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SPIRAL SECURITY MODEL TO COUNTER THE THREATS DUE TO HUMAN FACTORS IN WEB APPLICATIONS

BISWAJIT TRIPATHY
ASSOCIATE PROFESSOR
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SYNERGY INSTITUTE OF ENGINEERING & TECHNOLOGY
DHENKANAL

JIBITESH MISHRA
HEAD
DEPARTMENT OF INFORMATION TECHNOLOGY
COLLEGE OF ENGINEERING & TECHNOLOGY
BIJU PATNAIK UNIVERSITY OF TECHNOLOGY
GHATIKIA

ABSTRACT

Last few years, the security of web has taken a different turn. More and more attacks are done on applications. Also the severe lack of employee awareness is making security breaches particularly due to their weak operational practices. To make the task of the attackers easier, many a times the back-end systems are tied into the front-end ones. Due to the emergence of e-commerce systems, the integration of extranet has made the task of the security managers more complicated. The client side can be classified into external clients and internal employees. The social engineering practices employed by organizations may not be adequate for both categories of clients. We propose a spiral security model that includes the conventional planning phases to monitoring phases that takes the help of various technical components of web applications to counter the threats due to human factors. Though application firewall is a easier threat protection measure, but we propose a model that takes into account some corrective as well as preventive measures from the human perspective based on some technical components.

KEYWORDS

e- Commerce, Spiral Security, Human Factors, Corrective & Preventive.

1. INTRODUCTION

With the growth of e-commerce more and more web based applications are integrated to have intranet & extranet systems in place. India, an emerging economy, has witnessed unprecedented levels of economic expansion, along with countries like China, Russia, Mexico and Brazil. India, being a cost effective and labor intensive economy, has benefited immensely from outsourcing of work from developed countries, and a strong manufacturing and export oriented industrial framework. In 2009 out of $161.3 billion most of the FDI went to the IT and ITeS sector. Experts expect the Indian economy to be the world's biggest economy by 2040.

Strengthening the trust framework, including information security and network security, authentication, privacy and consumer protection, is a prerequisite for the development of the Information Society and for building confidence among users .

In a nutshell, the perception of cyber-threats therefore has two main aspects: On one side A new kind of vulnerability due to modern society's dependency on inherently insecure information systems, and the expansion of the threat spectrum, especially in terms of malicious actors and their capabilities, on the other side[12].

Attackers have changed trends to attack more on the application than the traditional attacks. Most of these attacks take a social approach [1,2] than the technical approach. Security processes need to be kept in all places keeping the attackers mentality in view. Particularly as the clients are used by the attackers through social practices, new social engineering methodologies should be kept in place involving the clients. We have proposed a spiral security model involving both corrective & preventive actions to counter the threats from the human factors. This paper consists of the following sections. Section 2 describes the existing security measures against application threats in the e-commerce systems. The vulnerabilities on web based systems due to the social factors and the protective measures are discussed in Section 3.

We have proposed a new security model called as spiral security model for the web based applications to counter the threats due to human factors in section 4. Section 5 gives the conclusion and final remarks.

2. EXISTING SECURITY MEASURES FOR E-COMMERCE APPLICATIONS THREATS

The major security issues are confidentiality, integrity and availability. Of late privacy and non-repudiation are added to the security of e-commerce systems. However, authentication, authorization and auditing are the three major factors for the security of applications. There are many recorded application vulnerabilities and their counter measures in the web application threat model [3]. In this section, we will categories of web application vulnerabilities and their countermeasures.

2.1. KEY APPLICATIONS THREATS

The key points for web applications are already identified as following.

- Input and data validation
- Authentication
- Authorization
- Configuration management
- Sensitive data
- Session management
- Cryptography
- Parameter manipulation
- Exception management
- Auditing and logging

The threats that can arise due to these key points are shown in the table below.

TABLE 1: KEY APPLICATION AREAS

Key Points	Description
Input and data validation	Input validation refers to validation of input by the application filters before additional processing.
Authentication	Authentication is the process where an entity proves the identity of another entity, typically through credentials, such as a user name and password.
Authorization	Authorization is to check how the application provides access controls for resources and operations.
Configuration management	Configuration management refers to the handling operational issues of the application. It includes questions like as to how the application is administered, which databases it connects to and how these settings are secured.
Sensitive data	Sensitive data refers to how your application handles any data that must be protected either in memory, over the wire or in persistent stores.
Session management	A session refers to a series of related interactions between a user and the web application. Session management refers to how the application handles and protects these interactions.
Cryptography	Cryptography refers to how the web application enforces confidentiality and integrity. It includes questions like how secured and tamperproof the data or libraries are? How strong are the seeds for random values that must be cryptographically strong?
Parameter manipulation	Parameter manipulation refers to safeguards of parameters and how the application processes input parameters.
Exception Management	It is the management of failure of application. It includes questions like does the application fails gracefully or does it return friendly error information to end users?
Auditing and logging	Auditing and logging checks as to how the application records security related events i.e. who did what and when?

The threats related to the key points can be shown in the following table.

TABLE 2: KEY APPLICATION THREATS

Key Points	Threats
Input and data validation	Buffer overflow, cross-site scripting, SQL injection
Authentication	Network eavesdropping, brute force attacks, dictionary attacks, cookie replay, credential theft
Authorization	Elevation of privilege, disclosure of confidential data, data tampering, luring attacks
Configuration management	Unauthorized access to administration interfaces, unauthorized access to configuration stores, retrieval of clear text configuration data, lack of individual accountability, over privileged process and service accounts
Sensitive data	Access sensitive data in storage, network eavesdropping, data tampering
Session management	Session hijacking, session replay, man in the middle
Cryptography	Poor key generation or key management, weak or custom encryption
Parameter manipulation	Query string manipulation, form field manipulation, cookie manipulation, HTTP header manipulation
Exception management	Information disclosure, denial of service
Auditing and logging	User denies performing an operation, attacker exploits an application without trace, attacker covers his or her tracks

2.2. SECURITY MEASURES AGAINST THE APPLICATIONS THREATS

The countermeasures for the traditional security threats are already given by many authors from time to time. For instance, in the SQL injection under the input validation, the countermeasure can be as follows:

- A thorough input validation should be performed. The application should validate its input prior to sending a request to the database.
- Parameterized stored procedures for database access should be used to ensure that input strings are not treated as executable statements. If stored procedures can't be used, SQL parameters can be used to build SQL commands.
- Least privileged accounts should be used to connect to the database.

Similarly, countermeasures to prevent cookies replay under authentication can include the following:

- An encrypted communication channel provided by SSL should be used whenever an authentication cookie is transmitted.
- A cookie timeout to a value should be used that forces authentication after a relatively short time interval. Although this doesn't prevent replay attacks, it reduces the time interval in which the attacker can replay a request without being forced to re-authenticate as the session has timed out.

Also, countermeasures for unauthorized access to administration interfaces under the configuration management can include the following:

- The number of administration interfaces should be minimized.
- Strong authentication e.g. using digital certificates should be done.
- Strong authorization with multiple gatekeepers should be done.
- Local administration should only be done. If remote administration is absolutely essential, encrypted channels such as VPN technology or SSL should only be used. In order to further reduce the risk, IPSec policies should be used to limit remote administration to computers on the internal network.

3. THREATS ON E-COMMERCE APPLICATIONS COMPONENTS DUE TO SOCIAL FACTORS

The major components of e-commerce applications are front-end web server, middle-tier application server and the back-end database server. Some of the counter measures of the key security issues as discussed earlier e.g. secured configuration, validating inputs, exception handling and authorizing users can be applied to the web server in order to protect it. The application server needs to apply the counter measures for authentications and authorization. The auditing and logging activities on transactions need to be employed in the application server as well. The database server needs to be protected by the usage of hashing techniques as sensitive data are available there. The various social factors that can cause threats to these components are discussed below.

3.1. KEY SOCIAL FACTORS ENABLING APPLICATION THREATS

The key social factor for gaining access to e-commerce applications is to get acquaintance of the system. Social engineering is the practice of obtaining confidential information by manipulation of legitimate users. Some of the key issues that can create threats to the e-commerce application is given below:

- Gathering information about employees through mailers e.g. survey etc.
- Gathering information about employees by developing relationships
- Forensic analysis of the hard drives, memory sticks etc.
- Pretending to be a senior manager or helpless user
- Pretending to be a technical support engineer
- Disgruntled employees

The threats that can arise due to these key points are mainly accessibility to the various resources of the e-commerce system. The CISCO 2008 annual report tells that human nature, in the forms of insider threats, susceptibility to social engineering and carelessness that leads to inadvertent data loss, continues to be a major factor in numerous security incidents [4].

3.2. COUNTER MEASURES FOR THE SOCIAL FACTORS

There are well defined counter measures for the security threats due to the social factors.
Some of them are given below.

- A well documented Security Policy accessible to employees & training provided to the employees
- Awareness of threats and impact of social engineering on the company
- Implementation of proper security audit
- Proper Identity Management policy for authentication
- Clear cut operating policies & procedures to limit vulnerabilities.
- Use of advanced physical solutions such as intelligent revolving doors, biometric systems, etc. to eliminate or reduce unauthorized physical access

Some of the hacker tactics and the combat strategy [5] from the social engineering aspect are listed. However, a more generic well-documented Security Policy and associated standards and guidelines can form the foundation of a good security strategy. The policy should clearly document in ordinary terms so that the ordinary user i.e. the employee will understand. Also along with each policy, the standards and guidelines to be followed should be clearly explained. Some of the broad outlines of this policy should include the following:

- Computer system usage: Monitoring the usage of the use of non-company standard mails or activity.
- Proper Information classification and handling: Confidential information should be properly classified and should not be available to everybody.
- Personnel security: Proper screening new employees and other visitors to ensure that they do not pose a security threat.
- Physical security: Proper authentication process for allowing employees to secure portions inside the company e.g. sign in procedures through electronic and biometric security devices etc.
- Information access: Password usage and guidelines for generating secure passwords, access authorization.
- Protection from viruses: Working policies for protection of the systems from viruses and other threats.
- Security awareness training: This ensures that employees are kept informedof threats and counter measures.
- Compliance monitoring: This ensures that the security policy is being complied with.
- Documentation destruction: All information should be disposed of by shredding not by discarding in the trash or recycle bins.

4. SECURITY MODEL FOR E-COMMERCE APPLICATIONS

As far as design of e-commerce applications are concerned, the counter measures of the key security issues on its major components are discussed earlier e.g. secured configuration, validating inputs, exception handling and authorizing users for web servers, authentications, authorization, auditing and logging activities for the application server, etc. In order to counter the vulnerabilities in the e-commerce application design, there are secured design considerations. For example, under input validation, constraining input is one of the preferred approach. This is about allowing good data. The idea here is to define a filter of acceptable input by using type, length, format and range. Use cases should be written and the acceptable input for the application fields should be written.

Similar to the input validation techniques, strong authentication techniques mainly in terms of passwords policies should be prepared. Strong passwords, password expiry period and account lockout policies can safeguard the servers. However, the concern is not in the design issues rather in the human issues. In this section, we propose some corrective & preventive measures from the human perspective.

4.1. DATA LEVEL VALIDATION

Though the design consideration makes input validation in a proper manner, what about the disgruntled employees who makes some changes in the data layer that can create chaos in the e-commerce system. For example, in a shopping cart example, if an accounting operator is given privilege of changing the rate of certain items as there is a change in the rates and he changes the rates of some other items whose rates are not changed, this is an issue of data integrity. Here there are two counter measures that can be offered as given below.

1. Allowing item wise privileges to the employee to change data.
2. Counter authorizing the changes by the account manager.

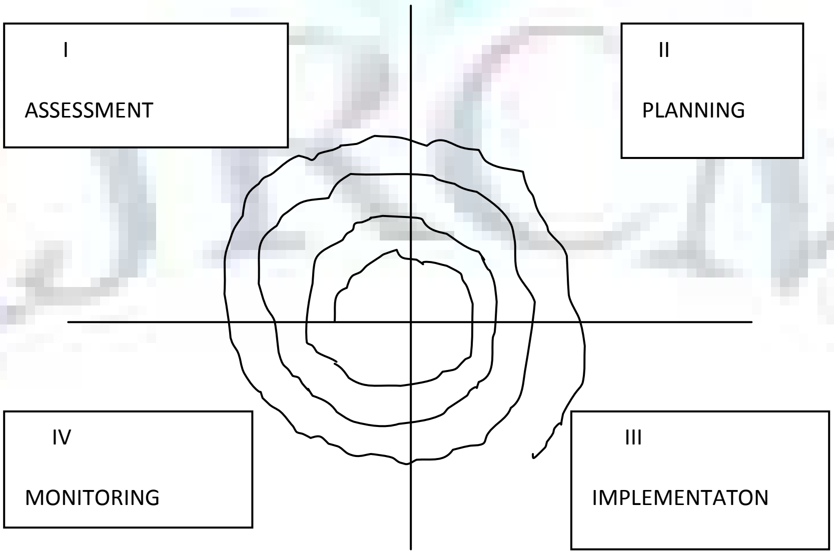
However, there is still human factor for both these cases. In the first case, many a times even though item wise privileges are given to the particular employee, he can mention certain problem in the system and get the general privilege from the system administrator.

With regard to the second case he might have obtained the password of his manager by some means. Therefore, even if a threat tree [6] will be drawn and both these threats due to human factors can be made "AND", still there is always a chance of malicious intent.

This type of threat can only be detected if the a data layer audit is made and its cycle should be short depending on the number of e-commerce transactions in the system.

Therefore, a continuous monitoring is required as may be seen in the proposed spiral model in figure 1 below:

FIGURE 1: SPIRAL MODEL FOR E-COMMERCE SECURITY



4.2. SYSTEM LEVEL AUTHORIZATION

When the design of application is made, minimum access to the system level recourses should given. In fact, restrictions should be placed on the application in terms of which system-level resources it can access. This risk mitigation strategy can limit damage to the Assessment Planning Monitoring Implementation application.

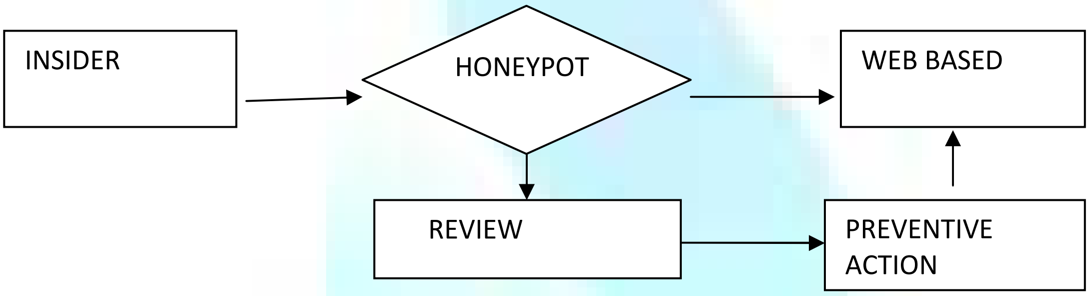
This code access security is a resource constraint model that can prevent code and Web applications from accessing specific types of system-level resources. When code access security is used, it inevitably influences the application design. Also, the application design should identify all of the identities that the application uses, including the process identity and any impersonated identities, including anonymous Internet user accounts and service identities. The design should also indicate to which resources these identities require access. At deployment time, the appropriate access control list can be configured on system-level resources to ensure that the identities of the application only have access to the resources they require. However, the insider threat research indicates that 57% of the insiders were granted access to system administrator's password upon hire and another 33% of the insiders were hired as privileged uses [7].

One of the major preventive method for insider threat is proper screening of employees. However, as prevention of insider threat is the costliest and can make much damage, some preventive actions can be made as given below:

- Conducting careful background checks.
- Clearly documenting insider threat controls.
- Enforcing separation of duties and least privilege.
- Implementing strict password and account management policies and practices.
- Monitoring and auditing every employee's online actions.
- Monitoring and responding to suspicious or disruptive behavior.
- Making usage of additional controls for system administrators and privileged users.
- Layered defense against remote attacks should be made.
- Following termination of employee immediately deactivate access.
- Collection of employee data for investigations, if required.
- Implement secure backup and recovery processes.

Also a better option can used to spot the disgruntled employees is implementation of a honeypot [8,9]. These honey pots can provide valuable information on the patterns used by insiders. We have suggested to use a honeypot as shown in figure 2 to identify the employees usage pattern and accordingly take preventive action.

FIGURE 2: A PREVENTIVE HONEYPOT MODEL FOR INSIDERS



In fact, both the data layer audit for a corrective action and the insiders usage patterns for a preventive action can be monitored regularly using the spiral model and fresh assessment about the security of the e-commerce application can be made. This Insiders System Review Honeypot assessment needs proper planning for final implementation. As this process is an ongoing one, we have proposed this spiral model for the security of web applications.

5. CONCLUSION

Though the design considerations from the security perspective for web applications are clearly stated in many of the research papers, the security issues from the human perspective is hardly considered from the technical perspective. Only some counter measures for social factors as discussed in section 3.2 are suggested by researchers from time to time. Even Intrusion Detection Systems (IDS) are not able to track insider attacks [8] and the complexity of using a combination of IDS systems [10] may not be adequate.

Therefore, we have proposed a spiral model that takes into account a data layer audit for corrective action and finding the insiders usage pattern from a honeypot application for preventive action, those work in conjunction with each other to make an effective web based security model from the human perspective.

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In this age of Commerce, Economics, Computer, I.T. & Management and cut throat competition, a group of intellectuals felt the need to have some platform, where young and budding managers and academicians could express their views and discuss the problems among their peers. This journal was conceived with this noble intention in view. This journal has been introduced to give an opportunity for expressing refined and innovative ideas in this field. It is our humble endeavour to provide a springboard to the upcoming specialists and give a chance to know about the latest in the sphere of research and knowledge. We have taken a small step and we hope that with the active co-operation of like-minded scholars, we shall be able to serve the society with our humble efforts.

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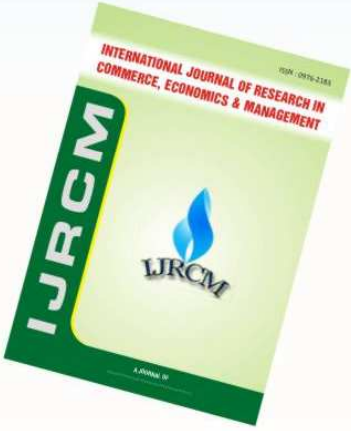

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