Fortify Developer Workbook

Jun 27, 2017

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Report Overview

Report Summary

On Jun 26, 2017, a source code review was performed over the Inbound code base. 2,150 files, 33,025 LOC (Executable) were scanned. A total of 4 issues were uncovered during the analysis. This report provides a comprehensive description of all the types of issues found in this project. Specific examples and source code are provided for each issue type.

Issues by Fortify Priority Order	
High	4

Issue Summary

Overall number of results

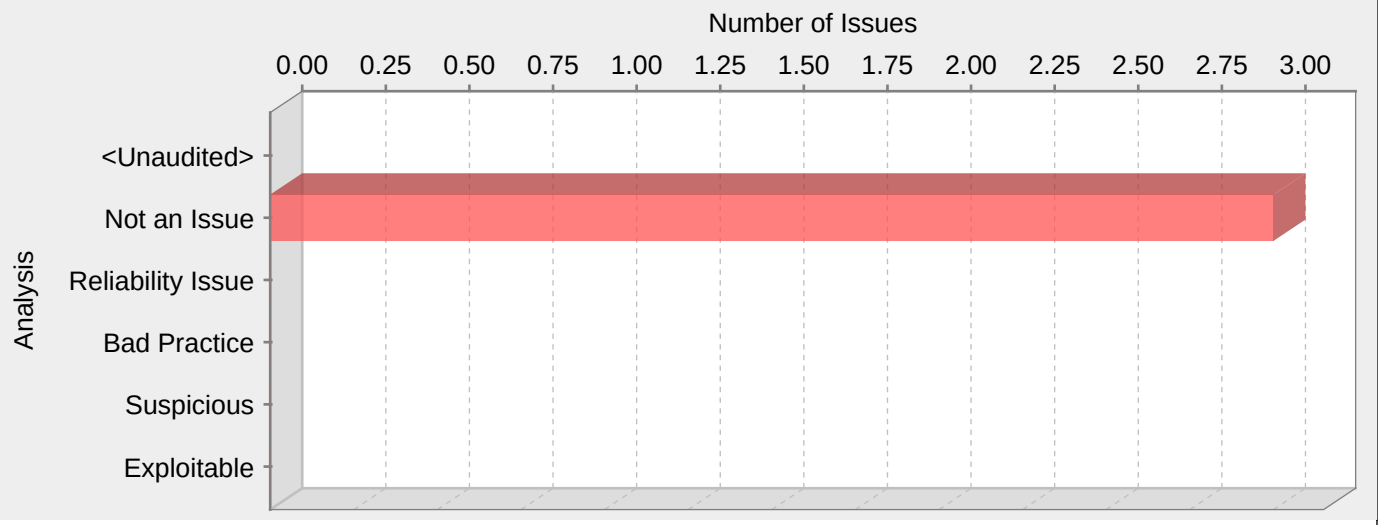
The scan found 4 issues.

Issues by Category	
Password Management: Hardcoded Password	3
Header Manipulation: Cookies	1

Results Outline

Vulnerability Examples by Category

Category: Password Management: Hardcoded Password (3 Issues)



Abstract:

Hardcoded passwords may compromise system security in a way that cannot be easily remedied.

Explanation:

It is never a good idea to hardcode a password. Not only does hardcoding a password allow all of the project's developers to view the password, it also makes fixing the problem extremely difficult. Once the code is in production, the password cannot be changed without patching the software. If the account protected by the password is compromised, the owners of the system will be forced to choose between security and availability.

Example 1: The following code uses a hardcoded password to connect to a database:

```
...
DriverManager.getConnection(url, "scott", "tiger");
...
```

This code will run successfully, but anyone who has access to it will have access to the password. Once the program has shipped, there is likely no way to change the database user "scott" with a password of "tiger" unless the program is patched. An employee with access to this information could use it to break into the system. Even worse, if attackers have access to the bytecode for the application they can use the javap -c command to access the disassembled code, which will contain the values of the passwords used. The result of this operation might look something like the following for the example above:

```
javap -c ConnMngr.class
22: ldc   #36; //String jdbc:mysql://ixne.com/rxsql
24: ldc   #38; //String scott
26: ldc   #17; //String tiger
```

In the mobile world, password management is even trickier, considering a much higher chance of device loss.

Example 2: The code below uses hardcoded username and password to setup authentication for viewing protected pages with Android's WebView.

```
...
webview.setWebViewClient(new WebViewClient() {
public void onReceivedHttpAuthRequest(WebView view,
HttpAuthHandler handler, String host, String realm) {
handler.proceed("guest", "allow");
}
});
...
```

Similar to Example 1, this code will run successfully, but anyone who has access to it will have access to the password.

Recommendations:

Passwords should never be hardcoded and should generally be obfuscated and managed in an external source. Storing passwords in plaintext anywhere on the system allows anyone with sufficient permissions to read and potentially misuse the password. At the very least, passwords should be hashed before being stored.

Some third-party products claim the ability to manage passwords in a more secure way. For example, WebSphere Application Server 4.x uses a simple XOR encryption algorithm for obfuscating values, but be skeptical about such facilities. WebSphere and other application servers offer outdated and relatively weak encryption mechanisms that are insufficient for security-sensitive environments. For a secure generic solution, the best option today appears to be a proprietary mechanism that you create.

For Android, as well as any other platform that uses SQLite database, a good option is SQLCipher -- an extension to SQLite database that provides transparent 256-bit AES encryption of database files. Thus, credentials can be stored in an encrypted database.

Example 3: The code below demonstrates how to integrate SQLCipher into an Android application after downloading the necessary binaries, and store credentials into the database file.

```
import net.sqlcipher.database.SQLiteDatabase;
...
SQLiteDatabase.loadLibs(this);
File dbFile = getDatabasePath("credentials.db");
dbFile.mkdirs();
dbFile.delete();
SQLiteDatabase db = SQLiteDatabase.openOrCreateDatabase(dbFile, "credentials", null);
db.execSQL("create table credentials(u, p)");
db.execSQL("insert into credentials(u, p) values(?, ?)", new Object[]{username, password});
...
```

Note that references to android.database.sqlite.SQLiteDatabase are substituted with those of net.sqlcipher.database.SQLiteDatabase.

To enable encryption on the WebView store, WebKit has to be re-compiled with the sqlcipher.so library.

Tips:

1. The Fortify Java Annotations FortifyPassword and FortifyNotPassword can be used to indicate which fields and variables represent passwords.

2. When identifying null, empty, or hardcoded passwords, default rules only consider fields and variables that contain the word password. However, the HPE Security Fortify Custom Rules Editor provides the Password Management wizard that makes it easy to create rules for detecting password management issues on custom-named fields and variables.

MVIClient.java, line 98 (Password Management: Hardcoded Password)

Fortify Priority:	High	**Folder**	High
Kingdom:	Security Features		
Abstract:	Hardcoded passwords may compromise system security in a way that cannot be easily remedied.		
Sink:	MVIClient.java:98 FieldAccess: KEYSTORE_PASSWD_PROPERTY()		

```
96   private static final String KEYSTORE_FILE_TYPE = "JKS";
97   private static final String KEYSTORE_FILE_NAME_PROPERTY = "keystore.filename";
98   private static final String KEYSTORE_PASSWD_PROPERTY = "keystore.password";
99   private static final String LEGAL_NAME = "Legal Name";
100  private static final String L_CHARACTER = "L";
```

Analysis:	Not an Issue	
Comments:	*VHAHAMWandlJ 2017-05-10 11:28 AM*	The references are not hardcoded passwords, but System Property names that refer to passwords

OutboundNCPDPMessageServiceImpl.java, line 76 (Password Management: Hardcoded Password)

Fortify Priority:	High	**Folder**	High
Kingdom:	Security Features		
Abstract:	Hardcoded passwords may compromise system security in a way that cannot be easily remedied.		
Sink:	OutboundNCPDPMessageServiceImpl.java:76 FieldAccess: KEYSTORE_PASSWD_PROPERTY()		

```
74   private static final String KEYSTORE_FILE_TYPE = "JKS";
75   private static final String KEYSTORE_FILE_NAME_PROPERTY = "keystore.filename";
76   private static final String KEYSTORE_PASSWD_PROPERTY = "keystore.password";
```

```
77
78          @Autowired
```

Analysis:	Not an Issue		
Comments:	*VHAHAMWandlJ 2017-05-10 11:28 AM*	The references are not hardcoded passwords, but System Property names that refer to passwords	

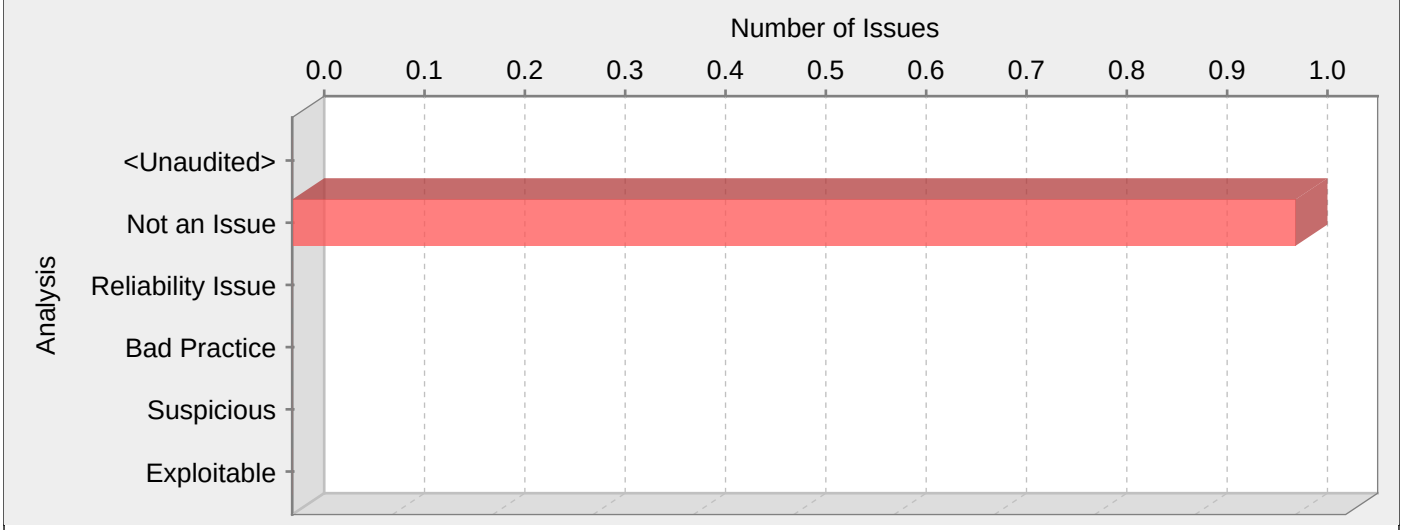
ClientPasswordCallback.java, line 17 (Password Management: Hardcoded Password)

Fortify Priority:	High	**Folder**	High
Kingdom:	Security Features		
Abstract:	Hardcoded passwords may compromise system security in a way that cannot be easily remedied.		
Sink:	ClientPasswordCallback.java:17 FieldAccess: E_AND_E_PASSWD()		

```
15  public class ClientPasswordCallback implements CallbackHandler {
16
17      private static final String E_AND_E_PASSWD = "eAnde.password";
18      private static final String E_AND_E_USERNAME = "eAnde.username";
```

Analysis:	Not an Issue		
Comments:	*VHAHAMWandlJ 2017-05-10 11:28 AM*	The references are not hardcoded passwords, but System Property names that refer to passwords	

Category: Header Manipulation: Cookies (1 Issues)



Abstract:

The method getCookies() in XSSRequestWrapper.java includes unvalidated data in an HTTP cookie on line 193. This enables Cookie manipulation attacks and can lead to other HTTP Response header manipulation attacks like: cache-poisoning, cross-site scripting, cross-user defacement, page hijacking or open redirect.

Explanation:

Cookie Manipulation vulnerabilities occur when:

1. Data enters a web application through an untrusted source, most frequently an HTTP request.

2. The data is included in an HTTP cookie sent to a web user without being validated.

As with many software security vulnerabilities, cookie manipulation is a means to an end, not an end in itself. At its root, the vulnerability is straightforward: an attacker passes malicious data to a vulnerable application, and the application includes the data in an HTTP cookie.

Cookie Manipulation: When combined with attacks like Cross-Site Request Forgery, attackers may change, add to, or even overwrite a legitimate user's cookies.

Being an HTTP Response header, Cookie manipulation attacks can also lead to other types of attacks like:

HTTP Response Splitting:

One of the most common Header Manipulation attacks is HTTP Response Splitting. To mount a successful HTTP Response Splitting exploit, the application must allow input that contains CR (carriage return, also given by %0d or \r) and LF (line feed, also given by %0a or \n)characters into the header. These characters not only give attackers control of the remaining headers and body of the response the application intends to send, but also allows them to create additional responses entirely under their control.

Many of today's modern application servers will prevent the injection of malicious characters into HTTP headers. For example, recent versions of Apache Tomcat will throw an IllegalArgumentException if you attempt to set a header with prohibited characters. If your application server prevents setting headers with new line characters, then your application is not vulnerable to HTTP Response Splitting. However, solely filtering for new line characters can leave an application vulnerable to Cookie Manipulation or Open Redirects, so care must still be taken when setting HTTP headers with user input.

Example 1: The following code segment reads the name of the author of a weblog entry, author, from an HTTP request and sets it in a cookie header of an HTTP response.

```
String author = request.getParameter(AUTHOR_PARAM);
...
Cookie cookie = new Cookie("author", author);
cookie.setMaxAge(cookieExpiration);
response.addCookie(cookie);
```

Assuming a string consisting of standard alpha-numeric characters, such as "Jane Smith", is submitted in the request the HTTP response including this cookie might take the following form:

```
HTTP/1.1 200 OK
...
Set-Cookie: author=Jane Smith
...
```

However, because the value of the cookie is formed of unvalidated user input the response will only maintain this form if the value submitted for AUTHOR_PARAM does not contain any CR and LF characters. If an attacker submits a malicious string, such as "Wiley Hacker\r\nHTTP/1.1 200 OK\r\n...", then the HTTP response would be split into two responses of the following form:

HTTP/1.1 200 OK

...

Set-Cookie: author=Wiley Hacker

HTTP/1.1 200 OK

...

Clearly, the second response is completely controlled by the attacker and can be constructed with any header and body content desired. The ability of attacker to construct arbitrary HTTP responses permits a variety of resulting attacks, including: cross-user defacement, web and browser cache poisoning, cross-site scripting and page hijacking.

Some think that in the mobile world, classic web application vulnerabilities, such as header and cookie manipulation, do not make sense -- why would the user attack themself? However, keep in mind that the essence of mobile platforms is applications that are downloaded from various sources and run alongside each other on the same device. The likelihood of running a piece of malware next to a banking application is high, which necessitates expanding the attack surface of mobile applications to include inter-process communication.

Example 2: The following code adapts Example 1 to the Android platform.

```
...
CookieManager webCookieManager = CookieManager.getInstance();
String author = this.getIntent().getExtras().getString(AUTHOR_PARAM);
String setCookie = "author=" + author + "; max-age=" + cookieExpiration;
webCookieManager.setCookie(url, setCookie);
...
```

Cross-User Defacement: An attacker will be able to make a single request to a vulnerable server that will cause the server to create two responses, the second of which may be misinterpreted as a response to a different request, possibly one made by another user sharing the same TCP connection with the server. This can be accomplished by convincing the user to submit the malicious request themselves, or remotely in situations where the attacker and the user share a common TCP connection to the server, such as a shared proxy server. In the best case, an attacker may leverage this ability to convince users that the application has been hacked, causing users to lose confidence in the security of the application. In the worst case, an attacker may provide specially crafted content designed to mimic the behavior of the application but redirect private information, such as account numbers and passwords, back to the attacker.

Cache Poisoning: The impact of a maliciously constructed response can be magnified if it is cached either by a web cache used by multiple users or even the browser cache of a single user. If a response is cached in a shared web cache, such as those commonly found in proxy servers, then all users of that cache will continue receive the malicious content until the cache entry is purged. Similarly, if the response is cached in the browser of an individual user, then that user will continue to receive the malicious content until the cache entry is purged, although only the user of the local browser instance will be affected.

Cross-Site Scripting: Once attackers have control of the responses sent by an application, they have a choice of a variety of malicious content to provide users. Cross-site scripting is common form of attack where malicious JavaScript or other code included in a response is executed in the user's browser. The variety of attacks based on XSS is almost limitless, but they commonly include transmitting private data like cookies or other session information to the attacker, redirecting the victim to web content controlled by the attacker, or performing other malicious operations on the user's machine under the guise of the vulnerable site. The most common and dangerous attack vector against users of a vulnerable application uses JavaScript to transmit session and authentication information back to the attacker who can then take complete control of the victim's account.

Page Hijacking: In addition to using a vulnerable application to send malicious content to a user, the same root vulnerability can also be leveraged to redirect sensitive content generated by the server and intended for the user to the attacker instead. By submitting a request that results in two responses, the intended response from the server and the response generated by the attacker, an attacker may cause an intermediate node, such as a shared proxy server, to misdirect a response generated by the server for the user to the attacker. Because the request made by the attacker generates two responses, the first is interpreted as a response to the attacker's request, while the second remains in limbo. When the user makes a legitimate request through the same TCP connection, the attacker's request is already waiting and is interpreted as a response to the victim's request. The attacker then sends a second request to the server, to which the proxy server responds with the server generated request intended for the victim, thereby compromising any sensitive information in the headers or body of the response intended for the victim.

Open Redirect: Allowing unvalidated input to control the URL used in a redirect can aid phishing attacks.

Recommendations:

The solution to cookie manipulation is to ensure that input validation occurs in the correct places and checks for the correct properties.

Since Header Manipulation vulnerabilities like cookie manipulation occur when an application includes malicious data in its output, one logical approach is to validate data immediately before it leaves the application. However, because web applications often have complex and intricate code for generating responses dynamically, this method is prone to errors of omission (missing validation). An effective way to mitigate this risk is to also perform input validation for Header Manipulation.

Web applications must validate their input to prevent other vulnerabilities, such as SQL injection, so augmenting an application's existing input validation mechanism to include checks for Header Manipulation is generally relatively easy. Despite its value, input validation for Header Manipulation does not take the place of rigorous output validation. An application may accept input through a shared data store or other trusted source, and that data store may accept input from a source that does not perform adequate input validation. Therefore, the application cannot implicitly rely on the safety of this or any other data. This means the best way to prevent Header Manipulation vulnerabilities is to validate everything that enters the application and leaves the application destined for the user.

The most secure approach to validation for Header Manipulation is to create a whitelist of safe characters that are allowed to appear in HTTP response headers and accept input composed exclusively of characters in the approved set. For example, a valid name might only include alpha-numeric characters or an account number might only include digits 0-9.

A more flexible, but less secure approach is known as blacklisting, which selectively rejects or escapes potentially dangerous characters before using the input. In order to form such a list, you first need to understand the set of characters that hold special meaning in HTTP response headers. Although the CR and LF characters are at the heart of an HTTP response splitting attack, other characters, such as ':' (colon) and '=' (equal), have special meaning in response headers as well.

Once you identify the correct points in an application to perform validation for Header Manipulation attacks and what special characters the validation should consider, the next challenge is to identify how your validation handles special characters. The application should reject any input destined to be included in HTTP response headers that contains special characters, particularly CR and LF, as invalid.

Many application servers attempt to limit an application's exposure to HTTP response splitting vulnerabilities by providing implementations for the functions responsible for setting HTTP headers and cookies that perform validation for the characters essential to an HTTP response splitting attack. Do not rely on the server running your application to make it secure. When an application is developed there are no guarantees about what application servers it will run on during its lifetime. As standards and known exploits evolve, there are no guarantees that application servers will also stay in sync.

Tips:

1. Many HttpServletRequest implementations return a URL-encoded string from getHeader(), will not cause a HTTP response splitting issue unless it is decoded first because the CR and LF characters will not carry a meta-meaning in their encoded form. However, this behavior is not specified in the J2EE standard and varies by implementation. Furthermore, even encoded user input returned from getHeader() can lead to other vulnerabilities, including open redirects and other HTTP header tampering.

2. A number of modern web frameworks provide mechanisms for performing validation of user input. Struts and Spring MVC are among them. To highlight the unvalidated sources of input, the HPE Security Fortify Secure Coding Rulepacks dynamically re-prioritize the issues reported by HPE Security Fortify Static Code Analyzer by lowering their probability of exploit and providing pointers to the supporting evidence whenever the framework validation mechanism is in use. We refer to this feature as Context-Sensitive Ranking. To further assist the HPE Security Fortify user with the auditing process, the HPE Security Fortify Software Security Research group makes available the Data Validation project template that groups the issues into folders based on the validation mechanism applied to their source of input.

3. Fortify RTA adds protection against this category.

XSSRequestWrapper.java, line 193 (Header Manipulation: Cookies)

Fortify Priority:	High	**Folder**	High
Kingdom:	Input Validation and Representation		
Abstract:	The method getCookies() in XSSRequestWrapper.java includes unvalidated data in an HTTP cookie on line 193. This enables Cookie manipulation attacks and can lead to other HTTP Response header manipulation attacks like: cache-poisoning, cross-site scripting, cross-user defacement, page hijacking or open redirect.		

Source: XSSRequestWrapper.java:189 javax.servlet.http.HttpServletRequestWrapper.getCookies()

```
187     @Override
188     public Cookie[] getCookies() {
189         Cookie[] cookies = super.getCookies();
190
191         for (Cookie c : cookies) {
```

Sink: XSSRequestWrapper.java:193 javax.servlet.http.Cookie.setValue()

```
191         for (Cookie c : cookies) {
192
193          c.setValue(stripXSS(c.getValue()));
194         }
195
```

Analysis: Not an Issue

Comments:	*VHAHAMWandlJ 2017-06-27 9:55 AM*	The purpose of this code is to clean dangerous characters and canonicalize the cookie value by reading it and setting it.