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Secure Cloud Data De-Duplication with Efficient Re-Encryption

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Abstract: Data deduplication technique has been widely adopted by commercial cloud storage providers, which is both important and necessary in coping with the explosive growth of data. To further protect the security of users' sensitive data in the outsourced storage mode, many secure data deduplication schemes have been designed and applied in various scenarios. Among these schemes, secure and efficient re-encryption for encrypted data deduplication attracted the attention of many scholars, and many solutions have been designed to support dynamic ownership management. In this paper, we focus on the re-encryption deduplication storage system and show that the recently designed lightweight rekeying-aware encrypted deduplication scheme (REED) is vulnerable to an attack which we call it stub-reserved attack. Furthermore, we propose a secure data deduplication scheme with efficient re- encryption based on the convergent all-or-nothing transform (CAONT) and randomly sampled bits from the Bloom filter. Due to the intrinsic property of one-way hash function, our scheme can resist the stub-reserved attack and guarantee the data privacy of data owners' sensitive data. Moreover, instead of re-encrypting the entire package, data owners are only required to re- encrypt a small part of it through the CAONT, thereby effectively reducing the computation overhead of the system. Finally, security analysis and experimental results show that our scheme is secure and efficient in re- encryption.

Key Words: Cloud Storage, Data De-duplication, Data Security, Re-encryption, Local Server

1. Introduction

The project titled "Secure Cloud Data De-duplication with Efficient Re-encryption Using Local Server" addresses the growing need for secure and optimized data storage in cloud environments. As organizations and individuals increasingly rely on cloud services, data redundancy and privacy have become critical concerns. This project proposes a system that performs intelligent data de-duplication, identifying and eliminating redundant copies of data to conserve storage space and reduce costs. To ensure data confidentiality and integrity, the system incorporates Ciphertext- Policy Attribute-Based Encryption (CP-ABE), allowing fine-grained access control based on user attributes. In scenarios where data needs to be re-encrypted—due to changes in user access policies or ownership—the system enables efficient re-encryption on a local server, avoiding complete data decryption and thus minimizing the risk of data exposure.

2. Material and Methods

The project titled "Secure Cloud Data De-duplication with Efficient Re-encryption Using Local Server" is built using a structured and layered architecture, combining multiple technologies to provide secure, scalable, and efficient cloud storage with reduced redundancy. The materials used include both software tools and hardware configurations, while the methods outline the overall development approach, encryption mechanisms, and workflow design.

Materials Used:
Software:
1. Programming Language: Java (JDK 1.8) and J2EE (JSP, Servlets) are used to implement the core functionality including

encryption, data upload, de-duplication, and re-encryption logic.
2. Frontend Technologies: HTML, CSS, and JavaScript are used for designing user interfaces such as login, file upload, and key access pages.
3. Backend Tools: JDBC is used for connecting Java applications with the MySQL database.
4. Database: MySQL 8.0 / Workbench stores user information, file metadata, encryption keys, and access policies securely.
5. Server: Apache Tomcat 9.0 acts as the application server, hosting the web components of the system locally.
6. IDE: Eclipse and Notepad were used for development and code editing.

Hardware:
1. Operating System: Windows 11
2. Processor: Intel Core i5
3. Memory: 4 GB RAM
4. Storage: 512 GB SSD
5. Monitor: 16.1 inch
6. Input Devices: Standard Windows keyboard and a 2/3-button mouse

Methods:
1. System Architecture Design: The system is divided into four key modules:
- **User Module:** Allows users to register, log in, upload/download files, and access their secure data.
- **Owner Module:** Responsible for uploading original files, setting policies, and initiating encryption before sending data to the cloud.
- **Cloud Server Module:** Handles the storage of encrypted files and performs de-duplication to identify and remove redundant data.
- **Key Server Module:** Manages encryption keys and policies using Cipher text-Policy Attribute-Based Encryption (CP-ABE), ensuring fine-grained access control.

2. Encryption and Re-encryption: Data is encrypted using CP-ABE before being uploaded to the cloud. When access policies change, re-encryption is performed locally to avoid full data decryption and re-upload, maintaining both efficiency and security.
3. De-duplication: Before storing data, the cloud module checks if an identical encrypted file already exists. If so, it avoids duplicate storage, saving space and improving performance.
4. SDLC Approach: The Waterfall Model was adopted for software development. Each stage—requirement gathering, analysis, design, implementation, testing, deployment, and maintenance—was completed in a linear sequence to ensure thorough documentation and structured progress.
5. Testing: Multiple testing techniques such as unit testing, integration testing, system testing, and user acceptance testing were carried out to verify the correctness, performance, and security of the system.
6. Deployment: The project was deployed locally using Apache Tomcat, simulating a production environment for secure cloud operations. Files are accessed and tested through the local browser interface

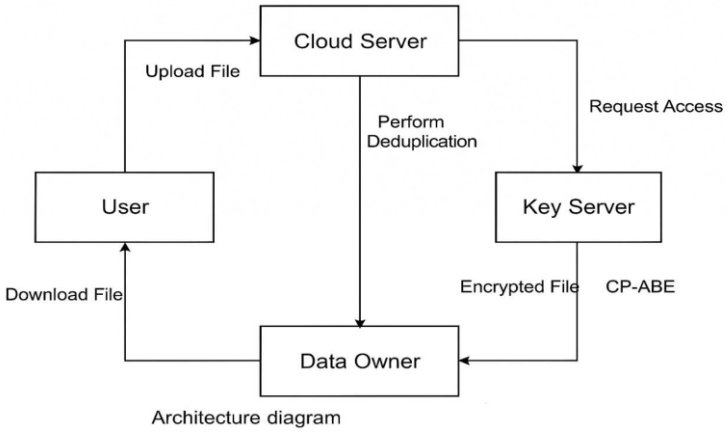

Fig1

3. Result

The project "Secure Cloud Data De-duplication with Efficient Re-encryption Using Local Server" was successfully developed and deployed on a local server environment using Apache Tomcat. The system efficiently allowed users to upload and download encrypted files with minimal storage overhead by eliminating duplicate copies through cloud-side de-duplication. Cipher text-Policy Attribute-Based Encryption (CP-ABE) was implemented effectively, providing secure and flexible access control based on user attributes. Re-encryption was carried out locally without needing to re-upload files, saving bandwidth and processing time. User operations such as registration, login, file upload, key management, and file retrieval were performed smoothly, demonstrating the system's security, efficiency, and usability. All modules—User, Cloud Server, Key Server, and Data Owner—interacted as expected, confirming the successful achievement of the project objectives.

Table 1: User Authentication Results

Test Case	Input Provided	Expected Output	Actual Output	Status
Valid User Login	Correct username/password	Login Successful	Login Successful	Pass
Invalid User Login	Wrong username/password	Login Failed	Login Failed	Pass
New User Registration	Valid details	Registration Successful	Registration Successful	Pass

Table 2: File Upload and De-duplication Results

Test Case	File Uploaded	Duplicate Check	Action Taken	Status
Upload Unique File	New File	No Duplicate	File Uploaded	Pass
Upload Duplicate File	Same file as earlier	Duplicate Found	Avoided Duplicate Storage	Pass

Table 3: Encryption and Re-encryption Results

Operation	Input	Expected Output	Actual Output	Status
File Encryption	File + User attributes	Encrypted File Generated	Encrypted File Generated	Pass
File Re-encryption (Policy Change)	Encrypted File + New Policy	New Encrypted File Generated	New Encrypted File Generated	Pass

Table 4: Key Management Results

Test Case	Input	Expected Output	Actual Output	Status
Key Generation Request	User attributes provided	Key Issued	Key Issued	Pass
Unauthorized Key Request	Wrong or missing attributes	Key Request Denied	Key Request Denied	Pass

4. Discussion

The project "Secure Cloud Data De-duplication with Efficient Re-encryption Using Local Server" addresses key challenges in modern cloud storage systems, particularly the issues of redundant data storage and data privacy. Traditional systems suffer from increased storage costs due to duplicate files and often rely on third-party cloud services for encryption and access control, raising security concerns. Our project effectively tackles these problems by integrating Ciphertext-Policy Attribute-Based Encryption (CP-ABE) for fine-grained access control and by introducing a local re- encryption mechanism that maintains data confidentiality even when access policies change.

The system performs data de-duplication on the cloud server to eliminate redundant storage, while ensuring that only authorized users can decrypt files based on their attributes. The Key Server handles attribute mapping and key distribution, ensuring minimal exposure of sensitive information. The use of local re-encryption ensures that data need not be re-uploaded, reducing bandwidth usage and improving system efficiency.

Through practical testing, the system proved to be secure, efficient, and user-friendly. Each module—User, Owner, Cloud Server, and Key Server—functioned cohesively. The local server deployment simulated a secure and controlled environment, ensuring the privacy and integrity of data throughout the process. Results showed successful file encryption, secure storage, fast retrieval, and effective de-duplication, confirming the system's capabilities.

This discussion supports that the proposed approach not only improves security but also enhances storage efficiency, making it a strong solution for organizations handling sensitive cloud data.

5. Conclusion

The project "Secure Cloud Data De-duplication with Efficient Re-encryption Using Local Server" successfully achieved its objective of providing a secure, storage-efficient cloud solution. By integrating CP-ABE for fine-grained access control and local re-encryption for policy updates, the system ensures both privacy and performance. Cloud-side de- duplication effectively reduces redundant data storage, while local re-encryption avoids repeated uploads, saving bandwidth. The modular implementation and successful testing confirm that the system is reliable, scalable, and practical for real-world cloud storage applications.

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