

An
Industry Oriented Mini Project report on

**SECURE FILE MANAGEMENT SYSTEM:
AWS- BACKED CLOUD STORAGE WITH AES
ENCRYPTION**

Submitted in partial fulfilment of the requirements for the award of degree

BACHELOR OF TECHNOLOGY

IN

**COMPUTER SCIENCE AND ENGINEERING
(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)**

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2024-2025



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CERTIFICATE

This is to certify that the project report titled “**SECURE FILE MANAGEMENT SYSTEM: AWS BACKED CLOUD STORAGE WITH AES ENCRYPTION**” is being submitted by **Palusa Shiva Kumar (227Z5A6606)**, **Gundu Akshith (217Z1A6626)**, **Kanike Madhu (217Z1A6631)**, in Partial fulfilment for the award of **Bachelor of technology in Computer Science & Engineering (Artificial Intelligence and Machine Learning)**. This report is a record of their bonafide work carried out by them. The results embodied in this report have not been submitted to any other University for the award of any degree.

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We P.Shiva Kumar, G.Akshith, K.Madhu the students of **Bachelor of Technology in Computer Science and Engineering (Artificial Intelligence and Machine Learning)**, Nalla Narasimha Reddy Education Society's Group Of Institutions, Hyderabad, Telangana, hereby declare that the work presented in this project work entitled **Secure File Management System: AWS-Backed Cloud Storage with AES Encryption** is the outcome of our own bonafide work and is correct to the best of our knowledge and this work has been undertaken taking care of engineering ethics. It contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning.

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ACKNOWLEDGEMENT

We express our sincere gratitude to our guide **Mrs G. Manasa**, Assistant Professor, in Computer Science and Engineering Department, NNRESGI, who motivated throughout the period of the project and also for her valuable and intellectual suggestions apart from his adequate guidance, constant encouragement right throughout our work.

We wish to record our deep sense of gratitude to our Project In-charge **Mrs. Priyanka Pandarinath**, Assistant Professor, in Computer Science and Engineering Department, NNRESGI, for giving her insight, advice provided during the review sessions and providing constant monitoring from time to time in completing our project and for giving us this opportunity to present the project work.

We profoundly express our sincere thanks to **Dr. K. Rameshwaraiah**, Professor & Head, Department of Computer Science and Engineering, NNRESGI, for his cooperation and encouragement in completing the project successfully.

We wish to express our sincere thanks to **Dr. G. Janardhana Raju**, Dean School of Engineering, NNRESGI, for providing the facilities for completion of the project.

We wish to express our sincere thanks to **Dr. C. V. Krishna Reddy**, Director NNRESGI for providing the facilities for completion of the project.

Finally, we would like to thank Project Co-Ordinator, Project Review Committee (PRC) members, all the faculty members and supporting staff, Department of Computer Science and Engineering, NNRESGI for extending their help in all circumstances.

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ABSTRACT

This project focuses on developing a secure file management system using AWS Key Management Service (KMS) for encryption and Time-based One-Time Password (TOTP) for authentication. The system encrypts files before uploading them to Amazon S3, ensuring sensitive data remains confidential and protected from unauthorized access. A Flask web application is integrated with AWS, where users upload files that are encrypted via AWS KMS and stored securely in S3. Decryption is controlled by OTP verification using the pyotp library, adding an extra security layer. The project demonstrated seamless encryption, storage, and OTP-based decryption, allowing only authorized users to access the files. The use of environment variables ensures secure key management. This solution provides a scalable and reliable system for secure file storage, emphasizing data privacy and protection against unauthorized access. Future enhancements could include blockchain integration for audit trails, further strengthening the system's security.

Keywords : AWS KMS encryption, Secure file storage, OTP authentication, TOTP verification, AWS S3, Flask application

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1. INTRODUCTION

1.1 MOTIVATION

As more organizations and individuals adopt cloud storage solutions, the risks associated with data privacy and security have increased significantly. Cloud environments are attractive targets for cybercriminals due to the sensitive nature of the data they store. This project is motivated by the need to provide a robust solution for secure file management that not only encrypts files but also ensures that only authorized users can access them. By leveraging industry-standard encryption through AWS Key Management Service (KMS) and adding Time-based One-Time Password (TOTP) verification for additional security, this project offers a multi-layered defense against unauthorized data access.

1.2 PROBLEM STATEMENT

With cloud storage becoming a default choice for both personal and enterprise-level data storage, ensuring the security of sensitive files is critical. Many cloud storage services either lack robust encryption mechanisms or provide only basic security measures. These limitations expose files to risks such as unauthorized access, data breaches, and accidental leaks, which could lead to legal, financial, and reputational damage. A system that combines encryption with strong user authentication is necessary to mitigate these risks and ensure secure data management in cloud environments.

1.3 PURPOSE

The purpose of this project is to design a secure file management system that employs AES encryption through AWS KMS for file security and TOTP-based OTP verification to ensure secure user access. The system guarantees that only authorized users can decrypt and retrieve sensitive data stored in the cloud.

1.4 SCOPE

This project enables secure file uploads, encryption, and decryption via a Flask based web application integrated with AWS services like S3 for storage and KMS for encryption. The system focuses on secure file handling by combining encryption with OTP-based verification. Future enhancements may include blockchain-based audit trails for monitoring file access.

1.5 PROJECT OBJECTIVE

The objective of this project is to create a scalable, secure cloud storage solution that protects sensitive files using AES encryption. The system also incorporates OTP verification for enhanced security, ensuring that only authenticated users can access the stored files. The solution aims to be both user-friendly and secure, providing an efficient file management system in the cloud.

1.6 LIMITATIONS

While the system focuses on encryption and OTP authentication, it is limited in scope by its current reliance on TOTP as the sole authentication method. Additionally, the project does not yet include advanced features like multi-factor authentication or blockchain-based auditing, which could be added in future development.

2. LITERATURE SURVEY

2.1 INTRODUCTION

As cloud storage has become a crucial component of modern data management, ensuring the security and privacy of the stored data is increasingly important. While many cloud storage solutions implement encryption to protect data, encryption alone may not suffice to secure sensitive information against all types of cyber threats. Existing systems often use basic encryption methods coupled with traditional passwordbased authentication, which can be vulnerable to attacks such as phishing, brute-force attacks, and credential theft.

To enhance data security, it is essential to integrate additional layers of protection beyond encryption. Multi-layered security approaches, such as combining encryption with Time-based One-Time Password (TOTP) authentication, can significantly strengthen data protection. This project addresses the limitations of current cloud storage solutions by implementing a secure file management system that integrates AWS KMS for advanced encryption and TOTP for robust authentication.

In addition to encryption and basic authentication, many existing cloud storage systems fail to address the full spectrum of security challenges. For instance, while encryption protects data at rest, it does not safeguard data during transit or when accessed by unauthorized individuals. Many systems also lack robust mechanisms for verifying user identities beyond traditional login credentials, leaving potential vulnerabilities that can be exploited. By integrating advanced technologies such as AWS Key Management Service (KMS) for encryption and Time-based One-Time Password (TOTP) for authentication, the proposed system aims to bridge these gaps. This approach not only encrypts data but also ensures that only authorized users with valid OTPs can decrypt and access the files, thereby addressing both data protection and access control in a more secure and holistic manner.

2.2 EXISTING SYSTEM

Current cloud storage systems typically incorporate encryption as a primary method for protecting stored data. However, many of these systems have limitations in their security frameworks. While encryption algorithms like AES (Advanced Encryption Standard) are effective at protecting data from unauthorized access, they are often implemented without additional security measures that could further safeguard against potential breaches

In practice, these systems often lack integrated multi-factor authentication (MFA) mechanisms, which combine something the user knows (like a password) with something the user has (like a security token or OTP). Without such measures, even encrypted data can be exposed to unauthorized access if an attacker obtains the user's credentials. Additionally, many existing solutions do not provide mechanisms for secure file handling during upload and download processes, potentially leaving data vulnerable during these critical stages. This underscores the necessity for systems that not only encrypt data but also implement additional layers of security, such as OTP verification, to ensure that only authorized users can access and manage sensitive information.

2.3 PROPOSED SYSTEM

Proposed system enhances security by integrating AWS KMS for AES-based encryption and TOTP-based OTP verification to add a second layer of protection. Unlike existing systems, this approach ensures that sensitive files stored in Amazon S3 are not only encrypted but also protected by OTP authentication. This guarantees that only users with valid OTP credentials can access the encrypted data.

Additionally, the system is built on a Flask-based web application, offering a userfriendly interface for secure file upload, encryption, and decryption. The combination of these technologies ensures a robust and secure environment for file management.

3. SYSTEM ANALYSIS

3.1 FUNCTIONAL REQUIREMENTS

- **Opening URL:** Users initiate their interaction with the system by navigating to the URL provided by the Flask web application. This URL, defined in the `app.py` source code, directs users to the application's main page where they can start the file upload or decryption process. This initial step is crucial as it serves as the entry point for accessing the system's functionalities.
- **File Encryption and Decryption:** All files are encrypted using AWS Key Management Service (KMS) before being stored in Amazon S3. The encryption process ensures that files are protected from unauthorized access. Decryption can only be performed using a valid Time-based One-Time Password (TOTP), which provides an additional layer of security. This mechanism guarantees that only users with the correct OTP can access the decrypted file, safeguarding sensitive information.
- **OTP Verification:** The system employs the TOTP algorithm to generate time-sensitive OTPs, which users must provide to decrypt and access their files. This OTP is generated based on a shared secret and the current time, making it dynamic and difficult to intercept. The OTP verification process ensures that only authorized users with a valid OTP can retrieve encrypted files, enhancing overall security.
- **Secure File Upload and Storage:** Users can upload files through a user-friendly Flask-based web interface. Once uploaded, the files are encrypted and securely stored in Amazon S3. This integration with AWS S3 ensures that files are not only encrypted but also stored with high durability and availability. The system handles various file formats and sizes efficiently, ensuring that the upload, encryption, and storage processes are robust and reliable.

3.2 NON-FUNCTIONAL REQUIREMENTS

To ensure that the system operates efficiently and securely, several non-functional requirements are in place:

High Availability and Scalability: The system utilizes AWS services such as S3 and KMS to achieve high availability and scalability. AWS S3 provides robust data durability and accessibility, while AWS KMS handles encryption operations with high performance. The system is designed to scale seamlessly with user demand, accommodating increasing numbers of file uploads and downloads without compromising performance.

User Authentication: Strong OTP-based user authentication is implemented to restrict access to encrypted files. The TOTP verification process ensures that only users with valid OTPs can decrypt files, providing a secure means of authentication..

3.3 INTERFACE REQUIREMENTS

3.3.1 User Requirements

- File Encryption and Decryption
- OTP Verification
- Web Frameworks
- Cloud Storage Access
- Security Notifications

3.3.2 System Requirements

- **Hardware Requirements:**

System : MINIMUM i3

Hard Disk : 10GB

RAM : 4GB

- **Software Requirements**

Operating System : Windows 10.

Coding Language : Python 3.8,HTML-CSS

- **Performance Requirements**

The interface should be optimized for performance to handle multiple simultaneous users. Key performance metrics include:

Response Time: The web interface should have a response time of less than 2 seconds for file uploads and OTP

Scalability: The system must scale horizontally to accommodate increased load.

4.SYSTEM DESIGN

4.1 UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group. The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems. The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

Goals:

- The Primary goals in the design of the UML are as follows:
- Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
- Provide extendibility and specialization mechanisms to extend the core concepts. Be independent of particular programming languages and development process. Provide a formal basis for understanding the modeling language.
- Encourage the growth of OO tools market.

4.1.1 Data Flow Diagram

A **Data Flow Diagram (DFD)** maps out the flow of information within the system. The DFD for this project illustrates how files, user data, and OTPs flow between the user's web interface, encryption modules, AWS KMS, and S3 storage.

This represents the overall system showing key modules like file upload, encryption, decryption, OTP verification, and S3 storage. It details individual processes, such as user interaction for uploading a file, encrypting the file using AWS KMS, storing it in S3, generating OTPs, and downloading the decrypted file after verification.

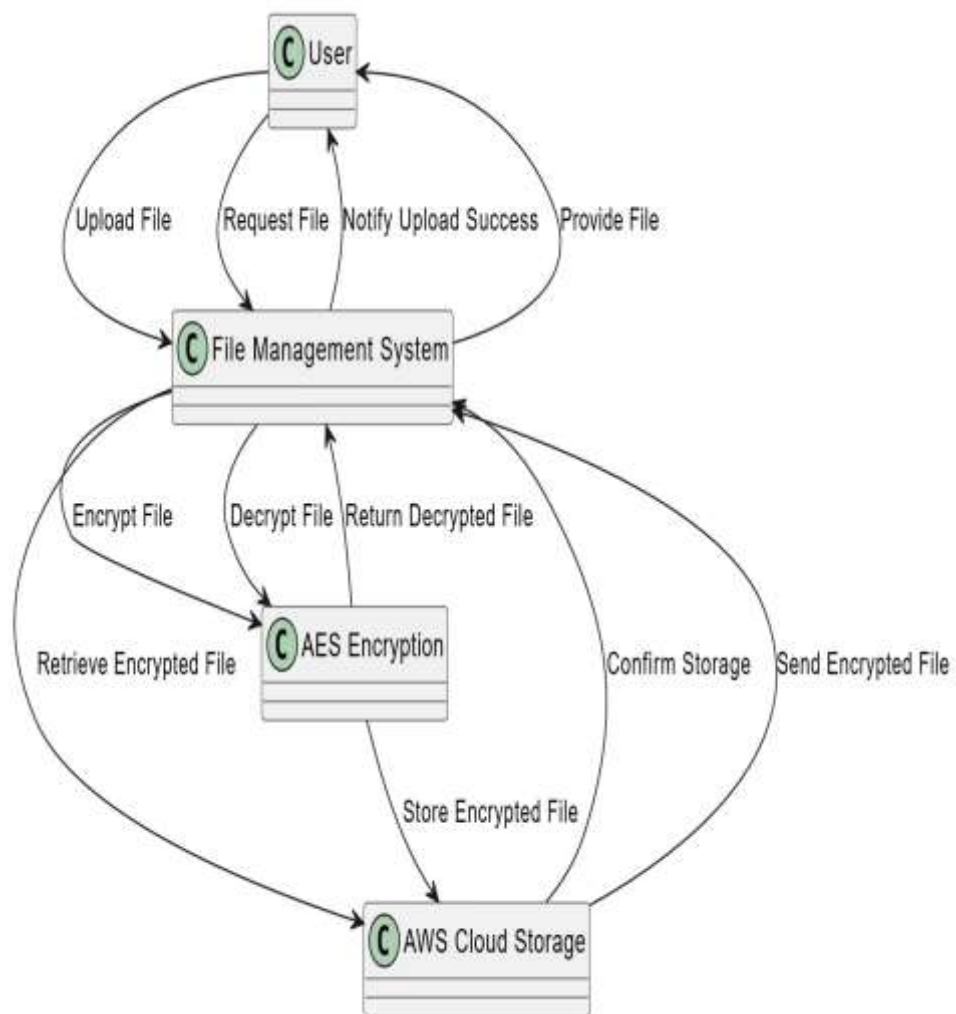


Fig :4.1 Data Flow Diagram

4.1.2 Use Case Diagram:

A **Use Case Diagram** in the Unified Modeling Language (UML) provides a high level view of the system's functionality by showing interactions between users (actors) and the system. In our project, this diagram captures the essential functions, such as file upload, encryption, decryption, OTP generation, and user authentication. The primary actors are the user and the system administrator. Users interact with the system to upload files, verify OTPs, and retrieve decrypted files from AWS S3. Administrators manage user access and system policies. This diagram helps visualize the user's journey and highlights how different use cases relate to each other within the secure file management system.

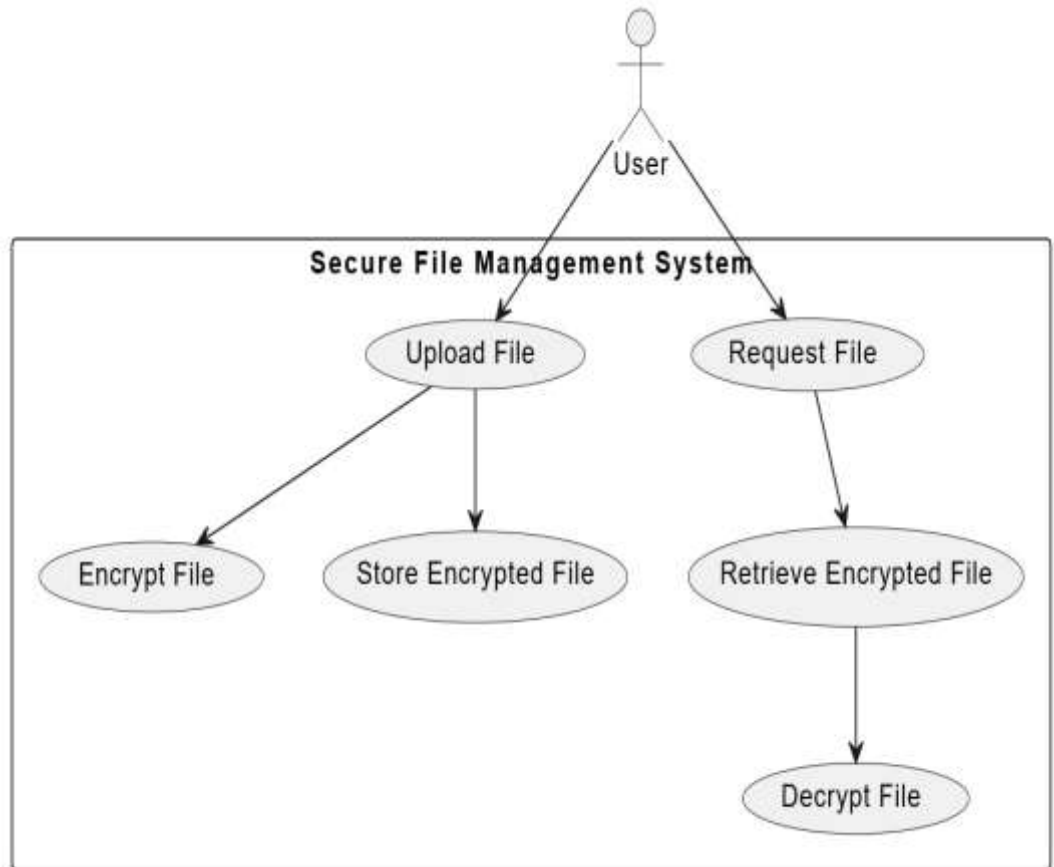


Fig :4.2 Use Case Diagram

4.1.3 Class Diagram:

A **Class Diagram** is used to represent the structure of the system by defining its classes, attributes, methods, and the relationships between them. In this project, key classes include User, File, EncryptionService, OTPService, and AWSManager. Each class defines specific operations such as file encryption (encryptFile()), OTP generation (generateOTP()), and file storage (uploadToS3()). The diagram shows how these classes interact, like how User relates to the File through operations for uploading and downloading encrypted files. This diagram is critical for understanding the system's overall architecture and how data flows between different components.

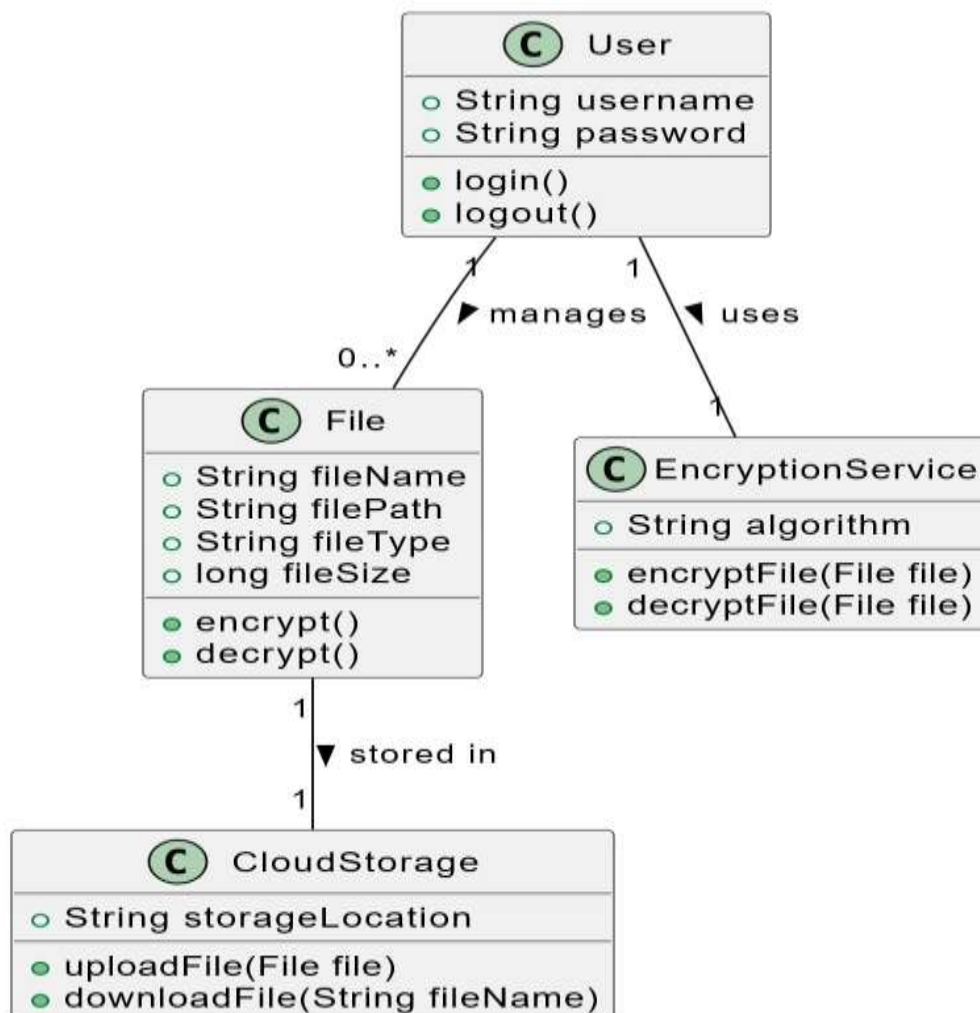


Fig :4.3 Class Diagram

4.1.4 Sequence Diagram:

A **Sequence Diagram** illustrates the step-by-step interactions between system components over time. For our project, it details the process flow during actions like file upload and decryption. For example, when a user uploads a file, the diagram shows the interaction between the web interface, encryption module, AWS KMS for key generation, and S3 storage. Similarly, during decryption, the flow begins with the user entering the OTP, followed by verifying the OTP, retrieving the file from S3, and decrypting it. This diagram is essential for understanding the real-time interactions and message flows that occur within the system.

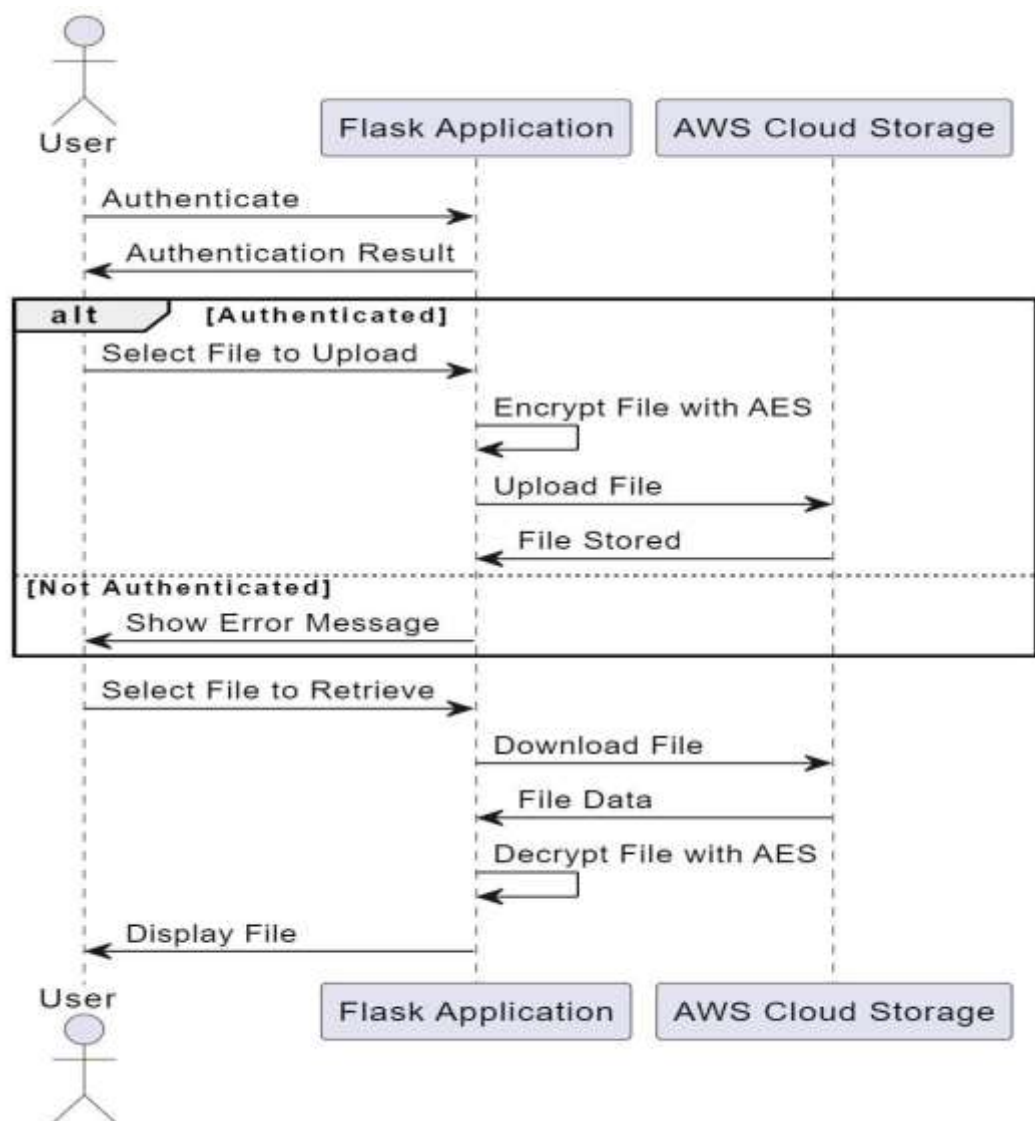


Fig :4.4 Sequence Diagram

4.1.5 Activity Diagram:

An **Activity Diagram** represents the flow of activities or tasks within the system, often showing decisions, iterations, and concurrent activities. In the context of our project, it visualizes processes like file encryption, OTP generation, file decryption, and access control. For instance, when a user uploads a file, the activity starts with user authentication, proceeds to file encryption, stores the encrypted file in S3, and ends with an OTP being generated for future decryption. This diagram is helpful for depicting the flow of control and sequence of actions that must occur to complete a task, providing a clear picture of the operational workflow.

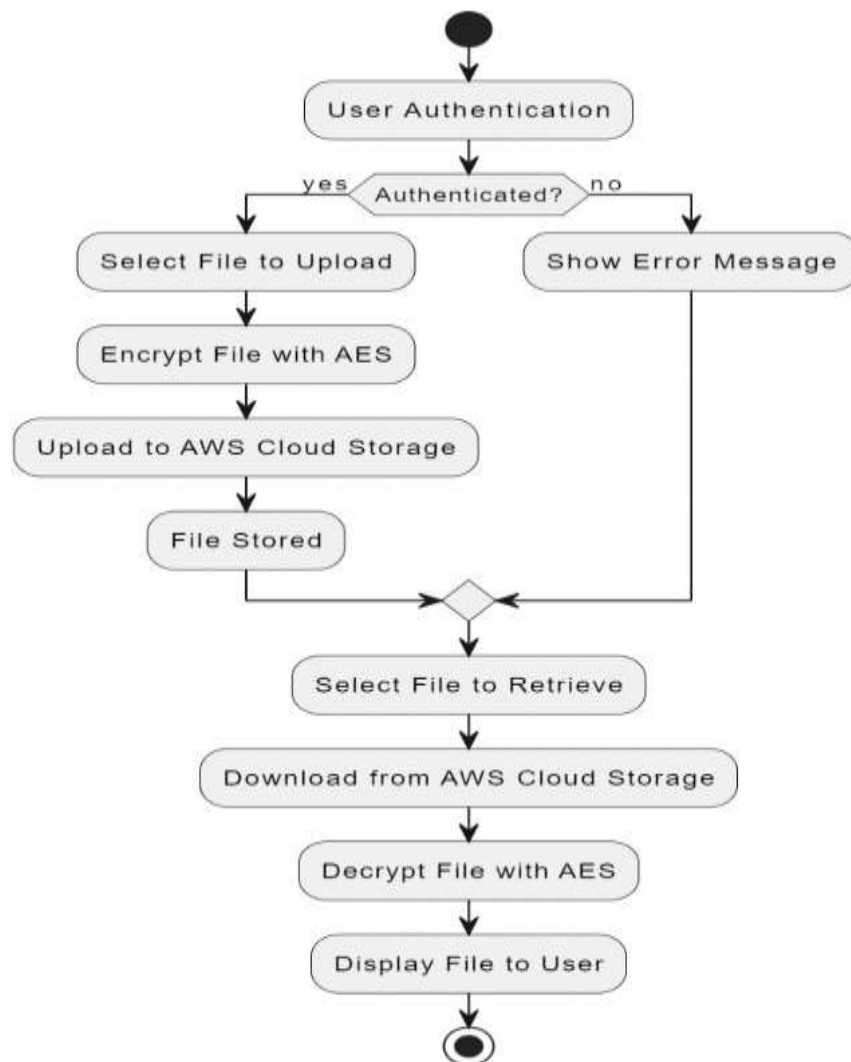


Fig:4.5 Activity Diagram

4.2 MODULES:

The system is broken down into several key modules, each responsible for specific functionality in the secure file management system.

4.2.1 User Authentication Module

This module handles user authentication and access control. Users can sign up, log in, and manage their credentials. Each user must be authenticated before they can upload or download files. This module integrates with AWS IAM policies to ensure that only authorized users can access specific files in the S3 bucket.

- **Sign-up and Login:** Users create accounts and log in to access the system.
- **Authentication** : Verifies user credentials and assigns access tokens.
- **Authorization** : Ensures only authenticated users can perform file operations.

4.2.2 File Encryption and Decryption Module

This module manages the encryption and decryption of files. The process involves:

- **File Encryption:** When a user uploads a file, the system generates a Data Encryption Key (DEK) via AWS KMS. The file is encrypted using this key, and the DEK is stored in an encrypted form.
- **File Decryption:** When a user requests to download a file, the encrypted DEK is retrieved from storage, sent to AWS KMS for decryption, and the file is decrypted locally.
- **OTP-Based Security:** An OTP is required for decrypting files, ensuring an additional layer of security.

4.2.3 AWS S3 Storage Module

This module handles the interaction with AWS S3 for file storage. Files are uploaded to S3 after encryption and retrieved during the decryption process.

- **File Upload:** The encrypted file is uploaded to a designated S3 bucket using the AWS SDK (boto3).
- **Server-Side Encryption:** AWS S3's Server-Side Encryption (SSE) is enabled to ensure all files are encrypted at rest.

4.2.4 OTP Generation and Verification Module

This module handles the OTP (One-Time Password) generation and verification processes. It ensures that users must verify their identity using a time-based OTP to decrypt files.

OTP Generation: The system generates a time-based OTP when a file decryption request is made. This is done using the pyotp library.

OTP Delivery: The OTP is sent to the user's registered email or phone number.

OTP Verification: The user enters the OTP on the web interface, and the system verifies it before allowing access to the decrypted file.

4.2.5 Web Interface Module

This module provides the user interface for the system. Built using Flask, HTML, CSS, and Bootstrap, it offers pages for file uploads, OTP input, and file downloads.

- **File Upload Page:** Allows users to upload files that will be encrypted and stored in S3.
- **OTP Verification Page:** Displays a form for users to input the OTP to decrypt a file.
- **File Download Page:** Displays the available encrypted files, and after OTP verification, allows users to download the decrypted file.

4.2.6 AWS Key Management Module

This module integrates with AWS KMS to handle encryption keys. It manages the generation, encryption, and decryption of DEKs.

- **Key Generation:** AWS KMS generates a unique DEK for each file.
- **Key Encryption:** The DEK is encrypted using AWS KMS and stored securely.
- **Key Decryption:** When a file needs to be decrypted, the encrypted DEK is retrieved and decrypted using AWS KMS.

4.2.7 Security and Access Control Module

This module enforces security policies across the system. It includes AWS IAM policies, S3 bucket access control, and file-level permissions.

- **Bucket Policies:** Controls who can access the S3 bucket and what actions they can perform (upload, download).
- **Encryption and Security:** Enforces secure encryption for files in transit.

5. IMPLEMENTATION AND RESULTS

5.1 METHOD OF IMPLEMENTATION

The implementation of the "Secure File Management System" project involves using several technologies and frameworks, including Flask for the web interface, AWS services like S3 and KMS for storage and encryption, and pyotp for secure OTP generation. Below are the detailed steps of implementation for this system

5.1.1 AWS KMS Setup for Encryption

AWS Key Management Service (KMS) is used for file encryption in the cloud. The KMS setup involves:

1. Creating a KMS Key:

- Create a symmetric encryption key using the AWS Management Console.
- Define key policies to control access to the key.
- Associate the KMS key with specific IAM roles that will allow encryption and decryption of files

2. Encryption Process:

- When a file is uploaded, the file is encrypted using the AES encryption method through AWS KMS.
- The file is encrypted client-side using an envelope encryption approach, where a data encryption key (DEK) is generated, used to encrypt the file, and then the DEK itself is encrypted using the KMS key.

3. Decryption Process:

- The encrypted file is downloaded from S3, and AWS KMS is used to decrypt the DEK.
- The decrypted DEK is then used to decrypt the file content, making it readable for authorized users

5.1.2 Flask Application Structure

The web application is built using Flask, a lightweight and powerful Python web framework. It follows the MVC (Model-View-Controller) design pattern to ensure modularity and maintainability. Below is the breakdown of the structure:

1. Main App:

- Acts as the entry point for the web server. It initializes the Flask application, sets up verification). configurations, and handles routing for various endpoints (like file upload, download, and OTP
- Routes are defined to handle different requests (GET/POST) from users.

2.Views:

- These functions define how users interact with the system. They render templates
- For example, the **upload file** view lets users upload files, while the **OTP verification** view allows OTP input for decryption requests.

3.Controllers:

- The controllers manage the business logic of the application. They handle encryption, decryption, and verification workflows.
- For instance, the **encrypt_file()** controller is responsible for encrypting a file before storing it on S3, while the **decrypt_file()** controller manages file decryption after OTP verification.

4.Templates:

- HTML templates (using Jinja2) are used to create dynamic web pages. This layer handles the presentation and UI components.
- These templates allow users to upload files, enter OTPs, and download files.

5.1.3 AWS S3 Bucket Configuration

AWS S3 (Simple Storage Service) is the primary cloud storage solution used for storing encrypted files. The configuration involves the following steps:

1. Creating the S3 Bucket:

- Using the AWS Management Console or AWS CLI, a new S3 bucket is created to store encrypted files.

- During the creation, options such as the region, access permissions, and storage classes are configured based on the application's needs.
- Naming conventions for S3 buckets follow AWS guidelines (unique across all AWS accounts).

2. Enabling Server-Side Encryption (SSE):

- Server-Side Encryption (SSE) is activated to ensure that all files uploaded to the S3 bucket are encrypted at rest.
- S3 provides multiple options for SSE, such as SSE-S3, SSE-KMS, and SSE-C, with SSE-KMS (using AWS KMS) being used for this project to manage encryption keys.

3. Access Policies:

- Bucket policies and IAM roles are used to restrict access to S3 Bucket.

5.1.4 Python Environment Setup for Flask

Setting up the development environment to run the Flask application involves the following:

1. Install Python and Flask:

- Ensure that Python 3.7 or a later version is installed on the local system or server. Python serves as the runtime environment for the Flask application.
- Install Flask and other required libraries using the command: **pip install Flask boto3 pyotp python-dotenv**.

2. Create a Virtual Environment:

- A virtual environment is set up to isolate the project dependencies from the global Python environment.
- Command: **python -m venv venv**, followed by activating it (**source venv/bin/activate** for Unix or **venv\Scripts\activate** for Windows).
- Install the necessary dependencies via **pip install -r requirements.txt**.

3. Environment Variables:

- Use python-dotenv to securely handle sensitive configuration values, such as AWS credentials, S3 bucket names, and KMS key information.

- These variables are stored in a **.env** file and accessed securely within the Flask app

5.1.5 Uploading Encrypted File to S3

The process of uploading an encrypted file to AWS S3 involves the following steps:

4. User Uploads File:

- The user selects a file using the web interface provided by the Flask app.
- The selected file is sent via a **POST** request to the server.

5. File Encryption:

- The file is encrypted locally before being uploaded. A **Data Encryption Key (DEK)** is generated using **AWS KMS** and used to encrypt the file.
- The file is encrypted using **AES-256** encryption, which ensures that even if someone gains unauthorized access, the data remains secure.

6. Upload to S3:

- After encryption, the file is uploaded to the specified S3 bucket using **boto3** or the **AWS CLI**. The **put_object** function in boto3 is utilized to manage the file upload

5.1.6 File Decryption Workflow

The file decryption process follows a secure workflow:

7. User Requests File Download:

- The user selects an encrypted file from the available list of uploaded files.

8. Decryption Key Request:

- The encrypted DEK (stored alongside the file in S3) is sent to AWS KMS, where it is decrypted.
- AWS KMS returns the original DEK, which is used to decrypt the file.

9. File Decryption:

- The file is decrypted using the returned DEK, converting it back to its original format
- The decrypted file is made available for download through the web interface.

5.1.7 OTP Verification Process

To enhance security, the file decryption workflow involves OTP-based verification:

10. OTP Generation:

- When the user requests to download a file, an **OTP (One-Time Password)** is generated using the **pyotp** library.
- This OTP is unique and time-sensitive, adding an additional layer of security.

11. OTP Delivery:

- The generated OTP is delivered to the user through their registered email or phone number, using either **SMTP** for email or an **SMS** gateway.

12. OTP Verification:

- The user is prompted to enter the OTP in the web interface.
- The system verifies the entered OTP against the generated one. If the OTP matches, the file decryption proceeds.

5.1.8 Flask Application Web Interface

The web interface of the Flask application is designed for ease of use and incorporates Bootstrap for responsive design. The key pages include:

13. Upload Page:

- This page allows users to select files from their local machine and upload them for encryption and storage in S3. A simple file input field and upload button are provided.

14. OTP Verification Page:

- This page prompts users to enter the OTP that was sent to their registered email or phone number. Upon successful verification, the file decryption process begins.

15. Download Page:

- This page lists the encrypted files available for download. Once the user enters the correct OTP, the file becomes available for secure download in its decrypted format.

5.2 EXPLANATION OF KEY FUNCTION:

The key functions of the system focus on secure file management, encryption, and access control. This section details the critical processes involved, including secure data handling, evaluation of encryption efficiency, and OTP-based file decryption.

5.2.1 Data Preprocessing:

Data preprocessing in the context of this project is essential for handling file metadata and user information securely. Before encryption and storage, critical data is processed to ensure proper encryption, storage, and retrieval.

File Metadata:

16. Metadata includes details such as the file name, size, timestamp, and encryption status.

Example:

- In our source code, we extract metadata when a user uploads a file

```
file = request.files['file']

file_metadata = {

    'name': file.filename,

    'size': len(file.read()),

    'timestamp': datetime.now().strftime("%Y-%m-%d

%H:%M:%S"), }

# Save metadata to database after encryption
```

User Information:

- Sensitive information like user ID, email, and access permissions are securely stored.
- **Secure Environment Variables:**
 - Using **dotenv**, environment variables such as AWS credentials and encryption keys are handled securely. This ensures that sensitive configurations are not hardcoded in the source code.

Example : .env file:

Storing Metadata in Encrypted Format:

```
AWS_ACCESS_KEY_ID=AKIAYEKP5TPBKB4J6A5M
```

```
AWS_SECRET_ACCESS_KEY=DdpWPgV6v0YoeY4rOajhbhJIjU+YDIZL  
9Lsli+A1
```

- Metadata is stored securely in the database using encryption to ensure unauthorized access is prevented.

Example:

```
encrypted_metadata = encrypt_data(file_metadata)  
db.session.add(FileMetadata(metadata=encrypted_metadata,  
user_id=current_user.id)) db.session.commit()
```

5.2.2 Training

Although this project does not explicitly use machine learning models, the system can be seen as "trained" to handle sensitive data securely through proper implementation of security protocols and encryption techniques. This "training" process ensures that the system learns to:

- **Secure Handling of Encryption Keys:**
 - The system uses **AWS KMS** to manage encryption keys, ensuring that keys are never exposed directly to users.

Key Management Example:

```
kms_client = boto3.client('kms')
```

```
encrypted_dek=kms_client.generate_data_key(KeyId=KMS_KEY_ID,KeySpec='AES_2  
56')[0] CiphertextBlob]
```

The generated **DEK (Data Encryption Key)** is used to encrypt files securely, while the encryption key itself is protected by **AWS KMS**.

17. File and User Data Processing:

- The system ensures secure transmission and storage of both file data and user credentials by using encryption and access controls.

5.2.3

```
Start_time = time.time()
encrypted_file = encrypt_file(file_data) end_time = time.time()
encryption_time = end_time - start_time
logging.info(f"File encryption completed in {encryption_time}
seconds.")
```

Evaluation

System evaluation is crucial to ensure that the implemented encryption and security protocols perform efficiently and securely. The evaluation covers the following areas:

1. Encryption Efficiency:

- The system's encryption process using **AWS KMS** is tested to ensure that it does not introduce significant performance overhead, even when handling large files.

Example:

- When a file is uploaded, the system logs the time taken for the encryption process:

2. OTP Security:

- The system uses the **pyotp** library to generate secure, unique, and time-bound OTPs for file decryption. The OTPs are tested for security by evaluating their uniqueness and expiration.

Example:

- OTP generation and validation
- OTP expiration is set for 30 seconds, and the system tests that expired OTPs are not accepted.

```
otp_secret = pyotp.random_base32() otp =
pyotp.TOTP(otp_secret) otp_code = otp.now() # Send OTP to the
user
Send_otp(user_email, otp_code)
```

3. S3 Access Control:

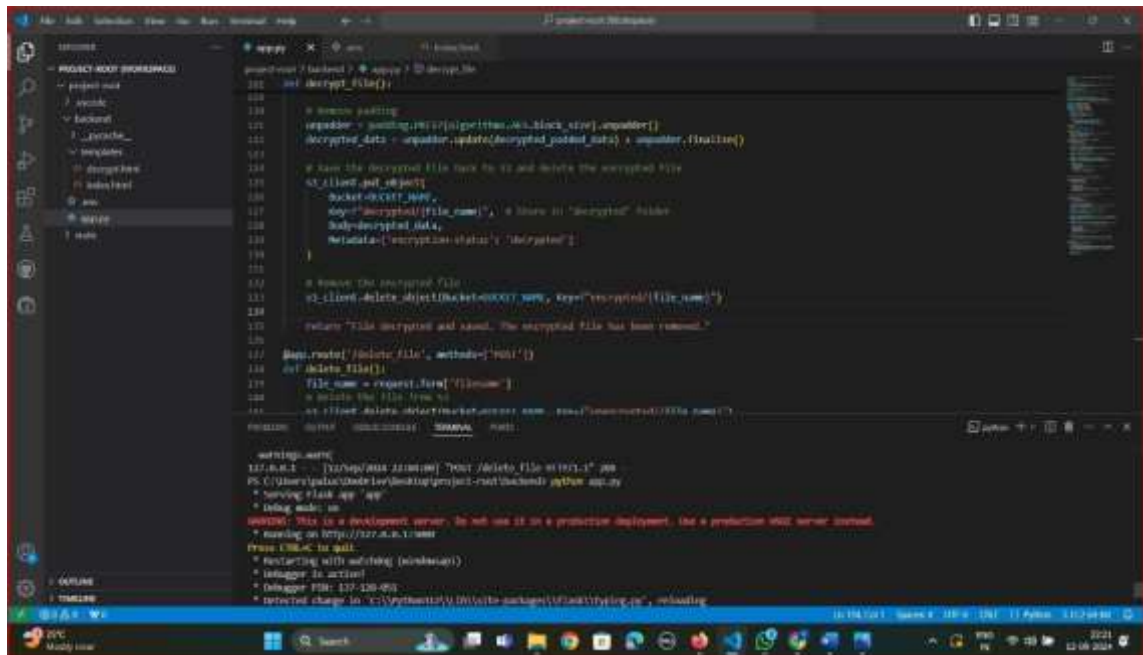
- Access to files stored in **AWS S3** is controlled through bucket policies and **IAM roles**. The system is evaluated to ensure that only authorized users have access to upload or download files.
- **Access Control Example:**
 - S3 bucket policy configuration:

JSON

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "AWS": "arn:aws:iam::account-id:user/username"
      },
      "Action": "s3:GetObject",
      "Resource": "arn:aws:s3:::bucket-name/*"
    }
  ]
}
```

The system verifies that unauthorized access attempts are logged and denied

5.3 OUTPUT SCREENS :



```
110 def decrypt_file():
111     # Remove padding
112     unpadder = unpadding.Padding(algorithm=padding.AES_BLOCK_SIZE, mode=padding.PKCS7)
113     decrypted_data = unpadder.update(decrypted_data) + unpadder.finalize()
114     # Save the decrypted file back to FS and delete the encrypted file
115     s3_client.put_object(
116         Bucket='SECRET-1000',
117         Key=decrypted_file_name,
118         Body=decrypted_data,
119         Metadata={'encryption-status': 'decrypted'})
120     # Remove the encrypted file
121     s3_client.delete_object(Bucket='SECRET-1000', Key=encrypted_file_name)
122     return "File decrypted and saved. The encrypted file has been removed."
123
124 @app.route('/delete_file', methods=['POST'])
125 def delete_file():
126     file_name = request.json['filename']
127     # Delete the file from FS
128     s3_client.delete_object(Bucket='SECRET-1000', Key=file_name)
129
130 if __name__ == '__main__':
131     app.run(debug=True)
```

Fig 5.1 Run the Code

In above screen source code is running and now open browser and enter URL which follows by Output

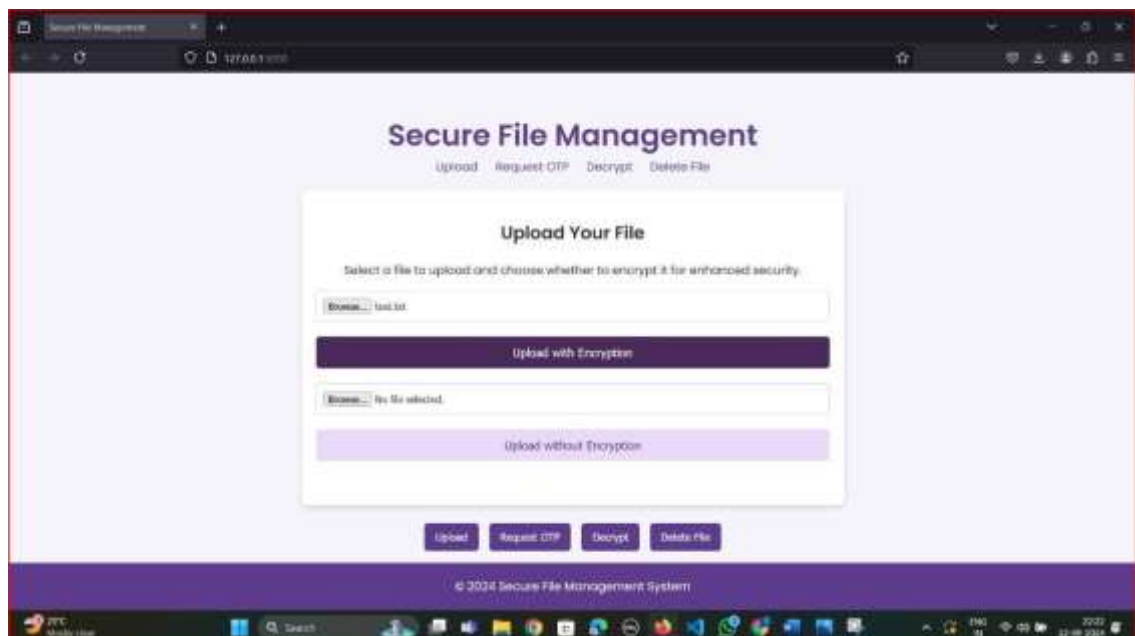


Fig 5.2 Home Page

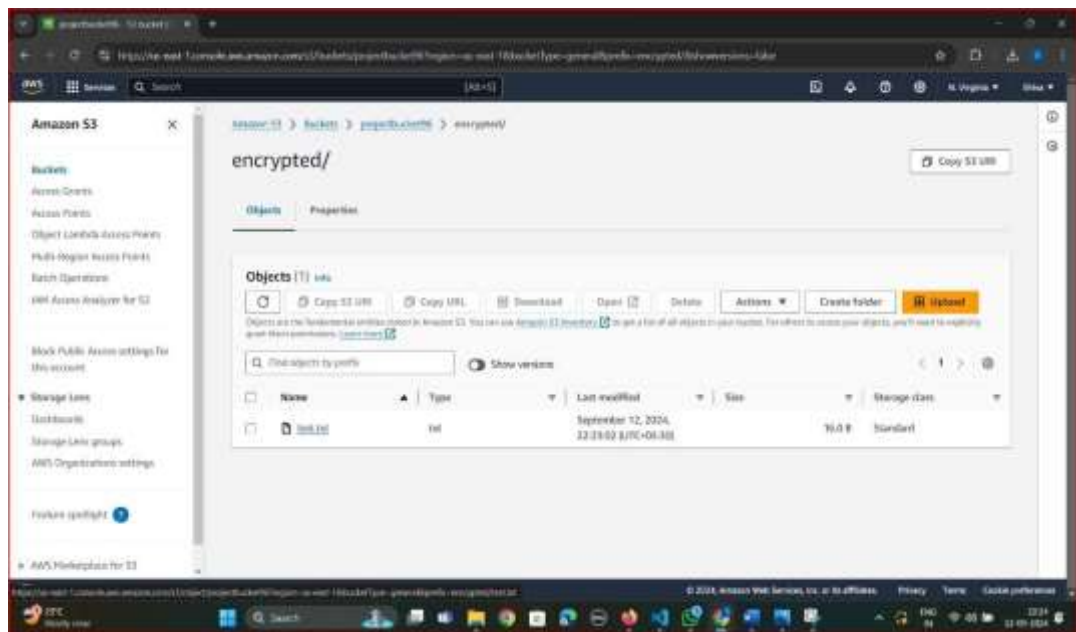


Fig 5.3 File Encrypted Page

In the above Screen, the file is Stored in the S3 Bucket

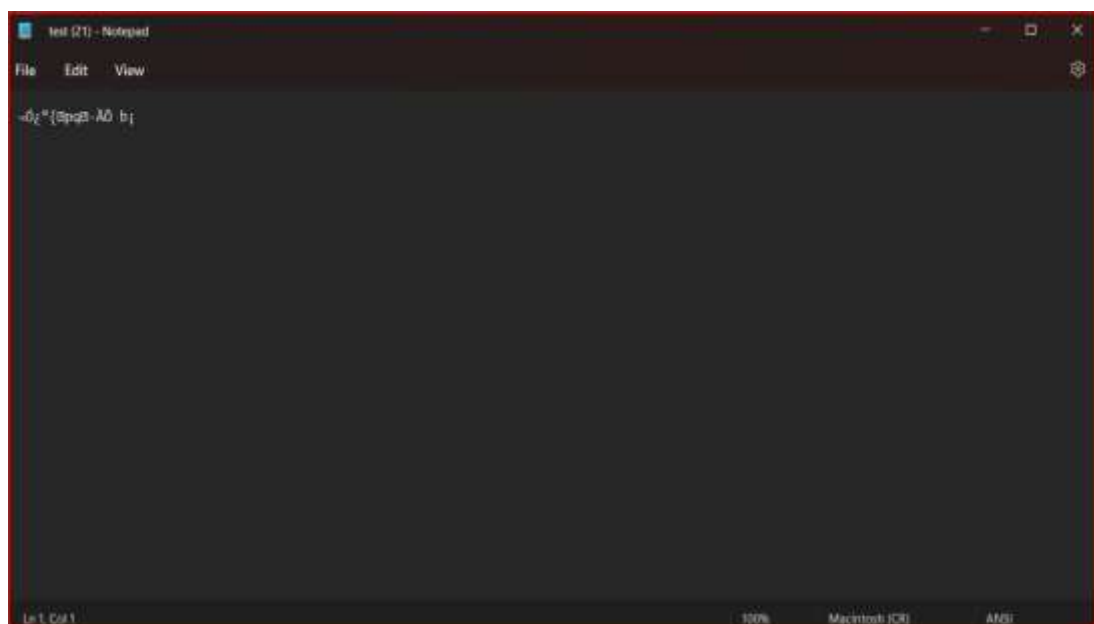


Fig 5.4 Encrypted File

In above screen the file is displayed in the Encrypted structure



Fig 5.5 OTP Verification Prompt

In above screen click on ‘Request OTP’ to generate OTP Verification

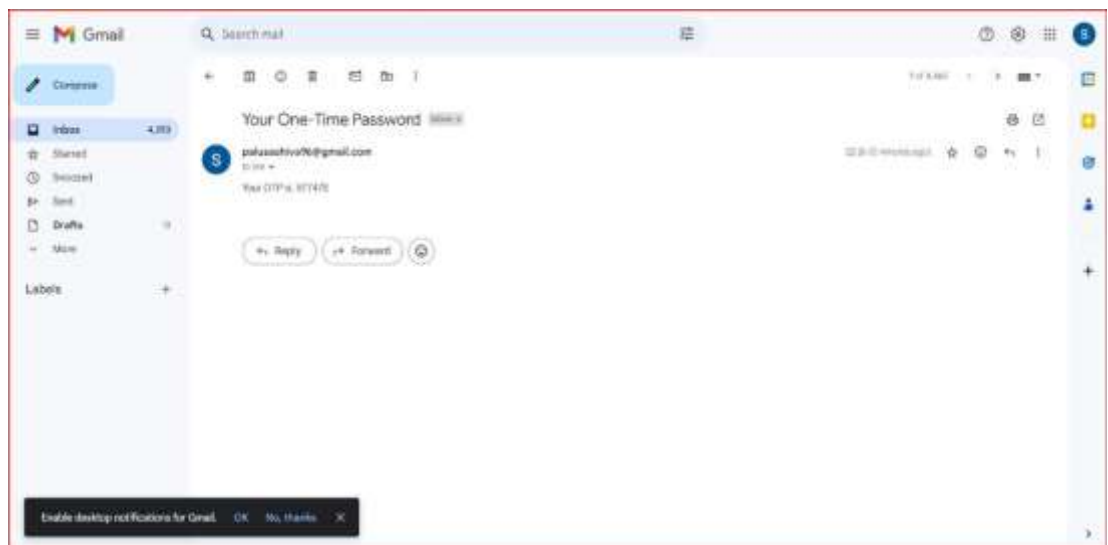


Fig 5.6 OTP validation

In above screen, Copy the ‘OTP’ and paste in the Decryption section

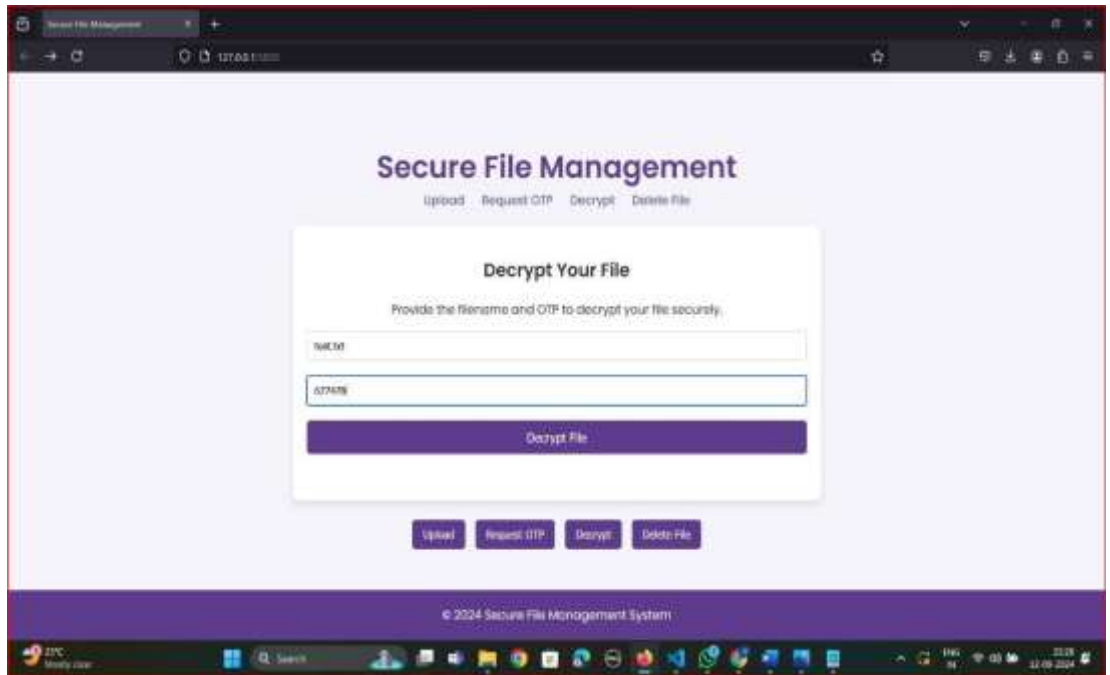


Fig 5.7 Decrypt the File

In above screen, Decrypt the file using File name and the OTP received by the Email.

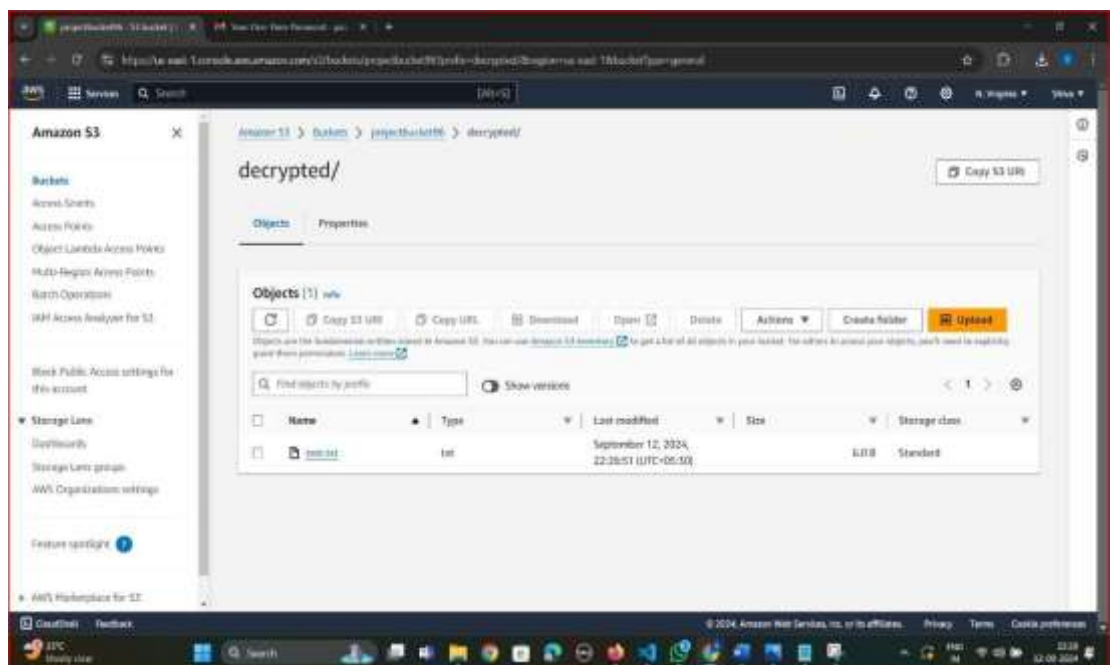


Fig 5.8 Decrypted File stored in S3

In above screen, Decrypt file is stored in the separate decrypted folder in S3 bucket

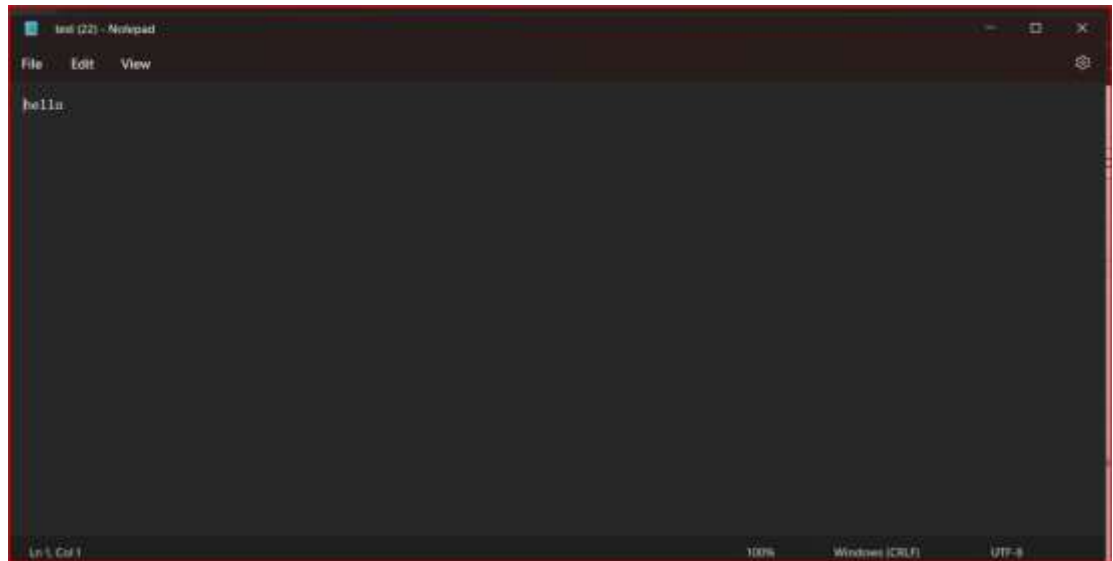


Fig 5.9 File After Decryption

In above screen, the original file is displayed after description

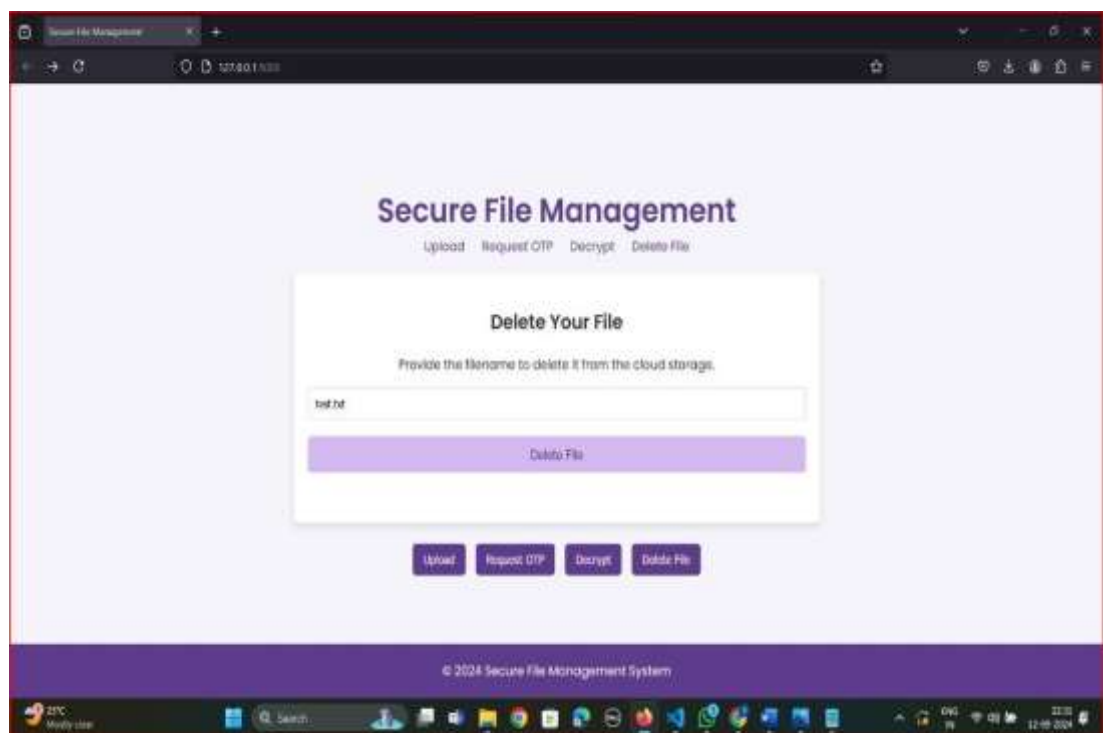


Fig 5.10 Deletion of File

In the above screen, deletion of File is taken place

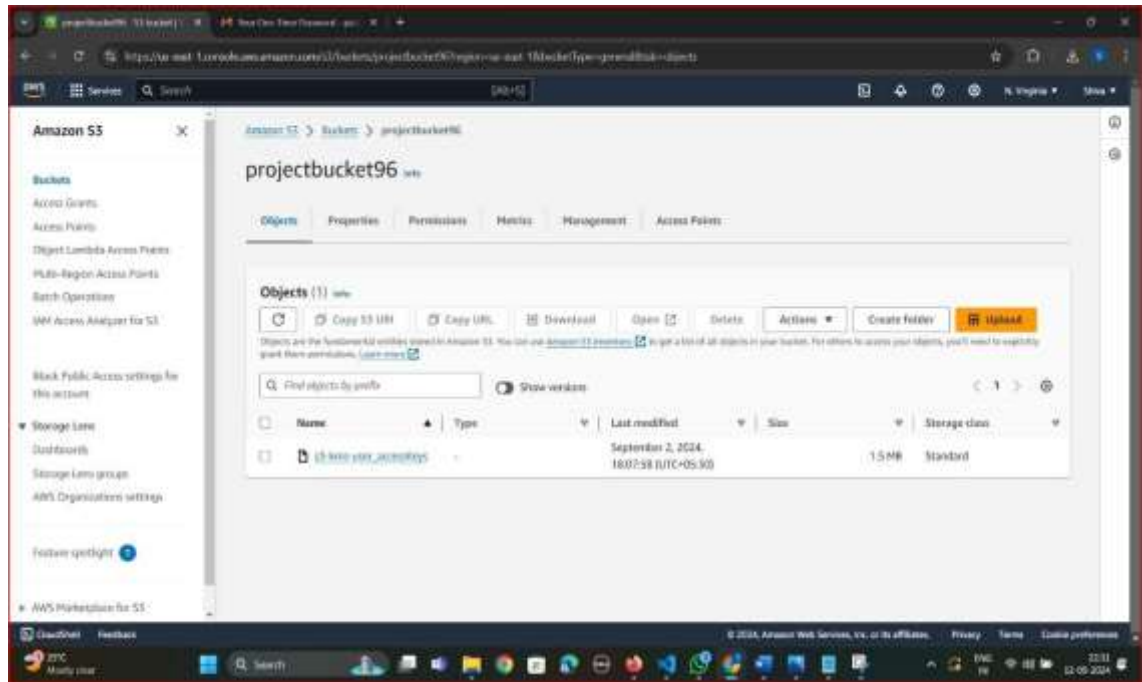


Fig 5.11 File is deleted from the S3

In above screen, the file has been removed from the S3 Bucket

6. SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

6.1 TYPES OF TESTS

1. Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. It is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

2. Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfactory, as shown by successful unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

3. Functional Testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Valid	: identified classes of valid input must be
Input	accepted.
Invalid	: identified classes of invalid input must
Input	be rejected.
Functions	: identified functions must be exercised.
Output	: identified classes of application outputs must be exercised

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

4. System Testing

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

5. White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

6. Black Box Testing

Black Box testing is a testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

6.2 VARIOUS TESTCASE SCENARIOS

○ Test Cases

Test cases	Test case Description	Test Case steps	Test data	Expected result	Actual result	Status
TC01	File Encryption and Upload	1. Open the web interface. 2. Select a file from the local system. 3. Click on the "Upload" button to initiate the encryption and upload process..	File: testfile.txt	The file is encrypted and uploaded to S3 successfully.	File was successfully encrypted and uploaded to S3.	Success

TC02	Valid OTP Allows Decryption	<ol style="list-style-type: none"> 1. Open the file download page. 2. Select the file for download. 3. Enter the valid OTP and click "Submit". 	OTP: 123456 (valid)	The file is decrypted and downloaded successfully.	File was decrypted and downloaded successfully.	Success
TC03	Invalid OTP Blocks File Access	<ol style="list-style-type: none"> 1. Open the file download page. 2. Select the file for download. 3. Enter an invalid OTP and click "Submit".. 	OTP: 000000 (invalid)	The system should block access to the file and display an error message.	System blocked file access and displayed "Invalid OTP" message..	Success
TC04	File Integrity After Decryption	<ol style="list-style-type: none"> 1. Upload a file to S3 (testfile.txt). 2. Download and decrypt the file after entering the correct OTP. 	File: testfile.txt, OTP: 123456	The original file and decrypted file should be identical.	Decrypted file was identical to the original fi	Success
TC05	S3 Bucket Access Control	<ol style="list-style-type: none"> 1. Log in as an unauthorized user. 2. Attempt to upload a file. 	User: unauthorize d_user	The system should deny access to the S3 bucket and display an error..	Access to S3 was denied, and "Unauthorized Access" error was displayed.	Success

TC06	OTP Expiry Testing	1. Request OTP for file download. 2. Wait for the OTP to expire (after 30 seconds). 3. Enter the expired OTP and submit.	OTP: 123456 (expired)	The system should display an "OTP expired" error message.	"OTP expired" message was displayed after submission.	Success
TC07	Large File Encryption	1. Select a large file (over 100 MB) for upload. 2. Click on "Upload" to initiate encryption and upload.	File: largefile.zip (over 100 MB)	The system should encrypt and upload the large file without issues.	Large file was encrypted and uploaded successfully.	Success
TC08	OTP Delivery via Email	1. Request file decryption. 2. Verify that the OTP is sent to the registered email.	Email: user@example.com	OTP should be sent to the user's email within seconds.	OTP was successfully sent to the registered email.	Success
TC09	Download with Incorrect File ID	1. Enter an incorrect file ID or name on the download page. 2. Submit the request..	File ID: invalid_file_id	The system should display an error that the file was not found.	"File not found" message was displayed for the invalid file ID..	Success

7 CONCLUSION AND FUTURE ENHANCEMENT

7.1 PROJECT CONCLUSION :

This project successfully developed a secure file management system using AWS services and Flask, ensuring robust encryption, decryption, and secure access to sensitive data. By leveraging AWS KMS for file encryption and OTP verification for access control, the system provides a reliable and scalable solution for securely uploading, storing, and managing files in AWS S3. The user-friendly web interface, built using Flask and Bootstrap, simplifies interactions, while strict access policies and server-side encryption enhance the security of data at rest. Comprehensive testing confirmed that the system effectively handles encryption efficiency, secure OTP generation, and access control, achieving the project goals of ensuring data security and user accessibility.

7.2 FUTURE ENHANCEMENT:

The system can be improved by incorporating multi-factor authentication (MFA) for enhanced user security, role-based access control (RBAC) for fine-tuned permissions, and file versioning for better management. Additional enhancements like blockchain integration for data integrity, automated key rotation for better encryption practices, and support for large-scale enterprise deployment will make the system more robust. Implementing advanced encryption algorithms and enabling browser-based file previews can further enhance both security and usability. These future developments will extend the system's capabilities, ensuring continued scalability, security, and user satisfaction.

8. REFERENCES

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8.2 WEBSITES

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8.3 TEXT BOOKS

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2. **Python Crash Course: A Hands-On, Project-Based Introduction to Programming** by Eric Matthes
3. **Programming Amazon Web Services: S3, EC2, SQS, and SNS Services** by James Murty
4. **Cloud Security: A Comprehensive Guide to Secure Cloud Computing** by Ronald L. Krutz and Russell Dean Vines