Project Report
Software and Security
95-748 A3

Section I - Exploiting Web Vulnerabilities

Broken Authentication - Authentication Bypass and Secure Password

Broken Authentication refers to a class of vulnerabilities that are related to flawed authentication implementations.

Authentication Bypass

For an authentication bypass we use a proxy to freeze the requests from webgoat, and then we change some sort of data depending on the problem. For the first bypass we change the security questions to be able to edit the password.

Vulnerability Identification

```
73    public boolean verifyAccount(Integer userId, HashMap<String, String> submittedQuestions) {
74      // short circuit if no questions are submitted
75      if (submittedQuestions.entrySet().size() != secQuestionStore.get(verifyUserId).size()) {
76        return false;
77      }
78
79      if (submittedQuestions.containsKey("secQuestion0")
80          && !submittedQuestions
81              .get("secQuestion0")
82              .equals(secQuestionStore.get(verifyUserId).get("secQuestion0"))) {
83        return false;
84      }
85
86      if (submittedQuestions.containsKey("secQuestion1")
87          && !submittedQuestions
88              .get("secQuestion1")
89              .equals(secQuestionStore.get(verifyUserId).get("secQuestion1"))) {
90        return false;
91      }
92
93      // else
94      return true;
95    }
96  }
```

```
private HashMap<String, String> parseSecQuestions(HttpServletRequest req) {
  Map<String, String> userAnswers = new HashMap<>();
  List<String> paramNames = Collections.list(req.getParameterNames());
  for (String paramName : paramNames) {
    // String paramName = req.getParameterNames().nextElement();
    if (paramName.contains("secQuestion")) {
      userAnswers.put(paramName, req.getParameter(paramName));
    }
  }
  return (HashMap) userAnswers;
}
```

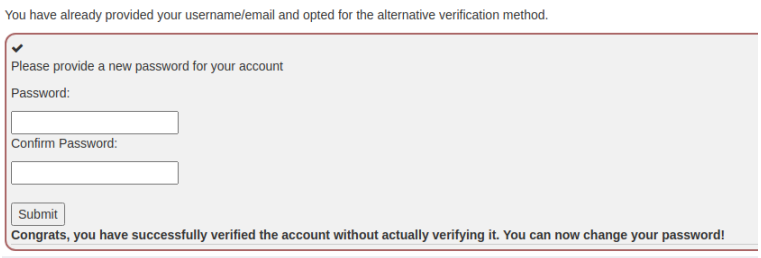
Based on the analysis of the source code, the verification logic of the security questions has implementation flaws. It was hard-coded to check for specific names in the HTTP Post request parameters. Given the execution flow, as long as the HTTP Post Request contains “secQuestion” as part of the parameter name, the validation will pass regardless of the security question.

Exploitation Steps

1. Intercept the HTTP Post Request and change the HTTP Post Parameter of “secQuestion0” and “secQuestion1” to any value that contains “secQuestion” in it.

```
17
18 secQuestionA=test&secQuestionB=test&jsEnabled=1&v
```

Screenshot of modified request



Screenshot of successful exploitation

Business Risks

The consequences of authentication are severe. Typically, attackers can take over the victims account and impersonate them to carry out actions on the application. Depending on the application itself, it may result in financial losses for the victims or even potential disruption of service if the compromised account is privileged.

Secure Password

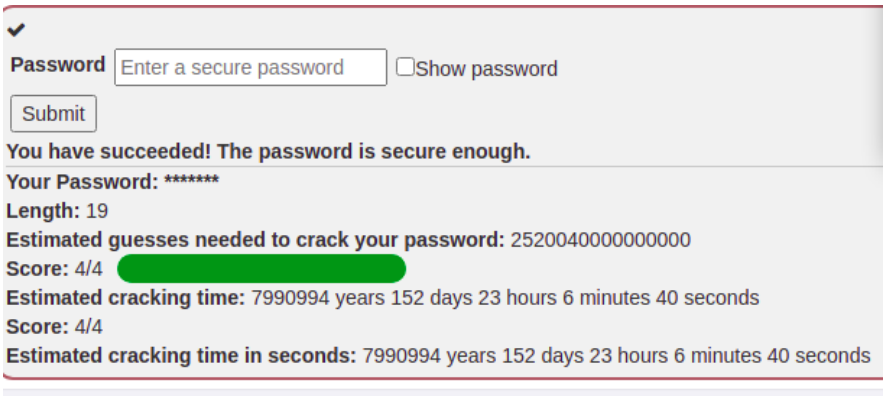
A secure password refers to a password which is resistant to brute force attacks. For instance, strong passwords typically involve the use of (in combination) alphanumeric values, special characters and increased length of the password.

Vulnerability Identification

This vulnerability is attempting to illustrate how insecure passwords can cause significant issues. Many users in organizations fail to maintain proper password etiquette and this results in easily crackable passwords being used. For this exercise, the use of weak passwords can be validated using the web form. It will attempt to demonstrate the strength of the password by performing several password strength estimation tests.

Exploitation Steps

This webgoat module is more of a demonstration, showing how quickly it could break a given password. In reality there are many ways to crack insecure passwords such as using John the Ripper or even through basic social engineering.



Screenshot of secure password submission

Business Risks

Although the risk of insecure passwords is becoming somewhat offset due to the introduction of multi-factor authentication, they still present a substantial problem for organizations that haven't implemented MFA. Additionally MFA fatigue and other attacks can break MFA meaning that the password is the final line of defense and if broken, an unauthorized user could gain access to company infrastructure.

Request Forgery - Client-Site Side Request Forgeries and Server Side Request Forgeries

Request forgery vulnerabilities refer to a class of vulnerabilities that leverages on the trust associated with the entity to perform typically unintended actions/transactions.

Request Forgery - Cross-Site Request Forgeries

Cross-Site Request Forgeries (CSRF) is a class of attack that forces end users to execute unwanted actions on a web application which they are currently authenticated in. The vulnerabilities that are exploited relate to trust between the user and the system. These actions were completed by a secondary user that has used the CSRF vulnerability to exploit items like session cookies and bypass preflight checks.

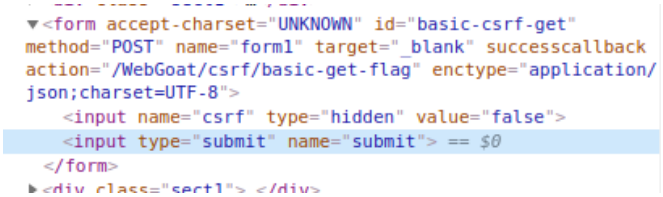
Vulnerability Identification

For this vulnerability, it can be identified by examining the underlying web forms by validating if the web form submission simply only relies on HTTP cookies. In the following sub-section, each exercise's vulnerability will be explained, along with the exploitation steps.

Exploitation Steps

<u>Exercise 1</u>

The original web form is vulnerable to CSRF attacks as it does not validate for any CSRF tokens or protection mechanisms.



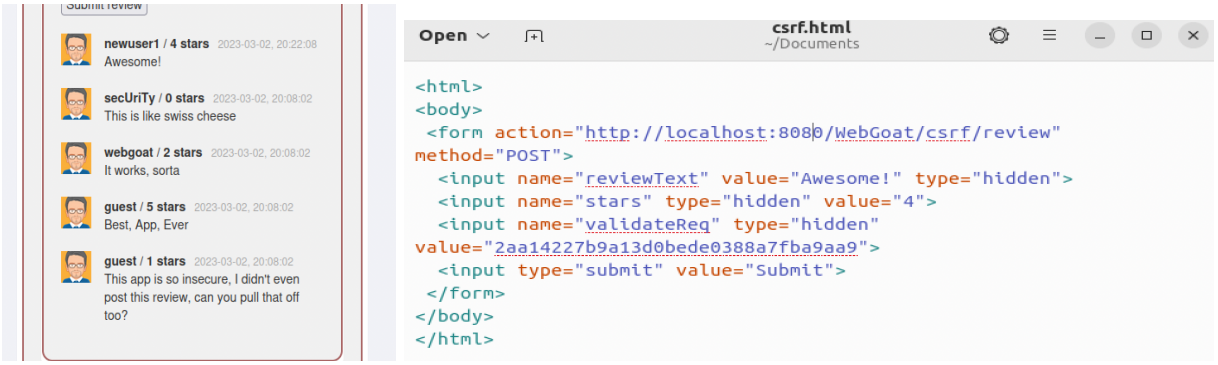
To exploit it, simply create another HTML form that sends the request to the same URL and submit the flag that was returned from the response.

<u>Exercise 2</u>

Similar to Exercise 1, in this exercise, there is an additional HTTP form parameter “validateReq” which we have to pay attention to.

```
<input type="hidden" name="validateReq"
value="2aa14227b9a13d0bede0388a7fba9aa9">
```

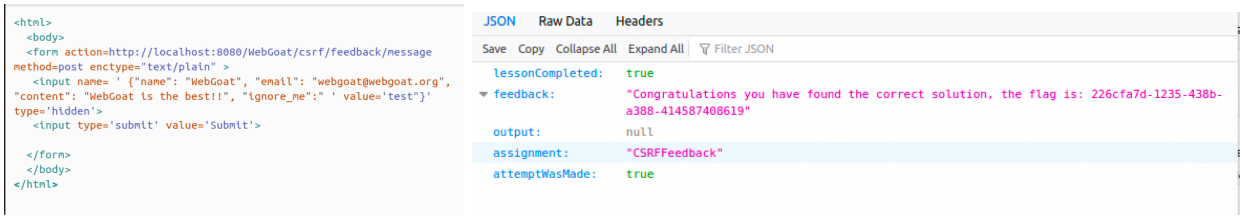
Thus, for the exploit, we have included the key parameters in the web form and submitted it on behalf of the logged in user. This will allow us to submit a forum response on behalf of another user. This is initiated by another source.

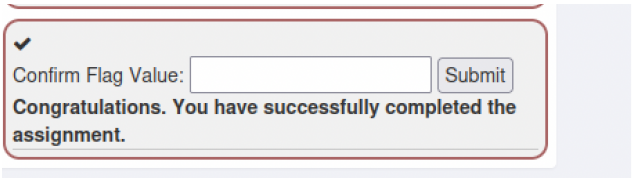


Note the post “Awesome!” that was made on behalf of the logged in user.

Exercise 3

The third exercise focuses on performing a CSRF attack on an API which is not protected against such an attack. The payload creates JSON data as text data that bypasses the preflight check, and allows access to the flag, which grants us the exploit.





Exercise 4

The final exercise is a login CSRF attack. For login CSRF, the attacker attempts to monitor the user activity of the victim through an attacker controlled user account. In this instance, we attempt to change session cookies to the account associated with the attacker by performing a CSRF login on the unsuspecting user.

Screenshot of successful exploitation using login CSRF attack

Business Risks

There are significant business risks associated with CSRF attacks. In many cases, seeing a successful CSRF attack can result in actions like unauthorized fund transfers and stolen session tokens. This could grant a threat actor significant control over user's data and privacy, which can result in the spread of malicious activities. Login credentials and user's data are heavily at risk during a CSRF attack as well.

Server Side Request Forgeries

A server-side request forgery is where a server-side application is induced to make requests to an unintended location. An example of server-side request forgeries include making connections to internal services to possibly leak or steal data.

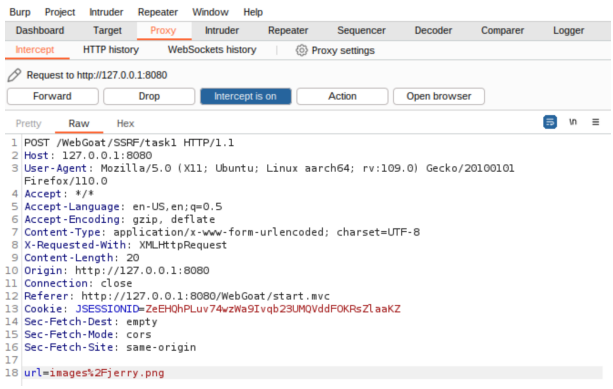
Vulnerability Identification

The request can be modified to fetch resources on behalf of the server.

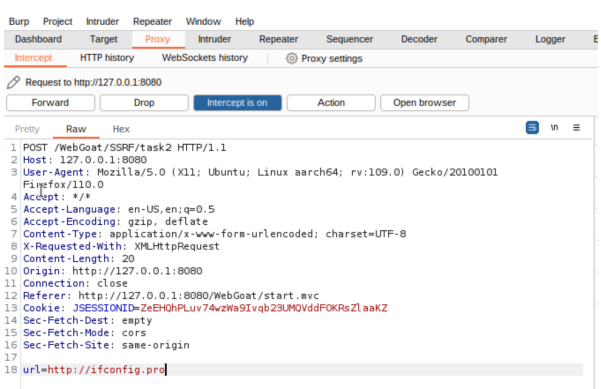
Task 1 and 2: Vulnerable HTTP Post Request Parameter

Exploitation Steps

1) Begin intercepting traffic, forward the requests until you reach the request you need to edit
2) Change the URL that the server should fetch

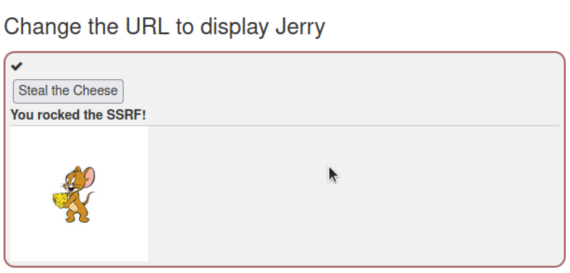


Task 1 Exploit: "images\%2Fjerry.png



Task 2 Exploit: "http://ifconfig.pro"

3) Forward the edited request on to the end user



Task 1: Successful Exploitation

Task 2: Successful Exploitation

Risk Exposure

This server-side forgery vulnerability can lead to the unauthorized actions and/or access of data. The vulnerability can be used as an end to itself (accessing sensitive data) or as a means of escalating an attack. An attacker can access the contents of an admin URL because the request is coming from the local machine itself and therefore bypasses the typical access controls. It is also possible to escalate an attack because an attacker can create a connection to a malicious third-party system. This makes the vulnerability a major risk for even bigger attacks. The exploitation of this vulnerability for the unauthorized access of data constitutes a business risk while the use of it to escalate an attack is a technical risk.

Injection Flaws – SQL Injection (Advanced)

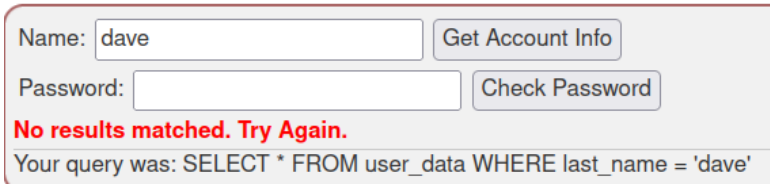
Structured Query Language (SQL) Injection (SQLi) is a type of injection attack that focuses on manipulating the SQL transaction performed by the consuming application.

SQL Injection (Advanced)

Vulnerability Identification

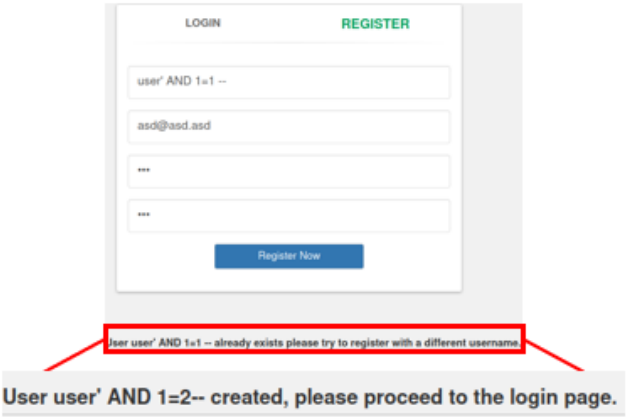
Exercise 1

The existing webform is vulnerable to error-based sql injection. In particular, the SQL query will reflect the SQL command that was executed onto the web application.



Exercise 2

In this exercise, the web form is vulnerable to Blind SQL injection. It is a type of SQL injection attack that asks the database true or false questions and determines the answer based on the application's response. This attack is often used when the web application is configured to show generic error messages. The vulnerability is in the Username field of the register form. Registering username with the payload `user' AND 1=1` will result in a true state which outputs "Already exists". Alternatively, entering a payload of `user' AND 1=2` results in a false state that outputs “created”.

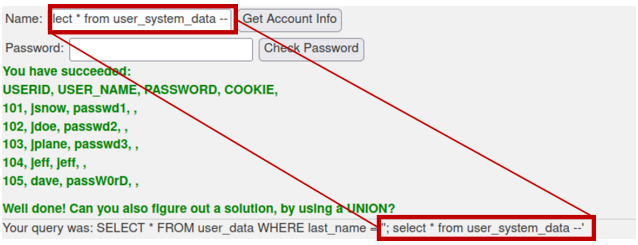


Exploitation Steps

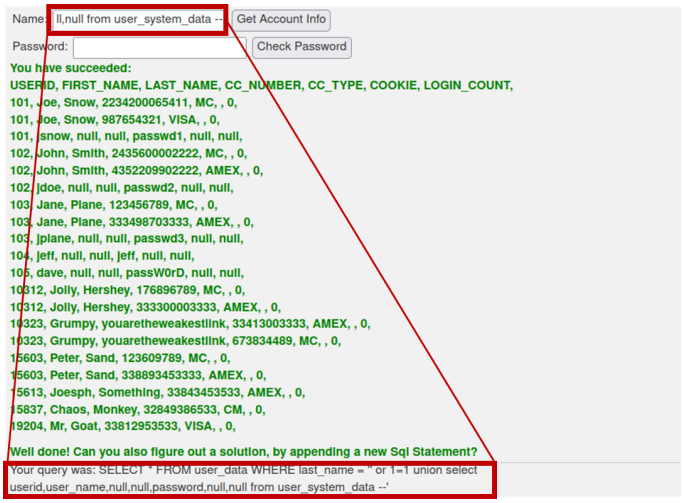
Exercise 1

The error-based SQL injection vulnerability can be exploited by appending a second SQL statement or performing an union query to extract the password.

1. Appending a second query at the end of the SQL query to get Dave's password.



2. Using a UNION query to get contents of user_sysyem_data database



Exercise 2

1. Register a new user and use burp suite to capture a raw single registration request and save it to a file .

2. Using sqlmap to dump the database to find tom's password

```
gabi@gabi-virtual-machine:~/Documents$ sqlmap -r regrequest.txt -p username_reg -v 1 -D PUBLIC -T SQL_CHALLENGE_U
SERS --dump --where "USERID='tom'" --no-escape
```

```
Database: PUBLIC
Table: SQL_CHALLENGE_USERS
[1 entry]
+--------+-----------------+--------------------------+
| USERID | EMAIL           | PASSWORD                 |
+--------+-----------------+--------------------------+
| tom    | tom@webgoat.org | thisisasecretfortomonly  |
+--------+-----------------+--------------------------+
```

Business Risks

Error-based and blind SQL injection are serious business risks that can lead to data theft, data manipulation, financial loss, reputational damage, and compliance violations. These attacks allow attackers to access and manipulate sensitive information stored in databases, which can result in financial and legal liabilities, loss of customers, and damage to an organization's reputation.

Broken Access Control – Insecure Direct Object Reference

Access control are mechanisms used to enforce policies such that users cannot act outside what their originally assigned permissions. However, Inject Direct Object Reference (IDOR) is a class of vulnerability which is due to improper enforcement of access control. It allows users to access privileged objects that are beyond their original permission assignment.

Insecure Direct Object Reference

Vulnerability Identification

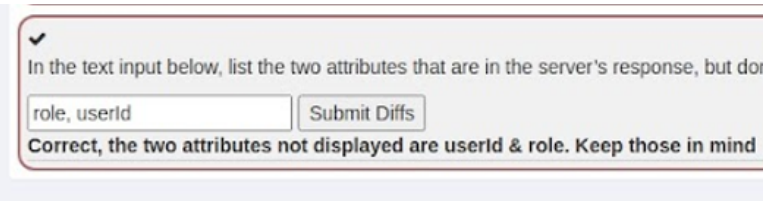
Direct Object References happen when an application uses client-provided input to access data and objects. They usually use GET, POST, PUT, DELETE methods. However, when the application provides the direct access to objects, the attackers can bypass the authorizations and disclose the private data. And this is considered as an insecure direct object reference.

```
[
  {
    "assignment":{
      "id":27,
      "name":"IDORViewOtherProfile",
      "path":"IDOR/profile/{userId}",
      "hints":null
    },
    "solved":false
  },
```


Exploitation Steps

Assuming that we know the userId and password from the insecure application, we could log in to the account.

1. We have to check the attributes that we could check on the server but not on the profile button. By using the BurpSuiteCommunity proxy scanner, we could find “role”, and “userId” attributes were missing on the profile.



2. In the next step, we attempted to guess the userId by incrementing the value by 1 for several iterations. Specifically, we found the userId of another profile by simply incrementing it. We were able to retrieve the attributes of the profile - WebGoat/IDOR/profile/2342388

3. In the final exercise, we were able to edit the other users’ profile by requesting the modified contents to the repeater with the targeted userId (“2342388”). Moreover, on this modification, we changed existing aspects to the following attributes. “Role:1, color:red, size:large, name:Buffalo Bill, userId:2342388”.

Risk Exposure

IDOR vulnerabilities can result in a variety of consequences. In typical cases, it leads to information disclosure whereby information is accessed by unauthorized individuals. As demonstrated in the exercise earlier, it can lead to authorized information modification as well. From a business perspective, this can lead to information leakage and illegal modification of data, causing both financial and reputational losses.

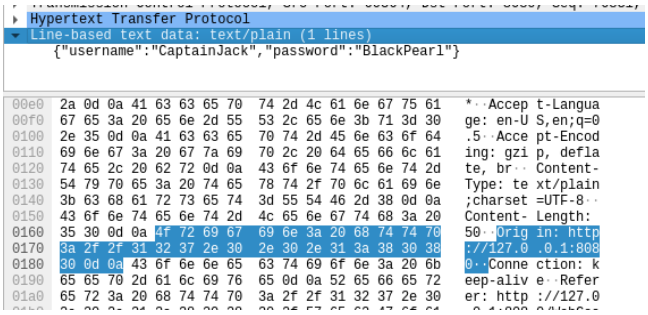
Sensitive Data Exposure - Insecure Login

Insecure Login

HTTP is a protocol used to link and load websites. Compared to HTTPS, HTTP is very insecure as it does not encrypt requests to which any user may intercept the request and view the data unencrypted within.

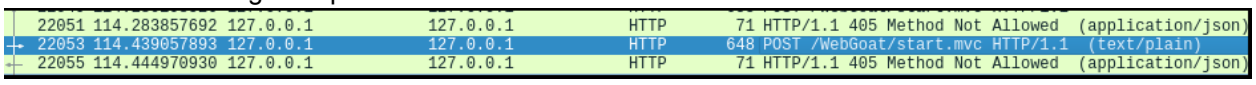
Vulnerability Identification

Since the webpage used HTTP and not HTTPS, we were able to intercept the request to view the data within the request. Since the data was not encrypted we were able to easily view both the username and password to correctly log in.

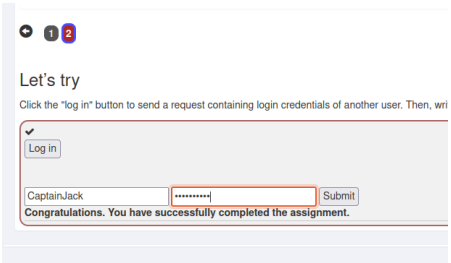


Exploitation Steps

1. Set up wireshark to view the packet flow from the web page
2. View the webpage and enter in a username and password (does not need to be correct)
3. Search through the packets for the text



4. Select the packet and select the down drop for “Line-based text data:”, you can then view in plaintext the username “CaptainJack” and password “BlackPearl”
5. Type in the username and password found and log in successfully



Risk Exposure

Web Pages that use HTTP and show sensitive information such as usernames and passwords run the high risk of being compromised by actors who may be using packet sniffers to view the packets on the network. For business' this can become a security risk compromising possible private information and can become a legal issue if compromised data is stolen.

Cross Site Scripting (XSS) - Reflected and DOM-based

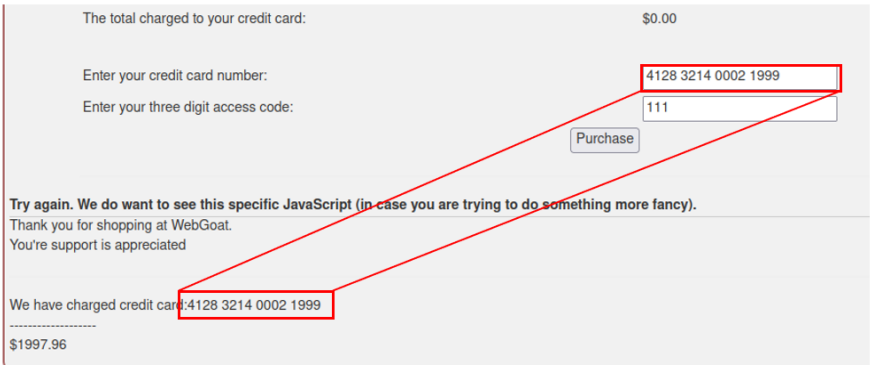
It is a type of injection attack that injects malicious scripts into websites. Typically,attackers manipulate the javascript functionalities on the vulnerable web application to perform various types of malicious activities (depending on the javascript functionality invoked) against the user. For example, XSS attacks can lead to stealing of sensitive data (tokens, etc), to tricking users to perform unintended actions.

Reflected XSS

A type of XSS attack where the injected script is reflected off the server.

Vulnerability Identification

Upon inspection of the web form, the credit card field appears to reflect user supplied input directly into the existing page upon submission.



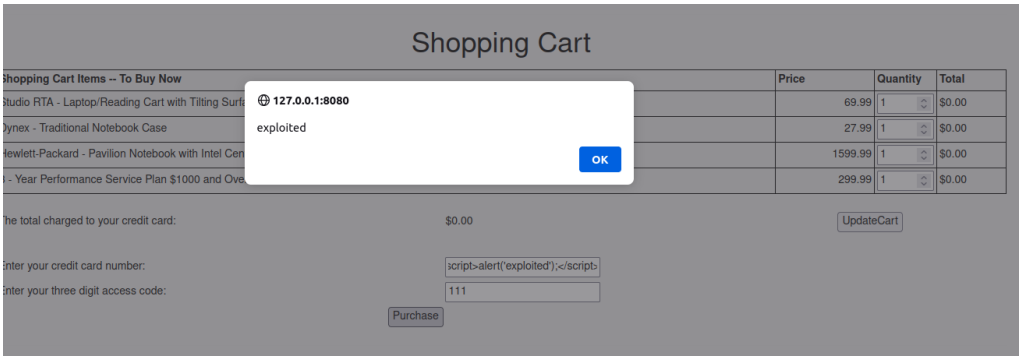
Exploitation Steps

1. Craft a XSS payload that results in an execution by the browser. A payload could be as simple as invoking common javascript functions like "alert" and "console". In this case, the payload will be written in the existing HTML page. Thus, the HTML tag for javascript - "<script>" has to be used to enclose the payload to ensure successful execution.

   Crafted Payload:

   `"<script>alert('exploited')</script>"`

2. Insert the payload in the credit card number field and click "purchase".



Successful DOM-based XSS attack

Risk Exposure

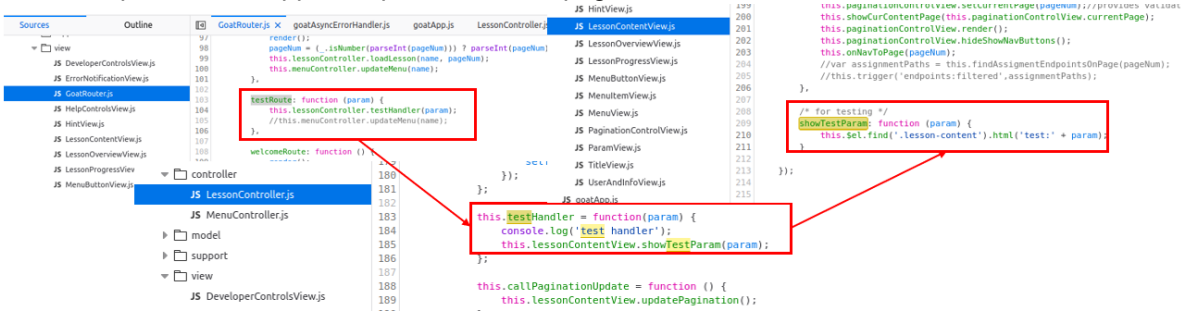
Web applications vulnerable to XSS have a range of impact, from user annoyance to complete account compromise. In this case, sensitive information such as the credit card information could be stolen and sent out of the application. However, as mentioned in WebGoat, this particular vulnerability is a form of “Self-XSS” which requires user interaction to be executed (reducing the likelihood of it happening).

DOM-based XSS

A type of XSS attack where the injected script is executed on the client browser (no interaction with the server).

Vulnerability Identification

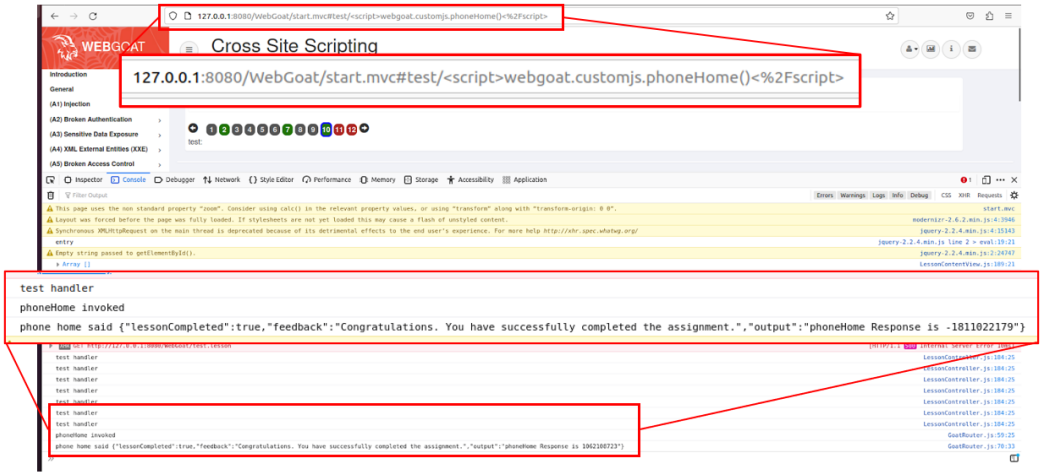
The vulnerability can be identified by viewing the source code of the javascript files that are loaded in the browser when the page is loaded. There is a test function that the developer mistakenly left behind. The test function prints user-supplied input on the web page.



Exploitation Steps

1. Enter the following payload into the browser:

http://127.0.0.1:8080/WebGoat/start.mvc#test/%3Cscript%3Ewebgoat.customjs.phoneHome()%3C%2Fscript%3E



Risk Exposure

Web applications vulnerable to XSS have a range of impact, from user annoyance to complete account compromise. A typical threat scenario is for the attacker to steal session cookies through XSS attacks. This allows the attacker to hijack the victim's user session and take over the account. The consequence of such attacks can result in the compromise of the confidentiality, integrity and availability of the affected system. Depending on the nature of the web application, it may result in potential financial and reputational losses as well. For instance, an administrator's account on a web stock trading platform was compromised through XSS. The attacker can perform various types of actions on the platform, such as manipulating stock prices or even bringing down the platform.

Insecure Deserialization

Insecure deserialization happens when user-controlled data is deserialized by the web application. Attackers attempt to manipulate the serialized data in order to modify the behavior of the consuming web application.

Vulnerability Identification

Original Source of the vulnerable Java class - Vulnerable Task Holder: https://github.com/WebGoat/WebGoat/blob/main/src/main/java/org/dummy/insecure/framework/VulnerableTaskHolder.java

```
// condition is here to prevent you from destroying the goat altogether
if ((taskAction.startsWith("sleep") || taskAction.startsWith("ping"))
    && taskAction.length() < 22) {
  log.info("about to execute: {}", taskAction);
  try {
    Process p = Runtime.getRuntime().exec(taskAction);
    BufferedReader in = new BufferedReader(new InputStreamReader(p.getInputStream()));
    String line = null;
    while ((line = in.readLine()) != null) {
      log.info(line);
    }
  } catch (IOException e) {
    log.error("IO Exception", e);
```

Vulnerable code segment

Exploitation Steps

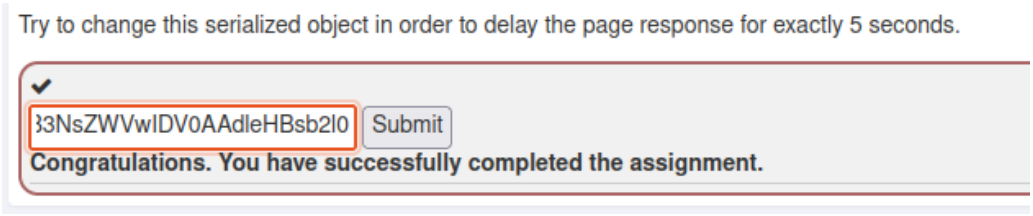
1. Recreate the serialized object with a malicious input. In this case, change the second parameter to the class to “sleep 5”.

```
 GNU nano 4.8                                                    Exploit.java
import java.io.FileOutputStream;
import java.io.ObjectOutputStream;

import org.dummy.insecure.framework.*;

public class Exploit {
        public static void main(String[] args) throws Exception {
                VulnerableTaskHolder vulnObj = new VulnerableTaskHolder("exploit", "sleep 5");
                FileOutputStream fos = new FileOutputStream("exploit.out");
                ObjectOutputStream os = new ObjectOutputStream(fos);
                os.writeObject(vulnObj);
                os.close();
        }
}
```

2. Encode the output using Base64 encoding.

```
softsec@ubuntu:~/Downloads$ cat exploit.out | base64 -w0
rO0ABXNyADFvcmcuZHVtbXkuaW5zZWNlcmUuZnJhbWV3b3JrLlZ1bGSlcmFibGVUYXNrSG9sZGVyAAAAAAAAAAICAANMABZyZXF1ZXN0ZWRFeGVjdXRpb25UaW1ldAAZTGphdmEvdGltZS9Mb2NhbERhdGVUaW1lO0wACnRhc2tBY3Rpb250ABJMamF2YS9sYW5nL1N0cmluZztMAAh0YXNrTmFtZXEAfgACeHBzcgANamF2YS50aW1lLlNlcpVdhLobIkiyDAAAeHB3DgUAAAfnAhoNJTgxQETceHQAB3NsZWVwIDV0AAdleHBsb2l0softsec@ubuntu:~/Downloads$
```

3. Enter the exploit into the form.



Screenshot of a successful application.

Risk Exposure

Successful exploitation of insecure deserialization often leads to remote code execution on the compromised host. This severely impacts the confidentiality, integrity and availability of the system/host as the attacker has control over them. If a business were to become vulnerable and exploited from this attack, it could mean data is compromised and the current system as well as other systems connected could be permanently affected.

Section II - Mitigation Strategies

Broken Authentication - Authentication Bypass

Mitigation Technique

This was a simple attack where we were able to use a proxy to freeze the request with a password reset. Since the vulnerability issue was due to the hardcoding of the checkpoint, we can mitigate this issue by having the actual full value being checked with parameters instead of accepting any value that contained the keywords that were hardcoded. In addition, 2 factor authentication can be implemented to mitigate risks of potential authenticated mechanism compromises.

Security Touchpoint

Architectural Risk Analysis can be an effective touchpoint to mitigate risks associated with authentication bypass attacks. Especially on this particular vulnerability, there are inherent flaws with the design of the authentication mechanism. The validation of the security questions were architecturally flawed as the checks were not inclusive and conclusive, which resulted in the check not being comprehensive. In addition, additional layers of authentication mechanisms were not implemented to act as guardrails. Through architectural risk analysis, we are able to identify such flaws from the design perspective.

Broken Authentication - Secure Password

Mitigation Technique

One of the key mitigation is to implement a secure password policy that is enforced during registration or account registration phases. A strong password policy includes a password length of 12 characters long, with a combination of uppercase letters, lowercase letters, numbers and symbols. In addition, it should not be found in a dictionary, or referenced from common names, characters, products or organizations.

Security Touchpoint

A relevant touchpoint for implementing Secure Password is Security Requirements. It is a White-hat approach to have explicit defense against black-hat world. By enforcing Security Requirements for Secure Passwords, we are able to ensure that the application has “defenses” by default when it comes to weak passwords. For instance, we mandate the requirements of a strong password policy as part of non-functional requirements of the application.

Request Forgery - Cross-Site Request Forgeries

Mitigation Technique

Cross Site Request Forgeries can be mitigated using the Synchronizer Token pattern. This is used to generate tokens to combat the CSRF browser authentication and cookie exploitation. These tokens allow an extra layer of validation as well as backend protection against CSRF attacks. These tokens are validated and checked every time a request is issued, mitigating these types of attacks.

Security Touchpoint

Penetration testing would be an effective security touchpoint against CSRF. If a company wanted to know if their company would be defended against such an attack, or if they have implemented a token system and need it to be tested, a skilled penetration tester would provide a great resource to test the effectiveness and strength of the current defenses in place. It allows the application to be validated against such attacks in an actual working environment.

Request Forgery - Server-Side Request Forgeries

Mitigation Technique

Server-side request forgeries can be prevented by implementing a white list. A white list is a list of things that are considered trustworthy and allowed to be accessed. In addition, checksums of the request can be calculated and implemented to prevent illegal modification of the data. Checksums are unique numbers associated with a file that are used to confirm that it is the one you expect and that it has not been modified. There are also integrity checking tools such as Tripwire which are used to detect data modification.

Security Touchpoints

Similarly to CSRF vulnerability, SSRF vulnerability can be detected through Penetration Testing security touchpoint. Through Penetration Testing, we attempt to identify poor handling of the program. In this instance, we will attempt to access protected/hidden trusted resources from a vulnerable public facing application. By performing Penetration Testing, we are able to validate the existence of the vulnerability with a high degree of confidence as we can get to demonstrate in an actual working environment.

Injection Flaws – SQL Injection (Advanced)

Mitigation Technique

SQL injections can be prevented by only allowing certain characters to be input into fields. For instance, the validation mechanism can check for the presence of illegal characters such as “!#@%” etc.
User-supplied inputs should not be trusted and should be sanitized if the application consumes it.

Security touchpoint

Abuse Cases is a potential security touchpoint that can be used to detect SQL Injection vulnerabilities. It tests the system behavior when malformed inputs are provided to the system. SQL injection vulnerabilities often cause the application to misbehave when such vulnerabilities are exploited. Thus, under Abuse Cases, when the application receives malformed inputs that are used in its SQL execution, the application is able to give away signs that the vulnerability exists due to the difference in application behavior.

Broken Access Control – Insecure Direct Object Reference

Mitigation Technique

To mitigate against IDOR vulnerabilities, all access points within the application should be enforced with authorization mechanisms. For instance, web application frameworks typically include authorization controls to restrict access to privileged resources based on the user's privileges. For example, Django has default authentication and authorization controls that prevent unauthorized access to privileged resources.

Security touchpoint

Code Review is an effective security touchpoint that can be used to detect IDOR related vulnerabilities. For example, one can review the authorization mechanisms in each of the application's public facing endpoints/interfaces. From a white-hat perspective, we are able to have deeper insights on the inner workings of the application by performing code review. Thus, we can trace inner logic of the application and identify potential entry points that lack authorization controls.

Sensitive Data Exposure - Insecure Login

Mitigation Technique

The way the sensitive data of the username and password was intercepted was due to the use of HTTP displaying the data unencrypted. To mitigate this vulnerability the webpage should use HTTPS to encrypt the sensitive data. This can prevent passing by packet sniffers from obtaining the sensitive data.

Security Touchpoint

Security Requirements is a potential security touchpoint that can help to detect this vulnerability. By enforcing such HTTPS as part of the non-functional requirements (security requirements), we can ensure that data is properly secured in transit. It would prevent a packet sniffer from being able to see exposed data. All sensitive data should be encrypted before sent into transit.

Cross Site Scripting (XSS) - Reflected and DOM-based XSS

Mitigation Technique

Both reflected and dom-based XSS have similar applicable mitigation techniques. The root cause of these two vulnerabilities is primarily due to the lack of input sanitization. If possible, user supplied inputs should be validated with well known validation libraries to prevent implementation flaws in the custom validation function. Alternatively, the use of escape functions can be used to encode the output so that it is safe to be executed on the client's browser.

Security Touchpoint

Code Review would have helped in identifying such vulnerabilities at source code level, before the deployment of the application. For instance, we can focus on looking for validation implementation in the source code that handles user-supplied inputs. Both the instances of reflected and dom-based XSS vulnerabilities can be easily identified through Code Review.

```
<html>
<body>
<?php
print "Not found: " . urldecode($_SERVER["REQUEST_URI"]);
?>

</body>
</html>
```

Screenshot of potential reflected XSS vulnerability (S, 2023)

```
<script>
var x = '<%= taintedVar %>';
var d = document.createElement('div');
d.innerHTML = x;
document.body.appendChild(d);
</script>
```

Screenshot of potential reflected XSS vulnerability (S, 2023)

During Code Review, such functionalities that use user-supplied inputs (as shown in the screenshot above) can be easily identified.

Insecure Deserialization

Mitigation Technique

Avoid using serialized objects from untrusted sources, such as user-inputs. If the use of serialized sources is necessary, ensure that the running code is executed in a low privileged environment. In addition, implementing integrity checks on serialized objects can help to detect any form of tampering.

Security Touchpoint

Insecure Deserialization, in practice, can be difficult to successfully execute as it has a set of preexisting conditions for its execution. For instance, such as a vulnerable component in the code that can be exploited to run the malicious code and the object's internal structure must be known to the attacker. Penetration testing is a good approach to identify such vulnerabilities as such an assessment is able to validate if the vulnerability can be successfully exploited even if the vulnerable component exists.

References

S, K. (2023). Cross site scripting (XSS). Cross Site Scripting (XSS) | OWASP Foundation. Retrieved February 21, 2023, from https://owasp.org/www-community/attacks/xss/