

For Cloudflare, protocols and ciphers can only be managed via the "Change Minimum TLS Version setting", "Change ciphers setting", and "Change TLS 1.3 setting" API calls [2].

5.2.5   References

[1]	Mozilla: SSL Configuration Generator
[2]	Cloudflare API v4 Documentation

5.2.6   Affected Item(s)

See **SSLScan Results for: report-uri.com:443**.

5.3   CSP configured without 'base-uri' directive

5.3.1   Background

Content Security Policy is delivered via an HTTP response header, much like HSTS, and defines approved sources of content that the browser may load. It can be an effective additional protection to Cross-Site Scripting (XSS) attacks and is also widely supported and usually easily deployed.

By specifying only those sources that the application wishes the browser to load content from, the application owner can protect visitors from a whole range of issues.

Recently, multiple security related headers have been added to web servers, and supported by web browsers, aiming to help prevent or mitigate the impact of certain exploit classes. Therefore, security industry best practices suggest that where possible, these headers be enabled and suitably configured. Doing so adds additional benefits and can aid in the overall security posture of an application.

Every CSP policy is composed of one or more directives, which act as a set of instructions to the browser. By setting directives which limit the origin of certain resources, CSP can act as an auxiliary defence measure and increase the security of the application. A well-configured Content Security Policy has the potential to provide strong protections against client-side code injection vulnerabilities, such as Cross-Site Scripting (XSS).

For the CSP policy to be effective, most web applications will require a custom policy which is tailored to the application. This is because an overly restrictive policy has the potential to break functionality, while an overly permissive policy defeats the purpose of CSP.

5.3.2   Details

Report URI's Content Security Policy (CSP), while comprehensive and robust, does not include the 'base-uri' directive.

The omission of 'base-uri' did not present a significant security risk to Report URI given the assessed configuration. This is primarily because the application did not use relative script imports, and the CSP explicitly set 'script-src' to 'self'. These configurations effectively entirely neutralised the risk that would typically be mitigated by the inclusion of the 'base-uri' directive. An attacker attempting to redirect script sources via HTML injection would still be blocked by the 'script-src' policy. Thus, while the inclusion of 'base-uri' can be considered a best practice, its absence in this specific scenario did not materially weaken the application's security posture.

The examples below demonstrate a typical attack and highlight that a poisoned 'base-uri' would not have impacted Report URI.

If an attacker succeeded in injecting the following into their target:

```
<base href="http://evil.com/">
```

Any relative scripts, such as the one below, would thereafter be loaded from the poisoned base-uri, as such: https://evil.com/example.js.

```
<script src="/example.js"></script>
```

However, this would not bypass the 'script-src' directive, as the next three figures show:

Figure 4 - script-src directive blocking a script from being loaded using relative paths from a different base-uri.

Figure 5 - The source code for the webpage whose error message is shown above.

```
Content-Security-Policy "script-src 'self' md.x-pt.net;";
```

Figure 6 - CSP for the webpage shown above.

Given that Report URI had: a strict 'script-src' directive, a 'form-action' directive and never included scripts using relative paths, there was never any possibility of exploiting the absence of the 'base-uri' directive.

Nevertheless, Report URI immediately implemented the suggested directive once informed, as shown below in the latest iteration of their CSP.

```
GET / HTTP/2
Host: report-uri.com
[snip]
                    ▲Request                  ▼Response
HTTP/2 200 OK
[snip]
Content-Security-Policy: default-src 'none'; script-src cdn.report-
uri.com 'nonce-/kMn0OmjUo84GVq5tvWs8OdA' static.cloudflareinsights.com;
style-src 'self' 'unsafe-inline' cdn.report-uri.com; img-src 'self' data:
cdn.report-uri.com; font-src 'self' cdn.report-uri.com; frame-src 'self'
cdn.forms-content.sg-form.com; frame-ancestors 'none'; form-action
'self'; connect-src 'self'; upgrade-insecure-requests; base-uri 'none';
report-uri https://scotthelme.report-uri.com/r/d/csp/enforce; report-to
default
[snip]
```

Figure 7 - Updated CSP, highlighting the added 'base-uri' directive.

5.3.3 Risk Analysis

Pentest Risk Category	Info
CVSS	N/A
Explanation	The issue is raised informationally as Report URI's stringent Content Security Policy (CSP) and robust site configuration effectively mitigated any potential exploitability arising from the absence of the base-uri directive.

5.3.4 Recommendation

See updated CSP in **Figure 7**, which includes the 'base-uri' directive. It is also possible to set the 'base-uri' to 'self' or explicitly to the website's domain (eg: 'example.com').

5.3.5 References

[1]	CSP Quick Reference Guide
[2]	OWASP: Content-Security-Policy
[3]	CWE: Protection Mechanism Failure
[4]	W3: Content Security Policy Level 3
[5]	Hacktricks: CSP Bypass – Missing base-uri
[6]	CTFTime: Writeup 11452

5.3.6 Affected Item(s)

- Report URI's CSP

6 Additional Information

6.1 WHOIS Database

The WHOIS database stores information about the individual or organisation who owns and manages a domain or IP address range. Attackers will review WHOIS entries trying to find useful information such as names and contact details for employees.

Best practices state that generic contact details should be used such as "whois@domain.com" rather than providing the name of a member of staff.

6.1.1 Entry for Domain: report-uri.com

```
$ whois report-uri.com
   Domain Name: REPORT-URI.COM
   Registry Domain ID: 1651365076_DOMAIN_COM-VRSN
   Registrar WHOIS Server: whois.namecheap.com
   Registrar URL: http://www.namecheap.com
   Updated Date: 2023-03-18T07:36:22Z
   Creation Date: 2011-04-17T11:55:31Z
   Registry Expiry Date: 2024-04-17T11:55:31Z
   Registrar: NameCheap, Inc.
   Registrar IANA ID: 1068
   Registrar Abuse Contact Email: abuse@namecheap.com
   Registrar Abuse Contact Phone: +1.6613102107
   Domain Status: clientTransferProhibited
https://icann.org/epp#clientTransferProhibited
   Name Server: CARL.NS.CLOUDFLARE.COM
   Name Server: COCO.NS.CLOUDFLARE.COM
   DNSSEC: signedDelegation
   DNSSEC DS Data: 2371 13 2
B86DC8BE786CAFA5B1D92F52AA23CD9B62AF70DBE9D907AC61A1F9469513B5F6
   URL of the ICANN Whois Inaccuracy Complaint Form:
https://www.icann.org/wicf/
>>> Last update of whois database: 2023-11-14T10:45:51Z <<<
```

6.1.2 Entry for IP Address Range: 2606:4700:: - 2606:4700:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF

```
$ whois 2606:4700::6811:b958
#
# ARIN WHOIS data and services are subject to the Terms of Use
# available at: https://www.arin.net/resources/registry/whois/tou/
#
# If you see inaccuracies in the results, please report at
# https://www.arin.net/resources/registry/whois/inaccuracy_reporting/
#
# Copyright 1997-2023, American Registry for Internet Numbers, Ltd.
#


NetRange:       2606:4700:: - 2606:4700:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
```

```
CIDR:           2606:4700::/32
NetName:        CLOUDFLARENET
NetHandle:      NET6-2606-4700-1
Parent:         NET6-2600 (NET6-2600-1)
NetType:        Direct Allocation
OriginAS:       AS13335
Organization:   Cloudflare, Inc. (CLOUD14)
RegDate:        2011-11-01
Updated:        2017-02-17
Comment:        All Cloudflare abuse reporting can be done via
https://www.cloudflare.com/abuse
Ref:            https://rdap.arin.net/registry/ip/2606:4700::


OrgName:        Cloudflare, Inc.
OrgId:          CLOUD14
Address:        101 Townsend Street
City:           San Francisco
StateProv:      CA
PostalCode:     94107
Country:        US
RegDate:        2010-07-09
Updated:        2021-07-01
Ref:            https://rdap.arin.net/registry/entity/CLOUD14


OrgAbuseHandle: ABUSE2916-ARIN
OrgAbuseName:   Abuse
OrgAbusePhone:  +1-650-319-8930
OrgAbuseEmail:  abuse@cloudflare.com
OrgAbuseRef:    https://rdap.arin.net/registry/entity/ABUSE2916-ARIN

OrgRoutingHandle: CLOUD146-ARIN
OrgRoutingName:   Cloudflare-NOC
OrgRoutingPhone:  +1-650-319-8930
OrgRoutingEmail:  noc@cloudflare.com
OrgRoutingRef:    https://rdap.arin.net/registry/entity/CLOUD146-ARIN

OrgNOCHandle: CLOUD146-ARIN
OrgNOCName:   Cloudflare-NOC
OrgNOCPhone:  +1-650-319-8930
OrgNOCEmail:  noc@cloudflare.com
OrgNOCRef:    https://rdap.arin.net/registry/entity/CLOUD146-ARIN

OrgTechHandle: ADMIN2521-ARIN
OrgTechName:   Admin
OrgTechPhone:  +1-650-319-8930
OrgTechEmail:  rir@cloudflare.com
OrgTechRef:    https://rdap.arin.net/registry/entity/ADMIN2521-ARIN

RTechHandle: ADMIN2521-ARIN
RTechName:   Admin
RTechPhone:  +1-650-319-8930
RTechEmail:  rir@cloudflare.com
RTechRef:    https://rdap.arin.net/registry/entity/ADMIN2521-ARIN

RAbuseHandle: ABUSE2916-ARIN
RAbuseName:   Abuse
RAbusePhone:  +1-650-319-8930
```

```
RAbuseEmail:   abuse@cloudflare.com
RAbuseRef:     https://rdap.arin.net/registry/entity/ABUSE2916-ARIN

RNOCHandle: NOC11962-ARIN
RNOCName:    NOC
RNOCPhone:   +1-650-319-8930
RNOCEmail:   noc@cloudflare.com
RNOCRef:     https://rdap.arin.net/registry/entity/NOC11962-ARIN
```

6.2   DNS Reconnaissance

Domain Name Service (DNS) is used to translate human readable hostnames such as
"www.pentest.co.uk" to the IP address which is hard for humans to recall. Threat actors use DNS
reconnaissance to identify hosts which they can subsequently target.

6.2.1   Identifying DNS Servers for Domain: report-uri.com

The following shows the "dig" command being used to identify the name servers responsible for the
target domain:

```
$ dig ns report-uri.com
; <<>> DiG 9.19.17-1-Debian <<>> ns report-uri.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 18384
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;report-uri.com.                 IN     NS

;; ANSWER SECTION:
report-uri.com.         86347 IN    NS    coco.ns.cloudflare.com.
report-uri.com.         86347 IN    NS    carl.ns.cloudflare.com.

;; Query time: 3 msec
;; SERVER: 192.168.1.1#53(192.168.1.1) (UDP)
;; WHEN: Tue Nov 14 10:51:33 GMT 2023
;; MSG SIZE  rcvd: 95
```

The target used Cloudflare's DNS service which is designed to be "always available" and has
integrated support for DDoS and DNSSEC.

This was an excellent configuration and would likely ensure the availability of DNS.

6.2.2 DNS Server Configurations

The following table summarises common insecure configurations. The data was gathered by assessing each of the NS servers listed above:

Check	Outcome
Zone Transfers Disabled	`True`
DNSSEC Enabled	`True`
Recursive Queries Disabled	`False, but DNS is managed by CloudFlare.`

Table 1 - DNS Server Configuration Analysis

Report URI had configured DNSSEC for their domain, which is considered best-practice and would help mitigate DNS poisoning attacks. While the DNS server enabled recursive queries, it was not managed by Report URI.

6.2.3 List of known subdomains at domain: report-uri.com

Attackers can use word lists to enumerate subdomains within a target domain. They do this looking for additional targets which may not otherwise be found.

As a DNS wildcard existed for *.report-uri.com, it was not possible to enumerate subdomains over DNS. Instead, the following is a list of hosts found via virtual host enumeration:

```
$ ffuf -u https://report-uri.com/ -H 'Host: SUBDOMAINS.report-uri.com'  -
ac -fs 151
        /'___\  /'___\           /'___\
       /\ \__/ /\ \__/  __  __   /\ \__/
       \ \ ,__\\ \ ,__\/\ \/\ \  \ \ ,__\
        \ \ \_/ \ \ \_/\ \ \_\ \  \ \ \_/
         \ \_\   \ \_\  \ \____/   \ \_\
          \/_/    \/_/   \/___/     \/_/


       v2.1.0-dev
_____

 :: Method           : GET
 :: URL              : https://report-uri.com/
 :: Wordlist         : SUBDOMAINS:
/usr/share/seclists/Discovery/DNS/subdomains-top1million-5000.txt
 :: Header           : Host: SUBDOMAINS.report-uri.com
 :: Follow redirects : false
 :: Calibration      : true
 :: Proxy            : socks5://127.0.0.1:1080
 :: Timeout          : 10
 :: Threads          : 40
 :: Matcher          : Response status: 200-
299,301,302,307,401,403,405,500
 :: Filter           : Response size: 151
_____

docs                    [Status: 200, Size: 7856, Words: 494, Lines: 199,
Duration: 576ms]
a                       [Status: 301, Size: 155, Words: 5, Lines: 8,
Duration: 573ms]
ams                     [Status: 200, Size: 30851, Words: 1811, Lines:
535, Duration
```

It was not clear what the 'ams' subdomain was used for. It presented minor differences with the report-uri.com website.

6.3 SSL/TLS Assessment

Transport Layer Security (TLS) is used to ensure the confidentiality and integrity of traffic as it transits a network. It is also used to give certainty of the identity of the client, server, or both. Insecure configurations are common. The following sub-sections show information gathered using SSLScan.

6.3.1 SSLScan Results for: report-uri.com:443

Protocol	Kex	Auth	Encrypt	Hash	Status
TLSv1.3	-	-	AES 128 GCM	SHA256	Recommended
TLSv1.3	-	-	AES 256 GCM	SHA384	Recommended
TLSv1.3	-	-	CHACHA20 POLY1305	SHA256	Recommended
TLSv1.2	ECDHE	ECDSA	CHACHA20 POLY1305	SHA256	Recommended
TLSv1.2	ECDHE	ECDSA	AES 128 GCM	SHA256	Recommended
TLSv1.2	ECDHE	ECDSA	AES 128 CBC	SHA	Weak
• Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	ECDHE	ECDSA	AES 256 GCM	SHA384	Recommended
TLSv1.2	ECDHE	ECDSA	AES 256 CBC	SHA	Weak
• Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	ECDHE	ECDSA	AES 128 CBC	SHA256	Weak
• Encryption operates in CBC mode					
TLSv1.2	ECDHE	ECDSA	AES 256 CBC	SHA384	Weak
• Encryption operates in CBC mode					
TLSv1.2	ECDHE	RSA	CHACHA20 POLY1305	SHA256	Secure
TLSv1.2	ECDHE	RSA	AES 128 GCM	SHA256	Secure
TLSv1.2	ECDHE	RSA	AES 128 CBC	SHA	Weak
• Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	RSA	RSA	AES 128 GCM	SHA256	Weak
• Key exchange is non-ephemeral					

TLSv1.2	RSA	RSA	AES 128 CBC	SHA	Weak
• Key exchange is non-ephemeral • Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	ECDHE	RSA	AES 256 GCM	SHA384	Secure
TLSv1.2	ECDHE	RSA	AES 256 CBC	SHA	Weak
• Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	RSA	RSA	AES 256 GCM	SHA384	Weak
• Key exchange is non-ephemeral					
TLSv1.2	RSA	RSA	AES 256 CBC	SHA	Weak
• Key exchange is non-ephemeral • Encryption operates in CBC mode • Hash uses weak algorithm					
TLSv1.2	ECDHE	RSA	AES 128 CBC	SHA256	Weak
• Encryption operates in CBC mode					
TLSv1.2	RSA	RSA	AES 128 CBC	SHA256	Weak
• Key exchange is non-ephemeral • Encryption operates in CBC mode					
TLSv1.2	ECDHE	RSA	AES 256 CBC	SHA384	Weak
• Encryption operates in CBC mode					
TLSv1.2	RSA	RSA	AES 256 CBC	SHA256	Weak
• Key exchange is non-ephemeral • Encryption operates in CBC mode					

Appendix A.   Suspected vulnerabilities, the value of multi-layered defences and a pro-active security mindset.

A1.   CodeIgniter Validation Placeholders RCE

Reviewing the application's source code, the 'composer.lock' file revealed the use of a CodeIgniter version which was reportedly vulnerable to Remote Code Execution (RCE).

In CodeIgniter < 4.3.5, the use of Validation Placeholders could lead to RCE, as reported on GitHub on May 21. The advisory provided a workaround, shown below, suggesting that validation rules should be placed within an array rather than being "piped" into one another.

```
$validation->setRules([
    'email' => ['required', 'valid_email,
'is_unique[users.email,id,{id}]'],
]);
```

Figure 8 – Suggested workaround

Reviewing the source code of the application showed that rules were being piped to one another, as shown in this example:

```
$validation->setRules([
    'id'    => 'max_length[19]|is_natural_no_zero',
    'email' =>
'required|max_length[254]|valid_email|is_unique[users.email,id,{id}]',
]);
```

Figure 9 – Example validation rule which uses placeholders – CodeIgniter [1]

As the impact was potentially significant, this was raised to Report URI before verifying that the application was vulnerable and that the issue could be exploited.

Given the absence of public proof-of-concept exploits for the vulnerability, the patch remediating this vulnerability was reviewed.

Starting with CodeIgniter 4, the validation process can substitute segments of the rule with the actual data being validated by employing *placeholders*.

Figure 9 illustrates this concept, where `{id}` is defined as a *placeholder* in the `is_unique` validation rule. The validation process replaces the `{id}` placeholder with its value prior to invoking `is_unique`, as demonstrated in **Figure 10** below.

> **ⓘ Note**
>
> Since v4.3.5, you must set the validation rules for the placeholder field (`id`).

In this set of rules, it states that the email address should be unique in the database, except for the row that has an id matching the placeholder's value. Assuming that the form POST data had the following:

```php
$_POST = [
    'id'    => 4,
    'email' => 'foo@example.com',
];
```

then the `{id}` placeholder would be replaced with the number **4**, giving this revised rule:

```php
$validation->setRules([
    'id'    => 'max_length[19]|is_natural_no_zero',
    'email' => 'required|max_length[254]|valid_email|is_unique[users.email,id,4]',
]);
```

So it will ignore the row in the database that has `id=4` when it verifies the email is unique.

> **ⓘ Note**
>
> Since v4.3.5, if the placeholder (`id`) value does not pass the validation, the placeholder would not be replaced.

Figure 10 – CodeIgniter documentation for placeholders – CodeIgniter

Reviewing the documentation and source code, it appeared that not only were *placeholders* able to execute code, they could do so even when they failed to pass validation rules.

The documentation for CI 3 [3] also stated (which was also partially true for CI 4):

"Any native PHP function that accepts one parameter can be used as a rule, like `htmlspecialchars()`, `trim()`, etc."

Given these elements, a potential proof-of-concept payload for the 'id' to execute code might look like this: `1]|system[whoami`.

After replacing the 'id' with our payload, CodeIgniter version 4.3.4 would call splitRules [3] on the entire rule list. It would return the following array:

```
Array
(
    [0] => required
    [1] => max_length[254]
    [2] => valid_email
    [3] => is_unique[users.email,id,1]
    [4] => system[whoami]
)
```

As seen above, it is likely that the payload would lead to code execution.

While Report URI used CI 3, which did not have the vulnerable feature, a patch was deployed the same day which addressed any remaining concerns. All validation rules were changed to use arrays, rather than pipe format shown in examples above. This prevents the sort of injection which enabled the placeholders to execute code. A static analysis rule was also added which forces validation rules to use Report URI's wrapped rules, rather than CI's default ones. Finally, the wrapped rules were changed to only accept arrays and not strings.

However, without CI 4's placeholders, untrusted data is never injected into the execution context, as one would expect. In the example below, taken from CI 3's documents, `users.email` is only ever passed as an argument and not parsed to determine the presence of rules within.

```
$this->form_validation->set_rules('email', 'Email',
'required|valid_email|is_unique[users.email]');
```

Figure 11 - Example validation rule in CI 3 -- CodeIgniter [2]

As such, while Report URI was never exposed to this vulnerability, additional measures have been taken to further strengthen defences against it. Finally, this issue also encouraged Report URI to accelerate their transition away from CodeIgniter.

References

[1]	CodeIgniter - Validation Placeholders
[2]	CodeIgniter - Prepping Data
[3]	CodeIgniter GitHub - splitRules
[4]	CodeIgniter - Callable: Use anything as a rule

A2. Race Condition on Email Change

During penetration testing, a race condition vulnerability was identified in the user email address change functionality. While the condition enabled the creation of duplicate user accounts, it was without immediate security risk, due to the robust "fail fast and fail early" principles employed by the application. The duplicates were clones, inheriting access to the original accounts' subscriptions – meaning that each duplicated account had their usage counted against the original account's limits.

The condition was reproduced by simultaneously submitting multiple email change requests within a single HTTP/2 packet. The application's logic to handle an email change—creating a new User object, transferring data from the old to the new, adding the new User to the database, and then deleting the old User—failed to account for concurrent executions. The race condition arose at the deletion phase, where requests following the initial one would fail silently as they referenced the now non-existent original user, resulting in account duplication.

An example is included below. All the requests were sent within the same HTTP/2 packet.

```
POST /account/change_email/ HTTP/2
Host: report-uri.com
[snip]
csrf_token=5a87ba0a57e4e9e4cf370f3513ca27f9&newEmail=[censored]&newEmailC
onfirm=[censored]&password=[censored]
··············································
POST /account/change_email/ HTTP/2
Host: report-uri.com
[snip]
csrf_token=5a87ba0a57e4e9e4cf370f3513ca27f9&newEmail=maxd-
test8%40pentest.co.uk&newEmailConfirm=maxd-
test8%40pentest.co.uk&password=[censored]
··············································
POST /account/change_email/ HTTP/2
Host: report-uri.com
[snip]
csrf_token=5a87ba0a57e4e9e4cf370f3513ca27f9&newEmail=maxd-
test4%40pentest.co.uk&newEmailConfirm=maxd-
test4%40pentest.co.uk&password=[censored]
```

The server responded to each with the same response, an example of which is below:

```
HTTP/2 302 Found
Content-Type: text/html; charset=utf-8

<h1>Redirect</h1>
<p><a href="/account/settings/">Please click here to
continue</a>.</p>[snip]
```

Report URI addressed the race condition, which had no impact but was nonetheless undesirable, by implementing an exclusive lock on the email change process, making the operation atomic and thereby eliminating the account duplication issue.

Despite the lack of security implications, it is worth commending Report URI's swift remediation of the issue.

A3.   Potential Issue – Path Access Control

The penetration test underscored the crucial need for comprehensive checks and stringent conditional access controls. Indeed, the application included certain controllers meant exclusively for command-line execution. In the routing definitions file, routes associated with these controllers were deliberately set to return a 404 error when accessed outside of a command-line context. An example response, highlighting the 404 handler is shown in **Figure 12**, though the response code deviates from 404 due to a CSRF error.

```
POST /process/ HTTP/2
Host: report-uri.com
[snip]
                ▲Request                ▼Response
HTTP/2 302 Found
Date: Thu, 02 Nov 2023 10:12:12 GMT
Content-Type: text/html; charset=utf-8
Location: /My404/csrf_error/
[snip]
```

Figure 12 - POST request to /process, highlighting the 404 handler for the request.

Interestingly, by prepending the path with an underscore, it was possible to bypass the 404 handler. However, all affected controllers inherited from a base command line controller class, whose constructor performed an additional verification of the execution context. Any attempt to create (access) these controllers outside of a command-line context would raise an error, as demonstrated below:

```
GET /_process?callback=test HTTP/2
Host: report-uri.com
                ▲Request                ▼Response
HTTP/2 500 Internal Server Error
Content-Type: text/html; charset=UTF-8

[snip]
<title>Server Error</title>
[snip]
<div id="nette-error">
<div>
<h1>Server Error</h1>
<p>We're sorry! The server encountered an internal error and
was unable to complete your request. Please try again later.</p>
<p><small>error 500</small></p>
[snip]
```

Figure 13 - Similar request as above, prepending the path with an underscore. The error message is highlighted.

As such, while it was never possible to reach the affected controllers, this issue highlights the importance of not making assumptions when security could be affected. Thanks to robust code and multi-layered validation, the application prevented the issue from being exploitable – and in fact, entirely mitigated the vulnerability before it was even discovered.

Report URI has since patched the issue to remove any residual risk.

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