IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 11, November 2015.
www.ijiset.com
ISSN 2348 – 7968

Detection Prevention of Input Validation Attacks For Web Application Security

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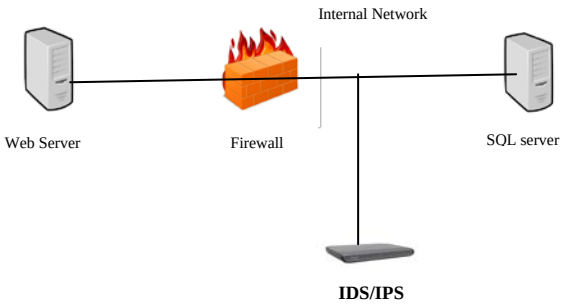
Abstract

Web applications are used to provide e- services such as social networking over the internet, the attacks over the web applications have also increased. Many systems are currently present for detecting and preventing web attacks, they are often limited in scope and functionality. Many existing tools can only respond to certain types of attacks. Most of the systems are also platform specific. These techniques are earlier used for purpose of network security but with recent advancement in application threats these tools are now used for securing application level attack. SWART is an Application Intrusion Detection System tool which secures web application by providing early warning to the attacker or the malicious user then it might be possible that the application is not further exploited for finding the loopholes. The proposed approach with PHP based web application and also perform Chi Square test to validate the assumptions. The Chi square Hypothesis testing is used to prove the importance of response tool for the web application.

Keywords: Input Validation Attacks, Cross-site Scripting Attack, Brute Force Attack, Validation Response Algorithm

1. Introduction

Nowadays, Attacks mainly focus to exploit vulnerabilities at application level. Intrusion Detection and prevention Systems is the process of monitor the network and analyzing for signs of possible flaws occurring in the web application. An IDPS able to detect traffic indicative of the new attack. An intrusion detection system (IDS) is automates the intrusion detection process. The proposed approach detect vulnerabilities by using Signature-based Intrusion Detection System(SIDS). A Signature-Based Intrusion Detection System compares the signatures or attack patterns, and compares the patterns against the well-known attack patterns that are stored in the database. As the attack pattern matches to the packed patterns, The Signature-Based Intrusion Detection System(SIDS) generate and sends report to the administrators.An intrusion prevention system (IPS) do all the process of an intrusion detection system. An Intrusion detection and prevention systems(IDPS) identify flaws in the web application, log information about the intruder, attempt to stop the attack and produce reports for security administrators. Fig(1) shows the block diagram of Intrusion Detection and Prevention System IDPS.



Fig(1):Intrusion Detection and Prevention System(IDPS)

2. Input Validation Attacks

An attacker intentionally send unusual input in the hopes of confusing the web application known as Input Validation Attack(IVA). If an attacker discovers that the application makes unsupported expectations about the type, length, format, or range of input data.. While the network level entry points are fully secured; The input to the web application used to test the system and a way to execute the code on an attacker's behalf. If the web application trust the input of an attacker, it may be susceptible to the input validation attacks.These attacks provide vulnerability to the web application.The proposed approach is explained about types of input validation attacks.

2.2 Cross-Site Scripting Attack:

In the Cross-Site Scripting attack the Scripts (JavaScript, VBScript, ActiveX, HTML) are embedded in web pages that run in the browser. These scripts can access cookies, create requests

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for getting private information. Web application often takes user input and use this input as a part of a web page. The use of XSS might compromise private information, manipulate, and create requests that can be mistaken for a valid user, or execute malicious code on the end-user systems. The data is usually layout as a hyperlink containing malicious data and which is distributed over any web page on the internet. In a typical XSS attack the hacker contaminates a legitimate web page with the malicious client-side script. When a legitimate user visits this web page the script is downloaded to the hacker browser and executed.

Example of Cross-Site Scripting:

An user to visit the specially expertised link by an attacker.When the user visit the link, the crafted code will get executed by the user's browser.

<?php

$name = $_GET['name'];

echo "Welcome $name
";

The attacker will craft an URL as follows and send it to the victim:

guestbook.php? name=guest<script>alert('Hacking attempt

detected')</script>

• **Reflected XSS:**

Reflected XSS is one type of cross-site scripting attack. It targets vulnerabilities that occur in the application, when data submitted by the user is immediately processed by the server to generate results that are then forward to the browser on the client system. An exploit is positive if it can send code to the server that is included in the Web page results sent back to the web browser, and when the results are sent the code is not encoded using special character encrypting hence being inferred by the browser rather than being displayed as the visible text. The most common way to make use of this exploit possibly involves a link using a twisted URL, such that a variable passed in a URL to be displayed on the page contains mischievous code. Something as simple as another URL used by the server-side code to produce links on the page, or user's name to be included in the text page so that the user can be entered by name, can become a exposure hired in a reflected cross-site scripting exploit.

Stored XSS:

Stored XSS is also known as HTML injection attacks, stored cross-site scripting abuses are those where some data sent to the server is stored (typically in a database) to be used in the formation of pages that will be served to other users later. This form of cross site scripting exploit can affect any visitor of the Web site, if the site is subject to a stored cross-site scripting vulnerability. The example of this sort of vulnerability is content management software such as oppurtunities and bulletin boards where victims are allowed to use raw HTML to format their posts. As with preventing reflected exploits, the key to securing the site against stored exploits is ensuring that all submitted data is translated to display entities before display so that it will not be inferred by the browser as code.

2.3 Brute Force Attack:

In a brute force attack, an automated software is used to create a large number of successive expectations as to the value of the desired data. Brute force attacks may be used by criminals to crash encrypted data, or by security experts to test an organization's network security. In this type of attack it could be very time consuming to try all possible combinations. A brute force attack is a trial method used to obtain information such as a user password or personal identification number (PIN). Brute force (also known as brute force cracking) is a trial and error method used by the application programs to crack the encrypted data such as passwords through exhaustive effort (using brute force) rather than employing logical strategies.

3.Proposed Approach:

SWART (Secure Web Application Response Tool) consists of four modules. Assumed that the application contains login page which uses SQL query to be connected with underlying database. .Fig(2) shows Framework for Cross-site scripting Attacks and Brute force attacks are the important part of the proposed approach.

- Brute Force Attack Module(Login sensor Module)
- Cross-site Scripting Module

These three modules implemented by the following process

• Classification Analyzing Engine
• Intrusion Detection Engine
• Threshold Comparator Module
• Response Redirect Module

The proposed mechanism used to detect and prevent input validation attacks but it also detect and prevent other types of attacks such as Invalidated redirects and forwards.

3.1 Session Manager:

Every application will need to be registered to the database. Session Manager provided a unique Authentication-token key When an application communicates with the server, the authentication token and the domain from the request headers are validated and only if the tokens are authenticated, a short-lived session will be set on the client side for near future access and the server will continue processing requests from the same.

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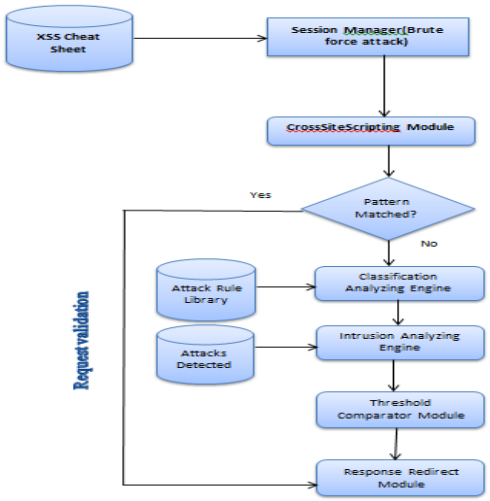


Fig (2)- Framework for Cross-site Scripting Module

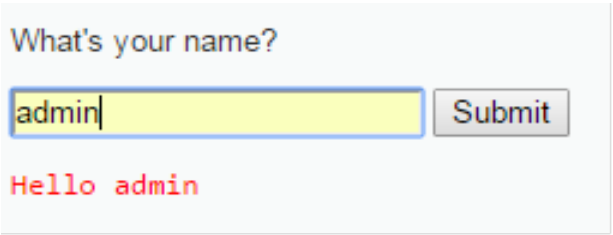
3.2 Brute Force Attack Module(Login Sensor Module):

The first module is Login Sensor Module. As the intrusion occurs from login module & Brute force attack is the most prominent attack that occurs at the login form. The proposed approach develop login form having username & password connected to underlying attack rule library. When the authorized user will enter the details the multistep verification form or the application form will be generated but if intruder tries to attack the login form with SQL query the attack pattern will be matched & intruder will be taken to alarm page.

3.3 Cross-Site Scripting Module:

This module also checks the attack pattern is matched from the attack rule library. If the attack pattern is matched, Intrusion Detecti on Engine detect the attack as intrusion & add attack score whenever attack is detected. Threshold Comparator Module compares the intrusion detection engine score with the adjusted threshold value. Response Redirect Module redirects the user according to the threshold value.When the attack detected from the hackers entry the malicious script logged and stored on the database by the server

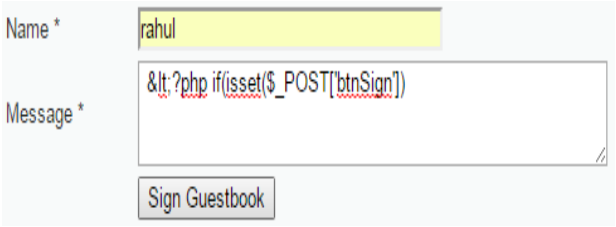
Reflected XSS-Attack:

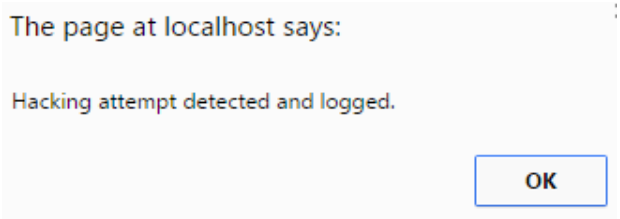


when data submitted by the client it is immediately processed by the server to generate results that are then sent back to the browser on the client system

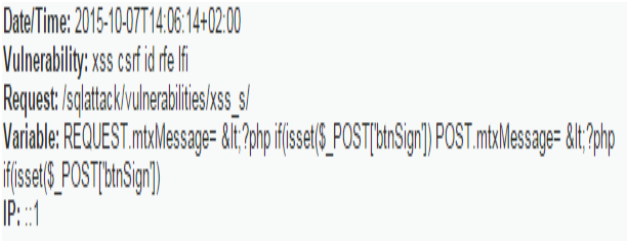
Stored XSS-Attack:

When an Attacker enter the invalid name and trying to edit the script of the client source code, the message will be stored on the database and logged in the server.





Log Result:



3.4 Classification Analyzing Engine:

Classification Analyzing Engine which classifies the input from the user to the attack into different categories. The attack pattern is matched from the attack rule library & pattern is matched. Blacklisting is used for identifying how the user is using the application. For extending the tool to another level of attacks such as authentication or business logic we can develop policy rules for identifying the malicious activity.

Classification Of Attacks	Risk Status
Authentication Testing	High
Authorization Testing	High
Business Logic Testing	Medium
Data Validation Testing	High
Denial of Service Testing	High

Table 1: Classification of Attacks

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3.5 Intrusion Detection Engine:

D e t e c t i on Engine which d e t e c t the attack as intrusion & add attack score whenever attack is detected. Whenever attack is detected the attack is logged in the intrusion table having field as Username, Attack Category, and Attack score for anal yzing attack rates over the application. If no intrusion is detected then connection to database is established after sanitizing the input. This provides double security to the database.

Intrusions occurs	**Risk score**
Input contain SQL Query	4
Input Contain Scripts, JavaScript , HTML	3
Session Invalidation	2
Privilege access	4
Invalidated redirects	2
Unauthorized directory Access	2

Table 2 Intrusion Risk Associated

3.6 Threshold Comparator Module:

Threshold Comparator Module which compares the intrusion detection engine score with the adjusted threshold value. The threshold value can be adjusted anytime according to the risk identified.

Risk	**Score**	**Response Redirect**
1-5	Low	Login Failed
5- 10	Medium	Account Logout
15-above	High	Alarm Page

Table 3 Threshold Score

3.7 Response Redirect Module:

Response Redirect Module which redirects the user according to the threshold value. If the attack occurs at the login time direct alarm page is generated. Analyzed the vulnerable input points of the web application are URL, Form Input, and Cookies. At runtime the Validation response of the application are checked for analyzing intrusions

3.8 Validation Response Algorithm I

Input : Login Input
Output : Validation Response
Set I → Login Input
If I Matches AttackPattern
Then set Attack → True
Goto Response Redirect Alarm Page
Else Login Successful
If (2 < login attempts < 5)
Then Goto Response
Warning Message

3.9 Validation Response Algorithm II

Input: User Input
Output: Validation Response
Do While(SessionID != null)
{
S →User Input
{
Check for Match Attack
Classification
{
If Match→ True
{
Check for Number Of Intrusions
{
Set Attack → True;
Set Attack → Attack +1;
Set Attack Score →Attack Points + Attack Points
}
Goto Response Redirect.
}
}
Else Connect to Database & Sanitize Input
}}

5. chi square test

The Chi square Hypothesis testing to prove the importance of response tool for the web application. Hypothesis testing is a test for accepting and rejecting the assumption about the population. Population here refers to the kind of data over which test is applied. Chi Square test (X2) is a non-parametrical test to find the association or dependency between the classified variables. In hypothesis testing to test whether number of users and number of forms can affect the number of attacks over the web application. Chi square test (X2) is divided in to three categories for testing.

1) Chi square test for Goodness of Fit: - It is applied when we have one categorical from the single population and want to test how close the observed values are from the expected values.

2) Chi Square test for Homogeneity: - It is applied when we have one categorical data from two different populations and we want to test the frequency distribution across different population.

3) Chi Square test for Independence: - It is applied when we have two categorical data from single population and we want to test the dependency between the variables. Chi square test for independence for finding dependency between the number of users and number of attacks and also for the requirement of response tool. Chi square test for independence for finding dependency between the number of users and number of attacks and also for the requirement of response tool. For performing test required the following:

Test1: Testing Dependency for Number of users and Number of Inputs for Number of Attacks.

Step1: State of Hypothesis

H0 = the number of users and number of inputs have no affect on Number of attacks over a web application.

H1 = the number of users and number of inputs affect number of attacks over a web application.

H0 is assumed as null hypothesis. Number of users, Number of Inputs and Number of attacks are variables.

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Step2: Significance Level
The significance level we have chosen is 0.001 which states that if H0 is accepted than it has 0.001 probability likely to dependent. If H0 is rejected than H1 has 99.99% likely to be dependent on variables**.** We have used contingency table of 3x2. Where degree of freedom df is (r-1)(c-1) which is resulted as 2**.**

$X^2 = \Sigma\, n\, (O - E)^2$……(1)

Test 2: Testing effect of warning response tool
Step1: State of Hypothesis
H0 = Warning response tool have no effect on web application attacks. H1=Warning response tool affect in lower web application attacks **Step2:** Significance Level
The significance level chosen 0.001 which states that if H0 is accepted than it has 0.001 probability likely to dependent. If H0 is rejected than H1 has 99.99% likely to be dependent on variables and also used possibility table of 2x 2. Where degree of freedom is (r-1)(c-1) which is resulted as 5.

	Observed Value(O)	Expected Value(E)	(O-E)	$(O-E)^2$	X^2
No Of Users	**15**	**30**	**15**	**225**	**75**
No Of Inputs	**25**	**50**	**25**	**625**	**12.5**
No Of Attacks	**100**	**50**	**50**	**100**	**2**
Chi Square Value					**22**

Table 4: Chi Square Test Table

6. Experimental Result:

To experiment the proposed mechanism concept of SWART was developed in PHP web application running on IIS server. The intrusions and attacks tested in SWART are as follows.1.Implementing Intrusion through login page. 2. Dropping a table from database.3. Deleting a particular record from database.4. Attacking stored procedure.5. Implementing Intrusion through XSS attack. 6. Implementing XSS attack together by an intruder.7. Warning intruder when providing malicious redirect. 8. Implementing more than one attack together. 9. Implementing Piggy back queries. 10. Sanitizing input after intrusion detection. We have developed packages for each module which can be implemented in PHP web application. Whenever intrusions are detected for ongoing user session the score, attack category, and number of attacks are stored in the database for admin evaluation. The ongoing experiments are related to implementing session and authentication manager to detect and prevent session related vulnerabilities. The Proposed approach collecting dataset for insecure web application and web application having SWART for applying chi-square test. The biggest advantage of implementing web application with proposed approach is there is no need for additional servers, Web application firewalls, due to which the organizational cost for the deploying and the maintenance cost of web application reduces. For the small organization who cannot hire security professionals and have lack of security awareness about the web application attacks can get benefit from this kind of approach

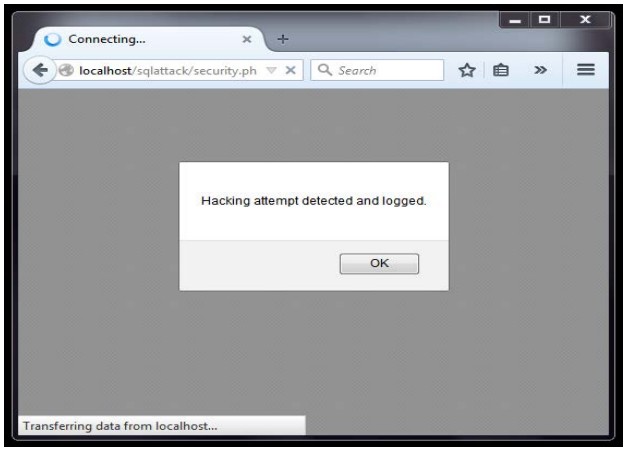
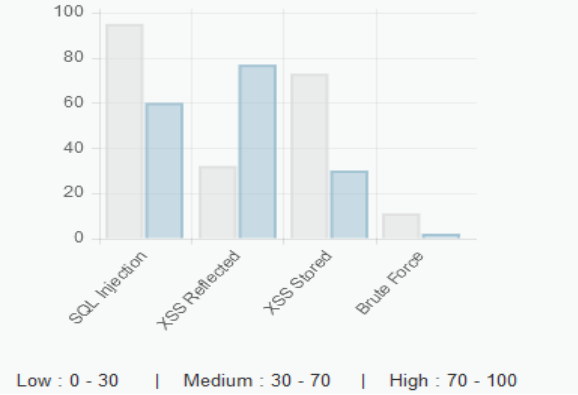


Fig 3 Warning Message Screen

7. Conclusion

Web applications are often deployed with minimum security as the developer mainly focuses on the implementation of the application. Moreover, the development team of the application lacks the security expertise because of budget constraint due to which application frauds & threats are increasing at an alarming rate. The proposed mechanism is a tool for detecting & preventing web application attack .The proposed approach with PHP web application and also perform Chi Square test to validate the assumptions of Input Validation Attacks. The proposed system aims at creating an open source cross platform application side intrusion detection and response framework to detect and respond to web application based intrusion attacks.



Grapical Result Comparison

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8. Future Work:

In future we will try to develop attack patterns for different attack category and will also integrate the proposed mechanism with JSP web application. As every IDPS has some false positive the proposed mechanism also suffers from this, will try to make it free from false positive.

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