Software Vulnerabilities

Written by Lewis Impey

**Missing Authentication for Critical Function**

This security vulnerability describes cases where the software does not perform any validation of the user’s identity before allowing access to privileged application functionality e.g. allow a user to add, modify or delete records without validating whether they are an admin or not (Software Security, no date).

The potential impact of this security vulnerability can depend on what functionality the software has, and can vary from trivial to severe. In the most severe of cases, its possible that private information could be disclosed or the entire application could be compromised.

To mitigated this software vulnerability, it is important that all functionality that uses privileged assets or information is identified. There should also be very clear roles defined for use within the application (such as admin and user) which have specific permissions given and withheld from them. It is also important to constantly check whether a user has access to the privileged information or assets that they are accessing (Missing Authentication for Critical Function, no date).

**Weak Passwords**

This security vulnerability is rather straightforward, but a weak password is a password that is usually short, common, a system default (password is password) or something that could be very easily guessed with brute force attacks. Also passwords that could be guessed using a subnet that contains words from a dictionary, names, words based on the username, etc.

Since a password is a key to your computer (or another device/application) that could possibly contain very private information, it is important that a strong enough password is set so that it could not be easily guessed by someone trying to get into your account or device with malicious intent.

(Christian B. Lahti, R. P. 2005) This is a very easy software vulnerability to fix, as it just entails changing a weak password to a stronger, more verbose password that is more difficult to guess. Below are some characteristics of a strong password that should be considered when creating a password:

* Contain both upper- and lowercase characters (e.g., a–z, A–Z).
* Have digits, punctuation characters, and letters (e.g., 0-9! (e.g., 0-9! @#$%^&\*()\_+|∼−=\′{}[]:“;'<>?,./).
* Are at least eight alphanumeric characters long.
* Not a word in any language, slang, dialect, jargon, etc.
* Are not based on personal information, names of family, etc.

It is also important that a even with a strong password you also store it properly, as it would not matter how verbose your password was if it was written down and stuck to your desk for anybody to see (Sudhanshu Chauhan, N. K. 2015).

Written by Shantanu Talukder

**File Upload Vulnerability**

This vulnerability comes in two forms-

1. Local file upload vulnerability- When a malicious script is being uploaded by the user directly and executed.

One way this can happen is when there are no restrictions on the users who can upload the files. This can easily be fixed by adding authentication checks via restricting who can upload (eg- log in/sign ups) and authorization checks via checking what files are being uploaded.

Another way this can happen is when a file name/contents are not sanitized and the non-sanitized file can contain an extension which the attacker can use to execute a code accessed via web. This can be avoided with application which has features that allows it to sanitize files before uploading.

1. Remote file upload vulnerability- is when the users provide a site URL which is used to save a file from that site locally on a disk. If the file is malicious is then used by the attacker to cause harm.

This can be prevented by

1. Checking what kind of file is being uploaded.
2. The allowance of only specific types of file extensions
3. Only specific users being able to access this form of file upload.
4. Storing files in a directory that is only accessible to authorized users.
5. Making stored files non executable.

**Missing Authorization Vulnerability**

This takes place when an application does not do an authorization check when a user tries to use its resources or use it to do something. This allows users who should not have the privilege to access certain data or actions to do so.

This can create a whole host of problems like leaking of sensitive data, modification data by the attacker, attackers to execute codes on a targeted device, denial of service to users and attacker could grant themselves privileges by modifying critical data.

This can be prevented by having the architecture and design of the software being reviewed, alongside other detection methods.

SQL Injection

Written by Jacob Beynon

**What is SQL Injection?**

SQL injection is a web-based vulnerability which allows the user to submit queries which interfaces with the data base. This grants access to information that is otherwise hidden to the user. This includes data which could belong to users or data which that application has access to.

If SQL injection is successful, then the user could remove or edit entries within the database itself. Most attacks recently have been due to SQL injection resulting in some major damage and even fines. If the SQL injection is not resolved and fixed, then it could be used as a backdoor into the server which the database is on and could cause major damage.

**How to SQL Inject**

Injecting SQL into a program is very easy. Say we have a program where we can search through the data base for a specific user, this is how we would do it:  
txtUsrId = getRequestString(“UsrId”)

searchSql = “SELECT \* FROM Users WHERE UserId = ” + txtUsrId;

This command allows us to enter in a user ID and it will search everything inside the Users table until it finds the given user. If instead of entering in the user ID of a user e.g., “Usr30005218”, we enter in a quire such as “5214 OR 1=1” This will then make the statement:

“SELECT \* FROM Users WHERE UserId = 5214 OR 1=1”

As 1=1 is true this results in every user being displayed within the program with all their private information. This is however the most basic way of SQL injection.

Another way SQL injection can occur is via the “=” operand. This occurs if you have a login screen where the user needs to enter in their username and password. If you enter in your details into the representative textboxes this is what the code would look like:  
UsrName = getRequestString(“Tb\_Username”);

UsrPassword = getRequestString(“Tb\_Password”);

“SELECT \* FROM Users WHERE Name= +”UsrName” + AND Pass=+ ”UsrPass”+”

Normally entering in your details here would either grant you access to your account or display an error message, but if you instead include the “=” operand then just like the example above all the account details will be displayed to the user.

Both problems we will be facing within our program and will need to create some code to prevent this from occurring.

**How to prevent SQL injection**

Prevent a SQL injection attack is rather simple to do. It can be as easy as writing a few lines of code to applying additional programs to work all together: Here are some ways that we will be trying to reduce SQL attacks on our program.

One way we can reduce SQL injections attack sis reducing the amount of access points. When constructing our program, we should only have the amount of SQL interactions needed for our program to run. If we have to many then this could be a sign of weakness and could be abused. We could also reduce the number of text boxes for user input so that the user has less limited area to attack.

Using a variety of hard coding and dynamic SQL commands reduces the about of possible SQL injection attacks. The main area for SQL injection is via the user input so if we reduce the need for user input and have pre-generated queries, this results in less ways off attacks. Of cause the program could not run properly if everything is hard coded so having a variety of both is a good procedure.

One of the main ways is having code which catches the SQL attack attempt. This can be done by many ways. As we are using SQLite it comes with a pre generated function called “string sqlite\_escape\_string()”. This function will escape any query being made if it detects any characters which are deemed special via SQLite.

**Buffer Overflow**

Written by Ryan Murunga

Data received can maliciously or unintentionally overrun a fixed capacity memory space and overwrite or corrupt data in adjacent spaces. This occurrence is termed as a buffer overflow.

Buffers are memory spaces that temporarily hold data while being transferred. They are vital in cases where the rate data is received is different from the rate data is processed. An example of a buffer overflow attack is when on a login interface page, the password input can be set to expect an 8-byte password, but instead when the user enters a 10-byte password, the excess data can overrun the adjacent memory spaces. A buffer overflow attack can cause system crashes, memory access errors or even make the program perform unauthorized tasks.

Among the various attacks of this nature, the commonly known ones are:

* Stack based buffer overflow, which occurs when a buffer located on the stack has more data written into it.
* Heap based buffer overflow, which occurs when the memory space is flooded having the application overwrite internal structures as a result.

Attackers use buffer overflows to alter the execution path of applications. When a carefully crafted malicious code is sent to the application and executed, the attacker can take over the application and cause harm.

C and C++ are programming languages that are highly susceptible to this kind of attack as they lack safeguarding techniques that guard against overwriting or data access in their memory. Programming languages that are relatively less susceptible to buffer overflow attacks are Java, Python and C# just to name a few.

**How to prevent/mitigate a buffer overflow attack**

All is not lost as you can protect your program against buffer overflow attacks and one way of doing so is address space randomization. This is randomly moving around the address space locations of data regions making it virtually impossible for the buffer overflow attack to happen for it depends on the locations of the executable code.

Data execution prevention, flagging certain memory areas as non-executable or executable is another data protection method. Furthermore, bounds checking can be applied at runtime, automatically checking that data written to a buffer is within acceptable boundaries.

A structured exception handler overwrite protection can be applied to assist in stopping harmful code from manipulating the Structured Exception Handling, a built in mechanism for managing software and hardware exceptions.

**Cross site scripting (XSS)**

Written by Nisa Shahril

**Overview of Cross-site Scripting (XSS)**

Cross-site scripting that is commonly referred as XSS, occurs when hackers execute malicious scripting code within a victim’s browser. XSS is one of the most common application-layer web attacks. XSS is also one of the most common security vulnerabilities in software to date.

**What is Cross-site Scripting (XSS)?**

XSS is a type of web security vulnerability that allows an attacker to compromise the interactions that users have with a vulnerable application. XSS normally allows an attacker to masquerade as a victim user, to carry out any actions that the user is able to perform, and to access any of the user’s data, this is what makes XSS differ from other web attacks such as SQL Injections. The users of the web application are the ones at risk instead. One successful XSS attack can have devastating consequences for an online business’s reputation or its relation with its clients. In general, XSS attacks are easy to execute, but difficult to detect and prevent.

**How does Cross-site Scripting (XSS) work?**

XSS works by manipulating a vulnerable website so that it returns malicious script to users. As when the code executes inside a victim’s browser, the attacker can fully compromise their interaction with the application.

**XSS Types of Attacks**

XSS attacks can be broken down into three types which are stored, reflected and DOM-based.

Stored XSS is also known as persistent XSS. It arises when an application receives data from an untrusted source and includes that data within its later HTTP responses in an unsafe way. Stored XSS is the more damaging attack because:

* The payload is not visible for the browser’s XSS filter
* Users might trigger the payload accidentally if they visit the affected page, while a crafter URL or specific form inputs would be required for exploiting reflected XSS.

Besides that, reflected XSS is the simplest variety of XSS. It arises when an application receives data in an HTTP request and includes that data within the immediate response in an unsafe way. The script will be embedded into a link and is only activated when the link has been clicked on. By tricking the user to click the link, the script can carry out any action, and retrieve any data to which the user has access.

Finally, DOM-based XSS or also known as DOM XSS will arise when an application contains some client-side script that processes data from an untrusted source in an unsafe way, usually by writing the data back to the DOM. Typically, the input field would be populated from part of the HTTP request, such as a URL query string parameter allowing the attacker to deliver an attack using a malicious URL, in the same manner as reflected XSS.

**XSS Attack Examples**

Stored XSS:

While browsing an e-commerce website, a perpetrator discovers a vulnerability that allows HTML tags to be embedded in the site’s comments section. The embedded tags become a permanent feature of the page, causing the browser to parse them with the rest of the source code every time the page is opened. The attacker adds a comment with a URL. From that point, every time the page is accessed, the HTML tag in the comment will activate a JavaScript file, which is hosted on another site, and has the ability to steal visitor’s session cookies.

An attacker can compromise the visitor’s account by using the session cookie, granting easy access to personal information and credit card data. The visitor however may never have even scrolled down in the comments section, is not aware that the attack took place.

Reflected XSS:

While visiting a forum site that requires users to log in to their account, a perpetrator executes this search query <script type=’text/javascript’>alert(‘xss’);</script> causing to occur:

1. The query produces an alert box saying: “XSS”.
2. The page displays “<script type=’text/javascript’>alert(‘xss’);</script> not found”.
3. The page’s URL reads http://ecommerce.com?q=<script type=”text/javascript”>alert(‘XSS’);</script>.

This tells the attacker that the website is vulnerable. Then, will create his own URL. While the sending address and subject line may appear suspect to some, it does not mean that it won’t be clicked on. They will be taken to the forum’s website, where the malicious script will be reflected back to their browser, enabling the attacker to steal their session cookies and hijack their forum account.

DOM XSS:

If you send a HTTP request like http://www.example.com/test.html#<script>alert(1)</script>, your JavaScript code will get executed, because the page is writing whenever you typed in the URL to the page with document.write function. If you look at the source of the page, you will not see <script>alert(1)</script> because its all happening in the DOM and done by the executed JavaScript code.

After the malicious code has been executed by page, you can simply exploit this DOM based XSS vulnerability to steal the cookies from the user’s browser or change the behaviour of the page on the web application as you like.

**Preventing XSS Vulnerabilities**

Preventing XSS is very crucial in some cases but can be much harder depending on the complexity of the application and the ways it handles user-controllable data.

* Filtering input on arrival. Web applications must properly validate any input and remove malicious scripts.
* Encode data on output. User-controllable data is output in HTTP resources, encode the output to prevent it from being interpreted as active content.
* Use appropriate response headers. Preventing HTTP responses that are not intended to contain HTML or JavaScript. Links should generally be disallowed if they do not begin with a whitelisted protocol such as http:// or https://.
* Content Security Policy (CSP). CSP is a browser mechanism that aims to mitigate the impact of XSS-like behaviour. This is for the last line of defense, where can use CSP to reduce the severity of any XSS vulnerabilities that is still occurring.

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