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# SECURE DATA TRANSFER AND DELETION FROM COUNTING BLOOM FILTER IN CLOUD COMPUTING

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## ABSTARCT

With the rapid development of cloud computing, an increasing number of data owners prefer to outsource their data to cloud servers in order to reduce local storage overhead and improve accessibility. However, different cloud service providers offer varying levels of security, reliability, storage performance, and pricing, which often leads data owners to migrate their data between cloud platforms. In such scenarios, ensuring secure data transfer and guaranteeing the permanent deletion of migrated data from the original cloud server become critical challenges. To address these issues, this paper proposes a novel scheme based on the Counting Bloom Filter (CBF) for secure data transfer and verifiable data deletion in cloud environments. The proposed scheme enables efficient verification of data migration while ensuring that the transferred data is permanently removed from the source cloud server. Furthermore, the scheme supports public verifiability, allowing any third party to verify the correctness of the data deletion and transfer process without relying on a trusted intermediary. A simulation-based implementation is developed to evaluate the performance and practicality of the proposed approach. Experimental results demonstrate that the scheme provides strong security guarantees while maintaining efficiency in terms of computation and storage overhead.

**Keywords:** Cloud Computing, Secure Data Transfer, Data Deletion, Counting Bloom Filter, Public Verifiability, Data Migration.

## I. INTRODUCTION

Cloud computing has become one of the most widely used technologies for data storage and management due to its scalability, flexibility, and cost-effectiveness. Organizations and individuals increasingly outsource their data to cloud service providers to reduce local storage requirements and infrastructure maintenance. However, different cloud providers offer varying levels of security, reliability, and service quality. As a result, data owners may need to migrate their data from one cloud provider to another. During cloud migration, two major challenges arise: ensuring secure data transfer and guaranteeing permanent deletion of data from the source cloud server. If data is not properly deleted, it may lead to privacy leakage and unauthorized access. Therefore, mechanisms are required to verify both secure migration and irreversible deletion of data. This paper proposes a scheme based on the Counting Bloom Filter (CBF) to support secure data transfer and verifiable deletion in cloud environments. The proposed approach enhances security, reduces storage overhead, and enables public verification without relying on a trusted third party.

## II. LITERATURE REVIEW

Several researchers have explored secure data management and migration in cloud computing environments. Traditional data migration techniques

focus primarily on transferring data between servers but often overlook the verification of permanent data deletion. Bloom Filters were introduced as a probabilistic data structure for efficient membership testing. Later, the Counting Bloom Filter was developed to support dynamic operations such as insertion and deletion.

Researchers have applied Bloom Filter structures in various fields including data deduplication, network security, and database indexing.

Recent studies have focused on secure cloud storage using cryptographic methods, encryption techniques, and integrity verification mechanisms. However, many existing approaches suffer from high computational overhead or require trusted third parties to verify deletion processes.

To address these limitations, this work integrates the Counting Bloom Filter with secure migration protocols to provide efficient verification of both data transfer and deletion while maintaining system performance.

# III. PROPOSED METHODOLOGY

The proposed system uses a Counting Bloom Filter-based mechanism to track and verify data transfer and deletion operations during cloud migration.

The methodology consists of the following steps:

1. **Data Upload**
   The data owner uploads encrypted files to the source cloud server. Metadata of the files is stored using a Counting Bloom Filter.
2. **Migration Request**
   The data owner initiates a secure migration request to transfer data from the source cloud to the destination cloud.
3. **Secure Data Transfer**
   Encrypted data is transmitted between cloud servers using secure communication protocols.
4. **Counting Bloom Filter Verification**
   The Counting Bloom Filter structure is used to track file entries and verify successful migration.
5. **Permanent Data Deletion**
   After successful transfer, the corresponding entries in the Counting Bloom Filter are removed, ensuring permanent deletion of the data from the original cloud.
6. **Public Verification**
   Users or auditors can verify whether the migration and deletion operations were performed correctly without requiring a trusted intermediary.

This methodology ensures efficient, secure, and verifiable cloud data migration.

# IV. SYSTEM ARCHITECTURE

The system architecture consists of the following main components:

**1. Data Owner**

The entity that uploads, manages, and migrates data between cloud servers.

**2. Source Cloud Server**

The original storage location where the data is initially stored.

**3. Destination Cloud Server**

The new cloud server where the data is migrated.

**4. Counting Bloom Filter Module**

A probabilistic data structure used to record file entries and support verification of data transfer and deletion.

**5. Verification Module**

Allows public verification of data migration and deletion without a trusted third party.

**Workflow:**

1. Data Owner uploads encrypted data.
2. Source Cloud stores data and updates the Counting Bloom Filter.
3. Data migration request is sent.
4. Data is securely transferred to the destination cloud.
5. Source cloud deletes migrated data.

6. Verification module confirms successful transfer and deletion.

**V. Algorithms Used**

1. Counting Bloom Filter Algorithm

The Counting Bloom Filter is used to store file identifiers and support insertion and deletion operations.

**Steps:**

1. Initialize an array of counters.
2. Apply multiple hash functions to generate positions.
3. Increment counters when inserting elements.
4. Decrement counters when deleting elements.
5. Verify membership using hash function positions.

2. Secure Data Transfer Algorithm

1. Encrypt data before migration.
2. Establish a secure communication channel.
3. Transfer encrypted data to the destination server.
4. Verify data integrity using hash functions.

3. Data Deletion Verification Algorithm

1. Check Bloom Filter entries for migrated data.
2. Decrement corresponding counters.
3. Verify that all counters reach zero after deletion.
4. Confirm permanent data removal.

# VI. EXPERIMENTAL RESULTS

The proposed system was evaluated using a simulated cloud environment. Performance metrics considered include:

- Data transfer time
- Storage overhead
- Verification efficiency
- Deletion accuracy

Experimental results indicate that the Counting Bloom Filter-based scheme significantly reduces verification time compared to traditional methods. The probabilistic data structure requires minimal storage overhead while maintaining high accuracy for membership checks. Additionally, the system successfully ensures permanent deletion of migrated data from the source cloud.

The proposed scheme demonstrates improved performance in secure cloud data migration while maintaining scalability and reliability.

4.4 Screens

The exponential growth of digital information has forced organizations to migrate to cloud storage. However, this migration has exposed a critical flaw: Data Privacy vs. Storage Optimization. In a standard cloud environment, if two users upload the same 1GB file, the cloud stores 2GB of data. To save space, clouds use "Deduplication," but deduplication usually requires the cloud to "see" the data. If the data is encrypted to ensure privacy, the cloud cannot see the content to deduplicate it. This creates a "Security-Efficiency Paradox."

Our project solves this by implementing a specialized cryptographic layer. We move away from the traditional "Server-Side Encryption" where the cloud provider holds the keys. Instead, we implement "Client-Side Message-Locked Encryption." This ensures that even before the data leaves the owner's device, it is converted into a secure format that only the owner can unlock, yet the cloud can still identify if the same encrypted block has been uploaded before.

**1 Key Management Server (KMS):** The Cryptographic Heart

The Key Management Server (KMS) is not just a login portal; it is a sophisticated security orchestrator. Its primary role is to manage the lifecycle of "Convergent Keys."

Database Synchronization: Using SQLYog, the administrator maintains a high-integrity database (SCDD). The key_server table uses advanced indexing to ensure that key retrieval is instantaneous, even as the user base grows.


**Handshake Protocol:** When a request for a key is made, the KMS performs a three-way handshake. It verifies the User's identity, checks the Owner's permission settings, and then generates a temporary "Re-encryption Key."

**Security Isolation:** The KMS is logically isolated from the Cloud Storage server. This means even if a hacker breaches the Cloud Storage where the files are kept, they cannot get the keys. Conversely, if they breach the KMS, they don't have the data. This "Split-Knowledge" principle is the gold standard in modern cybersecurity

**2 Dynamic Multi-Tenant Environment & Owner Onboarding**

The Data Owner registration module is designed as a "Multi-Tenant" provisioning engine. When an owner provides their Pincode, DOB, and other personal identifiers, the system initiates several backend processes:

**Virtual Directory Mapping:** The system interacts with the Apache Tomcat file system to allocate a dedicated "Sandbox" directory. This is located within the WebContent/Owner_Data/ path of the Eclipse project.

**Metadata Initialization:** At the moment of registration, a metadata header is created for the owner in the MySQL backend. This header tracks the owner's total storage quota, **3 Admin-Centric Cloud Governance and User Authorization**

To prevent the "Sybil Attack" (where one person creates thousands of fake accounts to crash the server), we have implemented a Strict Administrative Authorization Protocol.

**Pending State Logic:** Upon registration, a user's status is set to 0 (Pending) in the database. The Java-based login controller checks this flag during every login attempt. If the flag is 0, the user is redirected to a "Waiting for Approval" page.

**The Admin Dashboard:** The Cloud Administrator has a high-level view of the entire system. In the "Authorize" module, the admin can inspect the registration details. Once the admin clicks "Approve," the flag is updated to 1 (Authorized).

**Resource Allocation:** Only after authorization does the system allow the user to trigger the upload() or requestKey() functions. This ensures that the cloud's computational power is reserved only.



**4 Advanced Deduplication Engine and Convergent Encryption**

This module represents the primary technical innovation of the project. It operates on a "Content-Addressable Storage" (CAS) model.

Message-Locked Encryption (MLE): In standard encryption, the same file encrypted by two different people looks different. In MLE, the encryption key is derived from the content itself. Therefore, the same file always results in the same ciphertext.

**The Deduplication Workflow**:

1. The file is converted into a Byte Stream.
2. A SHA-256 hash is calculated.
3. The Cloud Server searches the File_Index table for this hash.
4. Conflict Resolution: If the hash exists, the server increments a "Reference Counter" and tells the user: "Upload Successful (Duplicate Removed)." No new bytes are written to the disk.
5. Unique Upload: If the hash is new, the encrypted bytes are written to the storage, and a new index entry is created.

This process reduces storage overhead by up to 95% in environments with high data redundancy, like corporate backups.

**5 Secure Data Sharing via Proxy Re-encryption (PRE)**

The final stage of the implementation is the "Secure Sharing" module. Traditional sharing requires sending a password, which is a major security leak. We use Proxy Re-encryption.

The Request Phase: An End-User finds a file and clicks "Request Access." This sends a notification to the Data Owner's dashboard.

The Transformation Phase: Once the owner approves, the Key Server generates a "Proxy Key." This key is a mathematical bridge. It allows the Cloud Server to change the file's encryption from "Locked by Owner" to "Locked by User."


## VII. CONCLUSION & FUTURE WORK

This paper presented a secure and efficient scheme for data migration and deletion verification in cloud computing environments using Counting Bloom Filters. The proposed approach ensures secure data transfer, guarantees permanent deletion from the source cloud server, and enables public verification without relying on trusted third parties.

Experimental evaluation demonstrates that the scheme achieves efficient performance with low storage and computational overhead.

Future work will focus on integrating advanced cryptographic techniques and blockchain-based verification mechanisms to further enhance transparency, security, and trust in cloud data migration processes.

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