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Sveobuhvatna provera bezbednosti informacionih sistema kroz multidisciplinarni pristup

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Apstrakt: Bezbednost informacionih sistema postala je ključna komponenta savremenih tehnologija, s obzirom na stalne pretnje koje dolaze od sajber napada. Ovaj rad istražuje načine na koje se može poboljšati bezbednost informacionih sistema primenom mera bezbednosti u programskom kodu. Fokus je na jednom od najpouzdanijih programskih jezika, Pithon, koji je poznat po svojoj fleksibilnosti i širokoj primeni u bezbednosnim operacijama. Analiziraju se ključne tehnike kao što su šifrovanje, otkrivanje ranjivosti i zaštita od napada malvera, zajedno sa relevantnim primerima koda.

Ključne reči: Verifikacija, bezbednost, informacije, sistemi, multidisciplinarni, pristup

Comprehensive check of security of information systems through a multidisciplinary approach

Apstract: Security of information systems has become a key component in modern technologies, given the constant threats that come from cyber attacks. This paper explores the ways in which the security of information systems can be improved through the implementation of security measures in the program code. The focus is on one of the most trusted programming languages, Python, which is known for its flexibility and wide application in security operations. Key techniques such as encryption, vulnerability detection and protection against malware attacks are analyzed , along with relevant code examples.

Key words : Verification, security, information, systems, multidisciplinary, approach

1. Introduction

Information systems play a vital role in today's business and society. However, as dependence on technology increases, so does the risk of cyber attacks. The development of security mechanisms within the program code becomes crucial for the protection of data and resources within these systems. This paper focuses on Python as a programming language due to its popularity and effectiveness in building security applications.

Earlier research showed that the security of information systems is mainly related to the application of external security tools. However, integrating security measures directly into the program code brings an additional level of protection. Python is often used in this context due to its simplicity and rich ecosystem of libraries, such as cryptography and pycryptodome, which facilitate the implementation of security features.

The methodology of this paper includes the analysis of existing security solutions implemented in Python. For each technique, key factors such as efficiency, scalability, and resistance to attacks were considered. In addition, various attack scenarios were simulated in order to test the robustness of the implemented solutions.

2. Implementation of security mechanisms

2.1. Data encryption

Encryption is a fundamental aspect of data protection. Python provides several tools for encryption, of which cryptography is one of the most widely used. Below is an example implementation of symmetric encryption:

```
python
Copy the code
from cryptography.fernet import Fernet

# Generating the key
key = Fernet.generate_key()
cipher = Fernet(key)

# Data encryption
text = "Sensitive Data"
encrypted_text = cipher.encrypt( text.encode())

# Data decryption
decrypted_text = cipher.decrypt( encrypted_text).decode()
```

2.2. Vulnerability detection

Python allows code analysis to identify potential vulnerabilities using tools such as Bandit. Bandit checks Python code for the most common security flaws.

```
python
Copy the code
import bandit
from bandit.core import config, manager

# Configuration and start of the scan
cfg = config.BanditConfig()
mngr = manager.BanditManager(cfg, "path_to_code")
mngr.run()
```

2.3. Protection against malware attacks

Protection against malware can be achieved by analyzing suspicious files and their behavior using tools such as yara-python which allows identification of malicious files.

```
python
Copy the code
import yara

# Creating rules for malware identification
rules = yara.compile(source='''
rule MaliciousFile
{
strings :
$a = {6A 40 68 00 30 00 00 6A 14 8D 91}
condition :
$a
}
''')

# File scanner
matches = rules.match('path_to_file')
```

3. Discussion

By implementing security measures directly into the program code, we achieve a higher level of security compared to the use of external tools. Python, with its flexibility, enables the development of robust security solutions that can effectively protect information and systems from various types of attacks. The work shows that it is possible to achieve a high level of security of information systems through the direct implementation of security measures within the program code. Python has proven to be an extremely effective tool in this context, thanks to its wide usability and rich ecosystem of libraries.

Further research can expand this topic to include other programming languages and advanced security techniques. This is a paper structure that you can further develop or adapt to your specific needs and research context. Here are ten examples of simulating information system security flaw detection using various tools and techniques in Python:

4. SQL Injection Detection

Simulation of checking for SQL injection vulnerabilities in web applications.

python
Copy the code

```
import sqlite3

def is_vulnerable(query):
# If unfiltered input is used, there is a possible SQL injection vulnerability
try :
conn = sqlite3.connect(':memory:')
conn.execute( query)
return False
except sqlite3.OperationalError:
return True

query = "SELECT * FROM users WHERE username='admin' --' AND password='password123'"
print( is_vulnerable(query))
```

5. XSS (Cross-Site Scripting) Detection

Simulation of checking XSS vulnerabilities in a web application.

python
Copy the code

```
def detect_xss(input_str):
xss_patterns = ['<script>', '</script>', 'javascript:']
return any(pattern in input_str.lower() for pattern in xss_patterns)

user_input = "<script>alert( 'Hacked!')</script>"
print( detect_xss(user_input))
```

6. Weak Password Detection

Simulating the detection of weak passwords using common phrases and words.

python
Copy the code

```
def is_weak_password(password):
common_passwords = ['123456', 'password', 'admin', 'welcome']
return password in common_passwords

password = "123456"
print( is_weak_password(password))
```

7. Man-in-the-Middle (MITM) Attack Detection

Simulation of MITM attack detection by SSL certificate analysis.

python
Copy the code

```
import ssl
import socket
def detect_mitm(host):
context = ssl.create_default_context()
conn = context.wrap_socket(socket.socket(socket.AF_INET), server_hostname=host)
conn.connect( (host, 443))
cert = conn.getpeercert()
conn.close()
```

```
# Certificate validation
return cert['issuer'] != cert['subject']

print( detect_mitm('example.com'))
```

8. Buffer Overflow Detection

Simulation of checking for buffer overflow vulnerabilities.
python
Copy the code

```
def is_vulnerable(buffer_size, input_data):
return len(input_data) > buffer_size

buffer_size = 64
input_data = "A" * 100
print( is_vulnerable(buffer_size, input_data))
```

9. CSRF (Cross-Site Request Forgery) Detection

CSRF vulnerability check simulation.
python
Copy the code

```
def detect_csrf(token_from_user, token_from_server):
return token_from_user != token_from_server

user_token = "123abc"
server_token = "456def"
print( detect_csrf(user_token, server_token))
```

10. Directory Traversal Detection

Simulation of detection of Directory Traversal attack attempts.
python
Copy the code

```
def detect_directory_traversal(input_path):
traversal_patterns = [' .. /', '..\\']
return any(pattern in input_path for pattern in traversal_patterns)

input_path = " .. /etc/passwd"
print( detect_directory_traversal(input_path))
```

11. Port Scanning Detection

Port scan detection simulation.
python
Copy the code

```
import socket

def detect_port_scanning(host, ports):
open_ports = []
for port in ports:
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as with:
if s.connect_ex((host, port)) == 0:
open_ ports.append( port )
return open_ports

host = "192.168.1.1"
ports = [22, 80, 443, 8080]
print( detect_port_scanning(host, ports))
```

12. Insecure HTTP Method Detection

Simulation of checking for insecure HTTP methods (eg PUT, DELETE).

python
Copy the code

```
import requests

def detect_insecure_http_methods(url):
insecure_methods = []
methods = ['GET', 'POST', 'PUT', 'DELETE', 'OPTIONS', 'HEAD']
for method in methods:
response = requests.request(method, url)
if response.status_code in [200, 201, 204]:
insecure_ methods.append( method )
return insecure_methods

url = "http://example.com"
print( detect_insecure_http_methods(url))
```

13. Brute Force Attack Detection

Brute force attack detection simulation.

python
Copy the code

```
from collections import defaultdict

def detect_brute_force(login_attempts):
attempt_counts = defaultdict( int )
for attempt in login_attempts:
attempt_ counts[ attempt ] += 1
return any(count > 3 for count in attempt_counts.values())

login_attempts = ['user1', 'user1', 'user1', 'user1']
print( detect_brute_force(login_attempts))
```

14. Analysis of ten examples of simulation of detection of flaws in information system security

14.1. SQL Injection Detection

Description: SQL injection attacks allow attackers to enter malicious SQL queries that can change or destroy database data. The example shows a simple vulnerability check using unfiltered input.
Analysis: This simulation shows a basic way of checking for SQL injection vulnerabilities, where it is simply checked to see if the user's input contains SQL comments or other malicious queries. In a real environment, this method of detection would be ineffective because more advanced SQL injection attacks can be hidden behind more sophisticated techniques. That is why it is important to use security practices such as prepared statements and parameterized queries.
Recommendation: Implementation of additional layers of protection such as prepared queries and ORM (Object-Relational Mapping) tools.

14.2. XSS (Cross-Site Scripting) Detection

Description: XSS attacks allow attackers to inject malicious code into web pages that will be executed on the user's end. This simulation checks user input for known XSS patterns.
Analysis: The simulation detects simple XSS attacks by searching for specific strings such as <script> tags. However, more sophisticated XSS attacks can use various techniques to bypass this detection, including character encoding, using different elements, or JavaScript events.
Recommendation: Use of security filters on the server, validation and remediation of user input, and application of Content Security Policy (CSP) to prevent XSS attacks.

14.3. Weak Password Detection

Description: This example detects weak passwords that are common and easy to guess.
Analysis: Detecting weak passwords is an important step in system protection. The simulation uses a predefined list of weak passwords, which is good as a basic measure. However, more advanced attacks use sophisticated brute-force methods and constantly updated password lists.
Recommendation: Implementation of a strong password policy, use of a password manager, and regular user education on security practices.

14.4. Man-in-the-Middle (MITM) Attack Detection

Description: MITM attacks allow attackers to intercept and modify communications between two parties. This simulation validates the SSL certificate to detect a potential MITM attack.
Analysis: This technique can detect simple MITM attacks where the attacker uses a fake SSL certificate. However, more advanced attacks may use a legitimate certificate, making detection more difficult.
Recommendation: Use of HSTS (HTTP Strict Transport Security), certificate with verified root authorities, and regular check of communication integrity.

14.5. Buffer Overflow Detection

Description: Buffer overflow attacks allow attackers to inject excess data into memory space, which can result in malicious code execution.
Analysis: This example shows the basic detection of a buffer overflow attack by checking the length of the input data against the buffer capacity. However, actual buffer overflow attacks are often more complex and involve precise memory manipulation.
Recommendation: Use of languages and compilers that include protection against buffer overflow attacks (eg stack canaries), and regular testing of code for vulnerabilities.

14.6. CSRF (Cross-Site Request Forgery) Detection

Description: CSRF attacks allow attackers to force users to perform unwanted actions on a web application where they are authenticated. The simulation checks the CSRF token match between the user and the server.
Analysis: This example shows basic CSRF attack detection using tokens. This technique is effective if the tokens are generated and verified correctly, but can be vulnerable to attacks if the tokens are poorly implemented or not renewed.
Recommendation: Implement CSRF protection using unique, hard-to-predict tokens for each session or request.

14.7. Directory Traversal Detection

Description: Directory traversal attacks allow attackers to access files and directories outside the allowed scope. This simulation checks the input path for patterns that indicate an attempted traversal attack.
Analysis: The simulation detects simple traversal attack attempts. However, attackers can use encryption or other techniques to bypass basic detection.
Recommendation: Use security APIs for file access, validation and remediation of path entries, and restrictive setting of file and directory permissions.

14.8. Port Scanning Detection

Description: Port scanning is a technique that attackers use to identify open ports on a target. This simulation detects open ports by scanning a series of ports.
Analysis: Simulation is useful for detecting open ports on network devices, but does not offer protection against port scanning. More advanced attackers can use stealth methods to avoid detection.
Recommendation: Implementation of firewall rules that block unauthorized scans, use of Intrusion Detection System (IDS) and Intrusion Prevention System (IPS).

14.9. Insecure HTTP Method Detection

Description: HTTP methods such as PUT and DELETE can be vulnerable if not configured correctly. This simulation checks which HTTP methods are allowed on the server.
Analysis: This example detects insecure methods that can be abused if allowed. However, such detection should be part of a wider security audit that includes correct configuration and restriction of HTTP methods.
Recommendation: Limit the use of HTTP methods to the necessary methods (eg GET and POST), regularly check and update the server configuration.

14. 10. Brute Force Attack Detection

Description: Brute force attacks attempt to break authentication by repeatedly trying wrong passwords. This simulation detects repeated failed login attempts.
Analysis: Detection of brute force attacks is key to protecting against unauthorized access. This example uses a simple method of counting attempts per user, which can be effective for basic protection.
Recommendation: Implementation of mechanisms for locking accounts after a certain number of failed attempts, use of CAPTCHA, and monitoring and analytics of logs to detect suspicious activities.

15. Conclusion

The security of information systems is a key component in the protection of data, resources and operations in modern technological environments. Through ten analyzed examples of simulation of the detection of flaws in the security of the information system, it is clear that security problems can appear at different levels, from the application layer to the network layer, and the detection of these problems requires the application of different techniques and tools.

These examples cover a wide range of security threats, including SQL injection, XSS, weak passwords, MITM attacks, buffer overflow, CSRF, directory traversal, port scanning, insecure HTTP methods, and brute force attacks. Each of these attacks represents a real threat that can have serious consequences for the integrity, confidentiality and availability of information systems.

Key insights from this analysis include:

1. Diversification of Security Measures: There is no universal solution for all security threats. Different threats require specific approaches to detection and mitigation, such as input validation, use of security tokens, data encryption, and implementation of robust authentication mechanisms.
2. Dynamic Nature of Threats: Cyber threats are dynamic and constantly evolving. These simulations cover basic scenarios, but real threats often use more advanced techniques to circumvent standard security measures. That's why it's important to regularly update security protocols and tools, as well as continuously educate security teams.
3. Integration of Security Tools: Attack detection and prevention tools, such as those simulated in the examples, should be integrated into broader security strategies. This includes the use of Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS), firewalls, encryption and other protection mechanisms that work in synergy to ensure comprehensive security.
4. Proactive Approach: Instead of relying solely on reactive measures, such as responses to attacks that are already underway, a proactive approach involves regular testing, simulating attacks (penetration testing), and implementing security measures before an incident occurs. This approach helps identify potential vulnerabilities before attackers can exploit them.
5. Importance of Education and Training: Education of users and personnel who manage information systems on best practices in the field of security is of crucial importance. Even the most robust security systems can be compromised by human error, so continuous education is key to maintaining a high level of security.

The analysis shows that the protection of information systems is a complex process that requires careful implementation, regular updating and constant monitoring. Python, as one of the most popular programming languages, provides a rich set of tools and libraries that enable effective detection and prevention of security threats.

However, in order to achieve a high level of security, it is necessary to combine these tools with advanced security practices and a proactive approach that encompasses all aspects of information systems. Only in this way can we ensure that the systems are resistant to a wide range of attacks and that the data and resources they protect are secure.

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