

Data Security - 24/25

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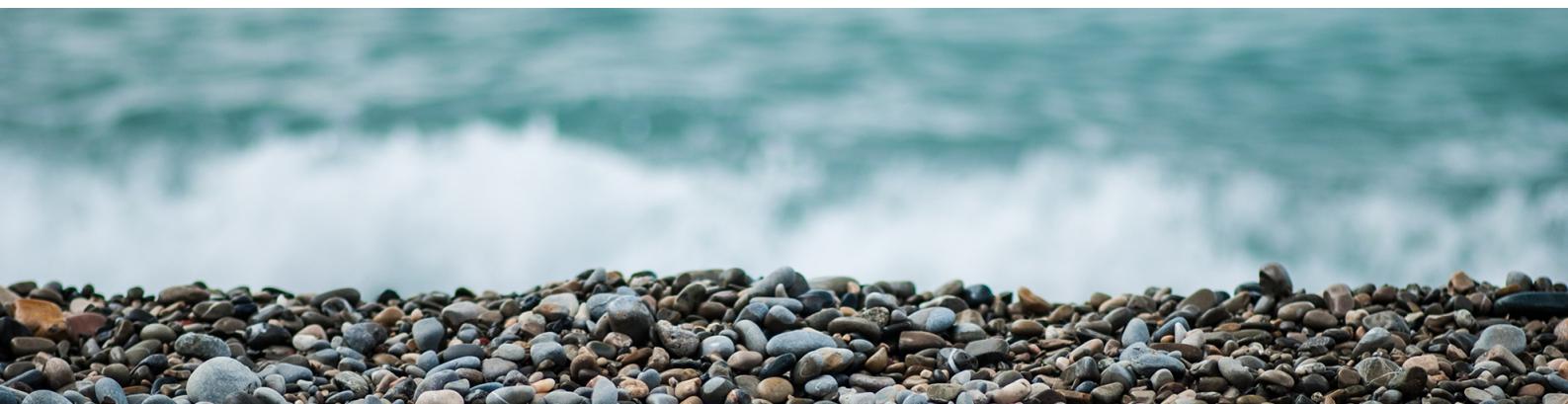
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FRONT SHEET

Individual Coursework

CANDIDATE NUMBER (C-NUMBER)

C2109911

MODULE NAME

Data Security

WORD COUNT

1796

SUBMISSION DATE

04/02/2025

DECLARATION

I certify that this assessment submission is entirely my work and I have fully referenced and correctly cited the work of others, where required. I also confirm the contents of my submission have not been generated by a third party, or through an Artificial Intelligence generative system*.

I have read the Student Discipline Regulations ([Student Discipline Regulations](#)) and understand any Assessment Related Offence/ Academic Misconduct may result penalties being applied.

By submitting this assessment submission, I am confirming that I am fit to sit according to the Assessment Regulations.

I declare that: This is my own unaided work.

Yes

No

The word count stated by me is correct

Yes

No

I'm happy for my work to be retained on the Elite repository and made available to staff and future students**

Yes

No

*Please note that all the assignments are submitted to Turnitin.

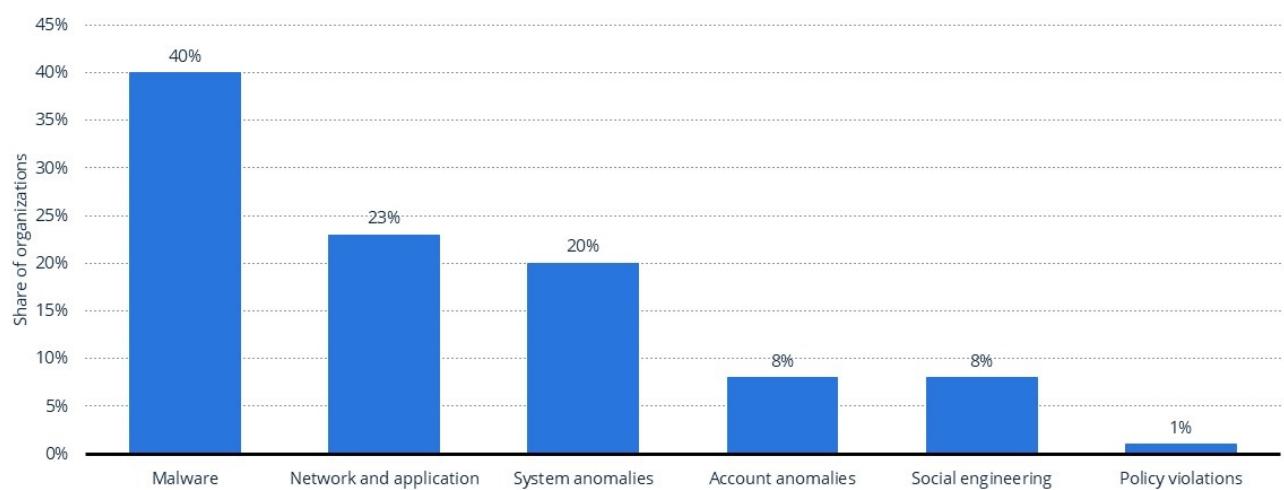
**Please note personal information (such as names) will be deleted

Introduction

eSecurityFin Limited is a financial services company which collects and manages a significant number of users' personal and financial data. Over the past year, there has been several security incidents like Data Breach, Phishing Attacks, and Insider threat. These incidents suggest several poor security practices.

Distribution of cyber attacks on financial and insurance organizations worldwide from October 2021 to September 2022, by type

Global most frequent cyber attacks in financial industry 2022, by type



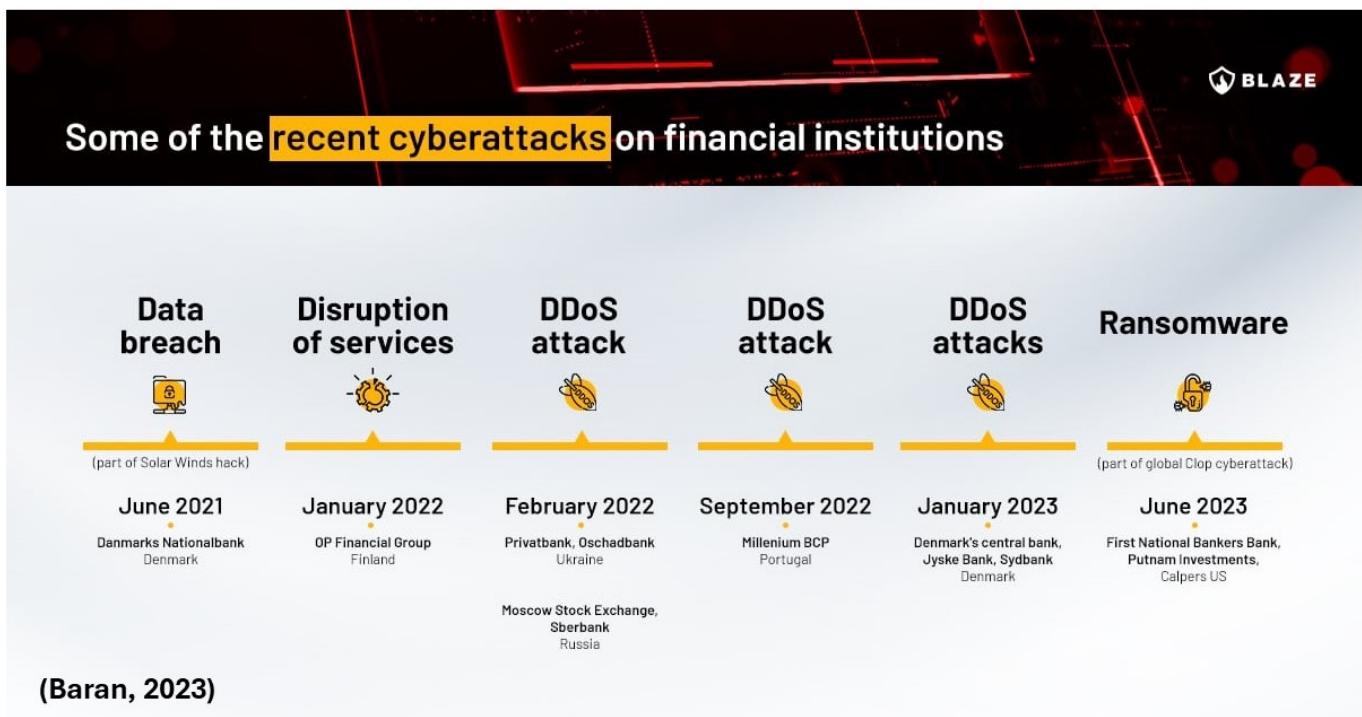
20 Description: Between October 2021 and September 2022, malware was the most common type of cyber attack in financial and insurance organizations. The attack vector targeted around 40 percent of organizations worldwide. Network and application anomalies ranked second, with 23 percent of organizations experiencing such cyber attacks, while system anomalies followed, with 20 percent. [Read more](#)
Note(s): Worldwide; October 2021 to September 2022; based on the VERIS framework; wider industry metrics may vary. *Figures are rounded. [Read more](#)
Source(s): Orange

statista

Analysis of Security Risks:

Weak credentials and poorly secured passwords expose systems to brute force and credential-stuffing attacks, compromising data confidentiality. Vulnerable software, including unpatched systems, poses risks like Remote Code Execution (RCE) and SQL Injection, enabling malware, ransomware, and DDoS attacks (America's Cyber Defense Agency, 2024). Social engineering exploits human error, with phishing attacks targeting employees and bypassing technical defenses. Insider threats, including disgruntled or compromised employees, increase the risk of unauthorized access or accidental damage. These risks undermine the organization's ability to protect sensitive financial data, necessitating robust technical controls, proactive monitoring, and comprehensive employee training to address the gaps effectively.

The above artifact, "Cyber Crime and the Financial Industry in the United States," highlights the widespread prevalence of cyberattacks within the financial sector. It visually underscores how vulnerabilities such as weak credentials, unpatched software, and social engineering are frequently exploited, aligning with the risks identified in this analysis. By illustrating the significant impact of these risks, this artifact emphasizes the urgency of implementing robust controls and proactive measures.



Critically Analyzing Current Security Practices and Their Effectiveness

Recent incidents reveal eSecureFin's inadequate security measures. Weak encryption methods expose sensitive data, with OWASP ranking cryptographic failures as a leading breach cause (OWASP, 2024). Poor employee training leaves staff vulnerable to phishing attacks targeting personal channels (Lenaerts-Bergmans, 2023). Reliance on single-factor authentication enables attackers to exploit weak passwords for critical access (Anon., 2024).

The artifact outlines major cyberattacks on financial institutions, including data breaches, DDoS attacks, and ransomware, highlighting vulnerabilities from weak encryption and human error. These recurring threats reinforce the urgency for enhanced encryption protocols, continuous training, and multi-factor authentication to strengthen eSecureFin's defenses and prevent similar breaches.



Security gaps and recommendations

Identifying security gaps and recommendations based on CIA Triad

Confidentiality:

Security gap:

Weak credentials and poor access control practices lead to risks in accessing financial data to threat actors.

Recommended mitigations:

- Strong credentials which are long, with random characters would make them unique and hard to brute force into. For example, using a password generator or a passphrase (America's Cyber Defense Agency, 2024).
- Multi-factor Authentication (MFA) paired with Single Sign-On (SSO) provides an additional layer of security for passwords.
- Use password throttling and password deny lists as a technical measure (National Cyber Security Centre, 2018).
- Encrypting financial information and passwords using a strong algorithm like AES ensures confidentiality event in the event of a data breach.

Integrity:

Security gap:

Vulnerable and outdated software poses the risk of sensitive financial and personal data to unauthorized modifications.

Recommended mitigations:

- Use hashing algorithms like SHA-256 validates that data is unchanged by unauthorized users.
- Audit trials help keep track of log files of who accessed or modified that data helping identify unauthorized access.
- Strict access control policies allowing only authorized personnel to access the data ensure mitigate unauthorized access (Anyanwu, et al., 2024).



Python Application to address security risks

```
import hashlib
import os
import base64
import hmac
import json
from cryptography.fernet import Fernet
import pyotp

#Generate and save a secret key for encryption
def generate_key():
    key = Fernet.generate_key()
    with open("secret.key","wb") as key_file:
        key_file.write(key) # Save the key securely return key

#Load the secret key
def load_key():
    return open("secret.key","rb").read()

# Encrypt data
def encrypt_data(data, key):
    f = Fernet(key)
    encrypted_data = f.encrypt(data.encode()) # Convert string to bytes before encryption
    return encrypted_data

#Decrypt data
def decrypt_data(encrypted_data, key):
    f = Fernet(key)
    decrypted_data = f.decrypt(encrypted_data).decode() # Convert bytes back to string after decryption
    return decrypted_data

# Source input validation
def validate_input(data):
    if not isinstance(data, str) or any(char in data for char in [';', '--', '"', '\\"']):
        raise ValueError("Invalid Input detected") # Prevent malicious characters
    return
```

```

data

# Hash password securely

def hash_password(password):
    salt = os.urandom(32)
    hashed_pw = hashlib.pbkdf2_hmac('sha256', password.encode(), salt, 1000000) # Apply hashing
    base64.b16decode(salt+hashed_pw).decode() # Encode to a storables format
    return salt, new_hash =


# verify hashed passwords

def verify_password(stored_hash, password):
    stored_hash = base64.b64decode(stored_hash) # Decode stored hash
    stored_pw = stored_hash[:32], stored_hash[32:] # Extract salt and hash
    new_hash = hashlib.pbkdf2_hmac('sha256', password.encode(), salt, 100000)
    return hmac.compare_digest(stored_pw,new_hash) # Securely compare hashes


# Generate OTP secret for MFA

def generate_otp_secret():
    return pyotp.random_base32()

# Generate OTP code

def get_otp_code(secret):
    totp = pyotp.TOTP(secret)
    return totp.now()

# Verify otp code

def verify_otp(secret, otp_code):
    totp = pyotp.TOTP(secret)
    return totp.verify(otp_code)

if __name__=="__main__":
    # Key management: Ensure an encryption key is available
    if not os.path.exists("secret.key"):
        key = generate_key()
    else:
        key = load_key()

#Secure data processing

sensitive_data = "Client Financial data"
encrypted = encrypt_data(sensitive_data, key)
decrypted = decrypt_data(encrypted, key)

print(f"Encrypted: {encrypted}")
print(f"Decrypted: {decrypted}")

```

#MFA implementation

```
otp_secret = generate_otp_secret()
print("Your OTP secret (store securely): ",otp_secret)
otp_code = get_otp_code(otp_secret)
print("Generated OTP Code (for testing):", otp_code)

user_otp = input("Enter OTP: ")
if verify_otp(otp_secret, user_otp):
    print("OTP verified successfully!")
else:
    print("Invalid OTP!")
```



Errors and correction processes:

1. Error: Cryptography module not installed

```
import hashlib
import os
import base64
import hmac
import json
from cryptography.fernet import Fernet
import pyotp

#Generate and save a secret key for encryption
def generate_key():
    key = Fernet.generate_key()
    with open('secret.key',"wb") as key_file:
        key_file.write(key)

Process finished with exit code 1
```

Solution: Module installation process.

```
Command Prompt
Volume Serial Number is 5EEC-AEA4
Directory of D:\Business Analytics\semester_2\Data security\assessment\Assessment

04-02-2025  00:48    <DIR>        .
04-02-2025  00:47    <DIR>        ..
04-02-2025  00:48    <DIR>        .idea
04-02-2025  00:50    <DIR>        .venv
  0 File(s)      0 bytes
  4 Dir(s)  28,709,605,376 bytes free

D:\Business Analytics\semester_2\Data security\assessment\Assessment>.\.venv\Scripts\activate
(.venv) D:\Business Analytics\semester_2\Data security\assessment\Assessment>pip install cryptography pyotp
Collecting cryptography
  Obtaining dependency information for cryptography from https://files.pythonhosted.org/packages/97/9b/443270b9210f13f6ef240eff73fd32e02d381e7103969dc66ce8e
89ee901/cryptography-44.0.0-cp39-abi3-win_amd64.whl.metadata
  Using cached cryptography-44.0.0-cp39-abi3-win_amd64.whl.metadata (5.7 kB)
Collecting pyotp
  Obtaining dependency information for pyotp from https://files.pythonhosted.org/packages/c3/c0/c33c8792c3e50193ef55adb95c1c3c2786fe281123291c2dbf0eaab95a6f
/pyotp-2.9.0-py3-none-any.whl.metadata
  Using cached pyotp-2.9.0-py3-none-any.whl.metadata (9.8 kB)
Collecting cffi>=1.12 (from cryptography)
  Obtaining dependency information for cffi>=1.12 from https://files.pythonhosted.org/packages/50/b9/db34c4755a7bd1cb2d1603ac3863f22bcecb1ba29e5ee841a4bc51
0b294/cffi-1.17.1-cp312-cp312-win_amd64.whl.metadata
  Using cached cffi-1.17.1-cp312-cp312-win_amd64.whl.metadata (1.6 kB)
Collecting pycparser (from cffi>=1.12->cryptography)
  Obtaining dependency information for pycparser from https://files.pythonhosted.org/packages/13/a3/a812df4e2dd5696d1f351d58b8fe16a405b234ad2886a0dab9183fb7
8109/pycparser-2.22-py3-none-any.whl.metadata
  Using cached pycparser-2.22-py3-none-any.whl.metadata (943 bytes)
Using cached cryptography-44.0.0-cp39-abi3-win_amd64.whl (3.2 MB)
Using cached pyotp-2.9.0-py3-none-any.whl (13 kB)
Using cached cffi-1.17.1-cp312-cp312-win_amd64.whl (181 kB)
Using cached pycparser-2.22-py3-none-any.whl (117 kB)
Installing collected packages: pyotp, pycparser, cffi, cryptography
Successfully installed cffi-1.17.1 cryptography-44.0.0 pycparser-2.22 pyotp-2.9.0

[notice] A new release of pip is available: 23.2.1 -> 25.0
[notice] To update, run: python.exe -m pip install --upgrade pip
(.venv) D:\Business Analytics\semester_2\Data security\assessment\Assessment>
```

Source used to consult for solutions.

The screenshot shows a browser window with the URL <https://pypi.org/project/cryptography/>. The page is titled "Project description". On the left, there's a sidebar with links like "Navigation", "Project description" (which is highlighted in blue), "Release history", "Download files", "Verified details" (with a green checkmark), "Project links" (including "homepage", "issues", and "source"), "Owner" (Python Cryptographic Authority), and "GitHub Statistics" (Repository, Stars: 6851). The main content area starts with a "Project description" section showing badges for "pypi v44.0.0", "docs passing", and "CI no status". It describes "cryptography" as a package for Python developers, supporting Python 3.7+ and PyPy3 7.3.11+. It includes code snippets for Fernet encryption and decryption. Below that, it says you can find more information in the documentation and provides a command to install it via pip. At the bottom, it links to the installation documentation.

Navigation

Project description

pypi v44.0.0 docs CI no status

`cryptography` is a package which provides cryptographic recipes and primitives to Python developers. Our goal is for it to be your “cryptographic standard library”. It supports Python 3.7+ and PyPy3 7.3.11+.

`cryptography` includes both high level recipes and low level interfaces to common cryptographic algorithms such as symmetric ciphers, message digests, and key derivation functions. For example, to encrypt something with `cryptography`'s high level symmetric encryption recipe:

```
>>> from cryptography.fernet import Fernet  
>>> # Put this somewhere safe!  
>>> key = Fernet.generate_key()  
>>> f = Fernet(key)  
>>> token = f.encrypt(b"A really secret message. Not for prying eyes.")  
>>> token  
b'...'  
>>> f.decrypt(token)  
b'A really secret message. Not for prying eyes.'
```

You can find more information in the [documentation](#).

You can install `cryptography` with:

```
$ pip install cryptography
```

For full details see [the installation documentation](#).

2. Error: Typo in module name

The screenshot shows a Python development environment. The code editor displays a file named `main.py` containing the following code:

```
85     otp_code = get_otp_code(otp_secret)
86     print("Generated OTP Code (for testing):", otp_code)
87
88     user_otp = input("Enter OTP: ")
89     if verify_otp(otp_secret, user_otp):
90         print("OTP verified successfully!")
91     else:
92         print("INVALID OTP!")
```

The terminal window below shows the output of running the script:

```
Process finished with exit code 1
```

Traceback (most recent call last):
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\Scripts\python.exe" "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py"
from cryptography.fernet import FerNet # Typo in module name
~~~~~  
ImportError: cannot import name 'FerNet' from 'cryptography.fernet' (D:\Business Analytics\semester\_2\Data security\assessment\Assessment\.venv\Lib\site-packages\cryptography)

### Solution:

The screenshot shows a Python development environment. The code editor displays a file named `main.py` with the following content:

```
1 import hashlib
2 import os
3 import base64
4 import hmac
5 import json
6 from cryptography.fernet import Fernet
7 import pyotp
8
9
10 # Generate and save a secret key for encryption
11 def generate_key():
12     key = Fernet.generateKey()
13     with open("secret.key", "w") as key_file:
14         key_file.write(key)
15     return key
16
17 # Load the secret key
18 def load_key():
19     return open("secret.key", "r").read()
20
```

The terminal window below shows the output of running the script:

```
"D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\Scripts\python.exe" "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py"
Traceback (most recent call last):
  File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py", line 6, in <module>
    from cryptography.fernet import FerNet # Typo in module name
                                         ^
ImportError: cannot import name 'FerNet' from 'cryptography.fernet' (D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\Lib\site-packages\cryptography\)
Process finished with exit code 1
```

At the bottom, the status bar indicates the current file is `main.py`, and the system information includes the date and time (19:43), file encoding (CRLF), character set (UTF-8), and Python version (3.12).

**3. Error:** The encrypted data wasn't properly encoded.

```
16     # Load the secret key
17     def load_key():
18         return open("secret.key", "r").read()
19
20
21     # Encrypt data
22     def encrypt_data(data, key):
23         f = Fernet(key)
24         encrypted_data = f.encrypt(data)
25         return encrypted_data
26
27     # Decrypt data
28     def decrypt_data(encrypted_data, key):
29         f = Fernet(key)
30         decrypted_data = f.decrypt(encrypted_data)
31         return decrypted_data
32
33     # Input validation
34     def validate_input(data):
35         if not isinstance(data, str) or any(char in data for char in [';', '--', "'", '"']):
36             raise ValueError("Input must be a string and cannot contain ';' or '--' characters")
37
38     # Main function
39     def main():
40         sensitive_data = validate_input(input("Enter sensitive data: "))
41
42         # Encrypt data
43         encrypted = encrypt_data(sensitive_data, key)
44
45         # Print encrypted data
46         print(f"Encrypted data: {encrypted}")
47
48         # Decrypt data
49         decrypted = decrypt_data(encrypted, key)
50
51         # Print decrypted data
52         print(f"Decrypted data: {decrypted}")
53
54
55     if __name__ == "__main__":
56         main()
```

```
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py", line 76, in <module>
    encrypted = encrypt_data(sensitive_data, key)
                  ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py", line 24, in encrypt_data
    encrypted_data = f.encrypt(data)
                      ^^^^^^^^^^^^^^
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\Lib\site-packages\cryptography\fernet.py", line 52, in encrypt
    return self.encrypt_at_time(data, int(time.time()))
          ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

**Solution:** Use of encode() method to encode the encrypted data.

The screenshot shows a Python development environment. The code editor displays `main.py` with the following content:

```

15     # Load the secret key
16     def load_key():
17         return open("secret.key", "r").read()
18
19     # Encrypt data
20     def encrypt_data(data, key):
21         f = Fernet(key)
22         encrypted_data = f.encrypt(data.encode())
23         return encrypted_data
24
25     # Decrypt data
26     def decrypt_data(encrypted_data, key):
27         f = Fernet(key)
28         decrypted_data = f.decrypt(encrypted_data)
29         return decrypted_data
30
31     # Input validation
32     def validate_input(data):
33         if not isinstance(data, str) or any(char in data for char in [';', '--', '"', "'"]):
34             raise ValueError("Invalid input")
35

```

The terminal below shows a stack trace:

```

File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py", line 76, in <module>
    encrypted = encrypt_data(sensitive_data, key)
                  ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\main.py", line 24, in encrypt_data
    encrypted_data = f.encrypt(data)
                      ^^^^^^^^^^^^^^
File "D:\Business Analytics\semester_2\Data security\assessment\Assessment\.venv\Lib\site-packages\cryptography\fernet.py", line 5:
    return self.encrypt_at_time(data, int(time.time()))
                  ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

```

A floating window titled "Snipping Tool" indicates "Screenshot copied to clipboard".

### A personal project to demonstrate python knowledge:

This code implements a **simple chat room** with both a **server** and multiple **clients** using Python's socket and threading modules.

#### Server Side:

- Listens for incoming client connections.
- Asks each client for an alias (username).
- Stores connected clients and their aliases.
- Broadcasts messages to all clients except the sender.
- Removes disconnected clients and notifies others.

#### Client Side:

- Connects to the server and sends an alias.
- Runs two threads:
  - **Receiving Thread:** Listens for incoming messages from the server.
  - **Sending Thread:** Takes user input and sends messages to the server.
- Handles server disconnects.

#### Key Features:

**Multi-threading:** Allows multiple clients to chat simultaneously.

**Message Broadcasting:** Messages are sent to all connected clients except the sender.

**Error Handling:** Prevents crashes when clients disconnect unexpectedly

A screenshot of a code editor window titled "network\_programming". The current file is "server.py". The code implements a simple chat room server using Python's socket module. It defines two functions: "broadcast" which sends a message to all clients except the sender, and "handle\_client" which processes messages from a single client. The server binds to "127.0.0.1" port 59000, listens for connections, and maintains a list of clients and their aliases.

```
1 import threading
2 import socket
3
4 host = '127.0.0.1'
5 port = 59000
6 server = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
7 server.bind((host, port))
8 server.listen()
9 clients = []
10 aliases = []
11
12 def broadcast(message, sender_client=None):
13     for client in clients:
14         if client != sender_client: # Avoid sending the message back to the sender
15             client.send(message)
16
17 def handle_client(client):
18     while True:
19         try:
20             message = client.recv(1024)
21             broadcast(message, client)
22         except:
23             index = clients.index(client)
24             alias = aliases[index].decode('utf-8')
25             print(f'{alias} has left the chatroom!')
26             broadcast(f'{alias} has left the chatroom!'.encode('utf-8'))
27             clients.remove(client)
28             aliases.pop(index)
29             client.close()
30             break
31
32
33 network_programming > chat_room_connection > pythonProject1 > .venv > server.py
```

A screenshot of a code editor window titled "network\_programming". The current file is "client.py". The code implements a client-side application for a chat room. It connects to the server at "127.0.0.1" port 59000, receives messages from the server, and sends messages to the server. The client uses threads to handle receiving and sending messages simultaneously.

```
1 import threading
2 import socket
3
4 # Client-side implementation
5 alias = input('Choose an alias >> ')
6 client = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
7 client.connect(('127.0.0.1', 59000))
8
9 def receive_messages():
10     while True:
11         try:
12             message = client.recv(1024).decode('utf-8')
13             if message == 'alias?':
14                 client.send(alias.encode('utf-8'))
15             else:
16                 print(message)
17         except:
18             print('An error occurred! Closing connection...')
19             client.close()
20             break
21
22 def send_messages():
23     while True:
24         message = f'{alias}: {input("")}'
25         client.send(message.encode('utf-8'))
26
27 receive_thread = threading.Thread(target=receive_messages)
28 receive_thread.start()
29
30 send_thread = threading.Thread(target=send_messages)
31 send_thread.start()
32
33 network_programming > chat_room_connection > pythonProject1 > .venv > client.py
```

A screenshot of a code editor window titled "network\_programming". The current file is "server.py". The code implements a simple chatroom server using sockets. It defines two functions: "broadcast" which sends a message to all clients except the sender, and "handle\_client" which manages individual client connections. The server binds to "127.0.0.1" port 59000, listens for incoming connections, and maintains lists of clients and their aliases.

```
1 import threading
2 import socket
3 ...
4
5 host = '127.0.0.1'
6 port = 59000
7 server = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
8 server.bind((host, port))
9 server.listen()
10 clients = []
11 aliases = []
12
13 def broadcast(message, sender_client=None):
14     for client in clients:
15         if client != sender_client: # Avoid sending the message back to the sender
16             client.send(message)
17
18 def handle_client(client):
19     while True:
20         try:
21             message = client.recv(1024)
22             broadcast(message, client)
23         except:
24             index = clients.index(client)
25             alias = aliases[index].decode('utf-8')
26             print(f'{alias} has left the chatroom!')
27             broadcast(f'{alias} has left the chatroom!'.encode('utf-8'))
28             clients.remove(client)
29             aliases.pop(index)
30             client.close()
31             break
32
33 def receive():
34     while True:
35         print('Server is running and listening...')
36         client, address = server.accept()
37         print(f'Connection established with {str(address)}')
38         client.send('alias?'.encode('utf-8'))
39         alias = client.recv(1024)
40         aliases.append(alias)
41         clients.append(client)
42         print(f'The alias of this client is {alias.decode("utf-8")}')
43         broadcast(f'{alias.decode("utf-8")} has joined the chatroom!'.encode('utf-8'))
44         client.send('You are now connected!'.encode('utf-8'))
45         thread = threading.Thread(target=handle_client, args=(client,))
46         thread.start()
47
48 if __name__ == "__main__":
49     receive()
```

A screenshot of a code editor window titled "network\_programming". The current file is "server.py". The code has been modified to use a "receive" function instead of the previous "handle\_client" function. The "receive" function handles new client connections and sends an "alias?" message to each client to request its alias. It then adds the client to the "clients" and "aliases" lists and broadcasts a welcome message to the rest of the room.

```
18 def handle_client(client):
19     while True:
20         alias = aliases[index].decode('utf-8')
21         print(f'{alias} has left the chatroom!')
22         broadcast(f'{alias} has left the chatroom!'.encode('utf-8'))
23         clients.remove(client)
24         aliases.pop(index)
25         client.close()
26         break
27
28 def receive():
29     while True:
30         print('Server is running and listening...')
31         client, address = server.accept()
32         print(f'Connection established with {str(address)}')
33         client.send('alias?'.encode('utf-8'))
34         alias = client.recv(1024)
35         aliases.append(alias)
36         clients.append(client)
37         print(f'The alias of this client is {alias.decode("utf-8")}')
38         broadcast(f'{alias.decode("utf-8")} has joined the chatroom!'.encode('utf-8'))
39         client.send('You are now connected!'.encode('utf-8'))
40         thread = threading.Thread(target=handle_client, args=(client,))
41         thread.start()
42
43 if __name__ == "__main__":
44     receive()
```

# Critical Evaluation of Encryption methods

## 1. Critical Evaluation of Encryption Methods

- **Issue:** Currently, the code only uses **Fernet symmetric encryption**.
- **Improvement:** Consider implementing **asymmetric encryption (RSA)** for key exchange or **AES-GCM** for better security.
- **Justification:**
  - **Fernet (AES-CBC mode) lacks authentication** and is vulnerable to padding oracle attacks.
  - **AES-GCM provides authenticated encryption**, ensuring integrity.
  - **RSA is useful for key exchange** in secure communications.
  -

### Implementation:

- Add an **AES-GCM-based encryption method**.
- Add an **RSA-based key exchange mechanism (Cryptography, 2021)**.

## 2. Evaluation of MFA Security

- **Issue:** The MFA implementation is basic and lacks protection against brute-force attacks (National Cyber Security Center, 2024).
- **Improvement:**
  - **Limit OTP attempts** by maintaining a retry counter (SoulFx, 2023).
  - **Use a time-based lockout mechanism** after multiple failed attempts.
  - **Hash OTP secrets before storage** instead of keeping them in plaintext (NIST, 2024).

### Implementation:

- Modify `verify_otp()` to limit retries.
- Store OTP secrets **securely using hashing**.

## 3. Security Recommendations

- **Issue:** The system lacks logging, access controls, and monitoring (National Cyber Security Center, 2024).
- **Improvement:**
  - Implement **logging** for authentication attempts.
  - Add **role-based access control (RBAC)** (Lindemulder & Kosinski, 2024).
  - Implement **secure key storage (e.g., HashiCorp Vault)** instead of storing keys in a local file (Owasp Cheat Sheet Series, 2024).

#### **Implementation:**

- Use Python's logging module for security monitoring.
- Store encryption keys securely using **environment variables or a vault**.



# Summary Report

## Summary Report

### Introduction

eSecurityFin Limited, a financial services company, manages a vast amount of sensitive personal and financial data. However, a series of security incidents, including data breaches, phishing attacks, and insider threats, have exposed significant vulnerabilities within the organization's security framework. These incidents highlight weak security practices, necessitating a comprehensive evaluation of risks and existing measures.

### Security Risks Analysis

#### Weak Credentials and Access Control

One of the most critical security gaps is the use of weak and easily compromised credentials. Brute force and credential-stuffing attacks exploit these vulnerabilities, threatening data confidentiality (America's Cyber Defense Agency, 2024). The reliance on single-factor authentication exacerbates this issue, making unauthorized access easier (Anon., 2024).

#### Vulnerable Software

Unpatched software poses risks such as Remote Code Execution (RCE) and SQL Injection, which cybercriminals exploit to launch malware, ransomware, and DDoS attacks (America's Cyber Defense Agency, 2024). The organization's failure to maintain updated systems significantly increases its exposure to these threats.

#### Social Engineering Attacks

Human error remains a significant security weakness. Phishing attacks, which manipulate employees into disclosing sensitive information, are prevalent. Attackers use personal communication channels like email and social media to deceive employees, emphasizing the need for robust awareness programs (Lenaerts-Bergmans, 2023).

#### Insider Threats

Current employees or former disgruntled staff pose internal threats. Whether intentional or accidental, insider incidents contribute to unauthorized access and data leaks, undermining security efforts.

### Evaluation of Security Practices and Effectiveness

Despite existing security measures, recent incidents demonstrate their ineffectiveness.

- **Weak Encryption:** Sensitive data lacks strong cryptographic protection, with OWASP ranking cryptographic failures as the second-leading cause of data breaches (OWASP, 2024). Implementing stronger encryption protocols is necessary.

- **Poor Employee Training:** A lack of structured cybersecurity training exposes employees to phishing risks (Lenaerts-Bergmans, 2023). Regular training programs are crucial to enhancing awareness.
- **Ineffective Access Controls:** The current system relies on single-factor authentication, making it susceptible to password-related attacks (Anon., 2024). Multi-factor authentication (MFA) is recommended to mitigate unauthorized access.

## **Recommendations Based on the CIA Triad**

To strengthen security, recommendations are structured around Confidentiality, Integrity, and Availability principles.

### **Confidentiality**

- Enforce strong password policies by implementing random, long, and complex passwords (America's Cyber Defense Agency, 2024).
- Implement MFA alongside Single Sign-On (SSO) for enhanced authentication security.
- Utilize password throttling and deny lists as technical countermeasures (National Cyber Security Centre, 2018).
- Encrypt sensitive financial data using advanced encryption standards like AES to maintain confidentiality even during breaches.

### **Integrity**

- Apply hashing algorithms like SHA-256 to verify data integrity and detect unauthorized modifications (Anyanwu et al., 2024).
- Maintain audit logs to track system access and detect anomalies.
- Restrict access based on the principle of least privilege to minimize data modification risks.

### **Availability**

- Strengthen backup systems to mitigate potential data loss.
- Implement DDoS mitigation strategies to ensure system uptime and accessibility.

## **Technical Improvements**

Several enhancements can improve system security.

- **Encryption:** Transitioning from Fernet (AES-CBC) encryption to AES-GCM enhances security by preventing padding oracle attacks. Introducing RSA encryption can further secure key exchanges (Cryptography, 2021).
- **Multi-Factor Authentication (MFA):** Introducing OTP retry limits and using hashed OTP secrets instead of plaintext storage will prevent brute-force attacks (NIST, 2024).
- **Access Control and Monitoring:** Implementing role-based access control (RBAC) and secure key storage solutions (e.g., HashiCorp Vault) will improve system security (Lindemulder & Kosinski, 2024).

## **Conclusion**

eSecurityFin Limited faces multiple cybersecurity challenges due to weak credentials, vulnerable software, social engineering attacks, and insider threats. Current security measures have proven insufficient, emphasizing the need for robust improvements. Strengthening encryption, enforcing access controls, conducting employee training, and adopting advanced security technologies will significantly enhance the organization's cybersecurity posture. By implementing the recommended improvements, eSecurityFin can mitigate existing risks and safeguard its financial and personal data effectively.





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# Appendix

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