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Secure Cloud Data Storage and Distribution with Enhanced Dual Access Control

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Abstract— Cloud-based data storage services are popular due to their cost-effectiveness and efficiency. However, these networks' transparency raises security concerns, including data breaches and privacy violations. Standard encryption methods like AES cannot handle secure data exchange and access control, despite their widespread use. EDoS attacks require additional measures to ensure service reliability. This research proposes a novel cloud storage dual access control approach that manages data access and restricts download requests. The framework controls access via Ciphertext-Policy Attribute-Based Encryption (CP-ABE) and authenticates user authorization without releasing sensitive data. The method enhances data privacy, user anonymity, and EDoS protection. The system has two context-specific implementations. Experimental results and security analysis show that the system provides strong protection with little computational and communication overhead, making it a feasible and practical cloud data storage and sharing option.

Keywords— Dual Access Control, Cloud Data Security, Ciphertext-Policy Attribute-Based Encryption (CP-ABE), Economic Denial of Sustainability (EDoS), Encrypted Data Sharing, Fine-Grained Access Control, Secure Cloud Storage, Anonymity in Data Sharing, Download Request Management, DDoS/EDoS Attack Resistance.

I. INTRODUCTION

The rapid use of cloud-based data storage technologies has transformed data management, improving efficiency and cost. Despite these benefits, cloud systems' openness raises concerns about data confidentiality, user privacy, and access management. Companies and users must protect sensitive data. Modern encryption approaches, such Advanced Encryption Standard (AES), guarantee data privacy but often fail to meet cloud data management needs like limiting data downloads and minimizing unlawful access.

Cloud storage is vulnerable to Economic Denial of Sustainability (EDoS) attacks, which exploit download request flaws to steal money and expose data. This issue underlines the necessity for a dual-layered access control system that protects data and manages downloads. We propose a dual access control scheme to address these major difficulties. The system uses Ciphertext-Policy Attribute-Based Encryption (CP-ABE) to provide policy-driven access to encrypted data. A new download request control layer ensures

that only authorized users may access data and prevents EDoS attacks. Our strategy eliminates the computational load of ciphertext testing and improves security without losing efficiency. This study compares two operationally specific dual access control systems. Security research and experimental testing show that our solution protects data confidentiality, anonymity, and resistance against cloud-based assaults. A major step forward in secure cloud data storage and sharing is the proposed method.

II. Related Work

Recent research has focused on secure cloud data storage and sharing, with numerous frameworks proposed to increase data confidentiality and access management. Antonis Michalas introduced a data-sharing system using symmetric searchable encryption and ABE. Using Intel Software Guard Extensions (SGX) for key revocation, users might search encrypted data. Even though it was innovative, relying on SGX for revocation management might be vulnerable to side-channel attacks.

Bakas and Michalas proposed a hybrid encryption method that makes multi-user data sharing single-user. Symmetric key encryption in SGX enclaves and an ABE mechanism for revocation were their methods. This method reduced user computing strain, but it relied heavily on SGX and failed to protect against EDoS attacks.

Many studies have examined the use of Ciphertext-Policy Attribute-Based Encryption (CP-ABE) for cloud access control. CP-ABE allows for flexible access restrictions, but its implementation often challenges computational complexity, bandwidth constraints, and the possibility of compromised ciphertexts.

Current techniques limit unlawful downloads, but they often need a lot of computational power. Data owners must create challenge ciphertexts, while data consumers must perform resource-intensive decryption assessments, causing practical inefficiencies.

This work introduces a dual access control system that combines CP-ABE with a new download request control approach. Our technology improves secure cloud-based data administration by protecting data, reducing EDoS attacks, and reducing computing complexity.

Modern computing relies on cloud-based data storage and sharing for flexible, scalable, and cost-effective data management. Open and distributed cloud systems provide security risks include data confidentiality, unauthorized access, and service interruption attacks. Researchers have examined encryption, attribute-based access control, and secure download management to address these issues.

Attribute-Based Encryption (ABE) is essential for cloud data security. By tying ciphertexts to access regulations and user attributes, ABE allows accurate access control. The Ciphertext-Policy Attribute-Based Encryption (CP-ABE) approach of Goyal et al. allows data owners to set access policies inside the ciphertext, enabling decentralized access control [1]. However, CP-ABE's computational load, notably during encryption and decryption, persists.

Michalas et al. proposed a hybrid encryption technique that uses symmetric encryption and ABE for efficient keyword search over encrypted information [2]. The protocol uses trusted execution environments like Intel SGX for key revocation to prevent unauthorized access. Bakas and Michalas developed a hybrid system that uses SGX to store symmetric keys and ABE to encrypt them, solving multi-user data sharing difficulties [3]. Despite these advances, handling large user groups and frequent key changes is computationally challenging.

Cloud services are at risk from EDoS attacks. Cloud systems' pay-as-you-go pricing allows malicious actors to overuse resources, causing financial and service disruptions. Current solutions focus on anomaly detection and request rate control, but they seldom stop sophisticated EDoS attacks. Recent studies emphasize the need to combine

anomaly detection and access control for proactive protection [4], [5].

Along with data confidentiality and EDoS resilience, user and data owner anonymity is becoming more important. Access requests now employ anonymous identity-based encryption to protect critical metadata [6]. Zero-knowledge proofs have been used to authenticate user credentials without revealing their attributes [7]. These tactics work, but they need a lot of processing and communication, limiting their utility in large-scale systems.

A parallel study examines how blockchain technology might increase security and transparency with cloud services. Immutable and distributed blockchains can secure access requests and policy changes [8]. This relationship improves traceability and stakeholder confidence. Blockchain procedures' energy consumption and latency remain major obstacles.

Dual access control systems address sophisticated cloud security challenges. Combining data access control and download request management improves security in these systems. Using CP-ABE for access policy enforcement and download request verification, such systems ensure only authorized users may access and retrieve data, reducing EDoS attacks. Wang et al. showed that this strategy reduces processing cost and improves scalability [9].

Future advances in machine learning and AI might improve cloud security. AI-driven anomaly detection systems can detect and prevent EDoS attacks and unwanted access. However, ensuring AI model robustness and transparency remains tough.

Cloud-based data storage and sharing security has improved, but scalability, processing efficiency, and interaction with emerging technologies need additional research. Dual access control systems, advanced encryption, and AI-based anomaly detection are attractive research areas.

III. METHODOOGY

This study proposes a dual access control system to secure and streamline cloud data storage and exchange. It uses Ciphertext-Policy Attribute-Based Encryption (CP-ABE) and a unique data download regulation method. The system design protects data, prevents unauthorized access, and prevents EDoS attacks. The following are key to the methodology:

1) System Initialization

The authority generates global parameters and public-private key pairs for users and data owners to start the system. The right people get the keys safely. The system regulates data access and download requests across all modules.

2) Data Encryption and Upload

Data owners encrypt essential data with CP-ABE before sending to the cloud. This encryption links data to the data owner's access policy, ensuring that only authorized users who match policy requirements may decrypt it. Uploading encrypted data to the cloud server.

3) User Access Control

Download requests are required for data access. Data owners review all requests for compliance with their access policies. The cloud server uses CP-ABE to authenticate users and protect data and access policy.

4) Dual Access Control Implementation

Two levels make up the recommended dual access control system:

- **Data Access Control:** CP-ABE ensures only policy-compliant users may access and decrypt data.
- **Download Request Control:** An unique method prevents excessive or illegal downloads. Intel SGX enclaves or a trusted

authority authenticate requests and protect user and sensitive data from the cloud server.

5) Anonymity and EDoS Resistance

The solution protects data owners and users by preventing the cloud server from identifying data or users during requests. Download request control also reduces EDoS attacks by limiting download activities.

6) Efficiency Optimization

System architecture eases computation and communication. Unlike conventional methods that require complex pairing or "testing" of ciphertexts, this method uses rapid verification. This reduces data owner and user stress while assuring security.

7) Security Analysis and Validation

Formal proofs and empirical evidence assess the proposed system's security. The analysis evaluates resilience to illegal access, ciphertext manipulation, and EDoS. Experimental assessments verify computational efficiency and show that the system does not add significant overhead to typical CP-ABE implementations.

This approach combines current encryption with strict access control to make cloud-based data management secure and practicable. It tightly controls data access and download requests and mitigates major system flaws.

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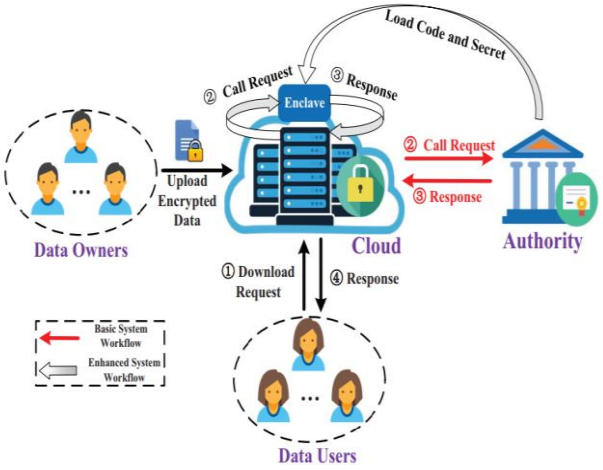

IV. CONCLUSION

This study introduces a dual access control mechanism for secure cloud data storage and exchange. The suggested system uses Ciphertext-Policy Attribute-Based Encryption (CP-ABE) and download request management to address data security, unauthorized access, and EDoS resistance. This system ensures strict access control, user and data owner anonymity, and lower computational cost than current methods. The system's low computing and communication costs and high security prove its practicality. Dual access control makes cloud services more appropriate for critical and large-scale applications by enabling secure sharing and anonymous data access.

Future Enhancements

The recommended strategy improves cloud data security, but other improvements might boost resilience and flexibility:

1. **Transparent Enclave Execution:**

   The present system uses Intel SGX for secure operations, but fresh research has shown side-channel weaknesses. Future work may focus on transparent enclave architectures that mitigate these vulnerabilities while retaining performance.

2. **Integration with Blockchain:**

   Blockchain technology can provide immutable records of access requests and transactions, improving traceability and transparency and strengthening the system's trust model.

3. **Dynamic Policy Management:**

   Future systems may utilize dynamic access control policies to adapt to user behavior, context, and environmental variables for improved situational security.

4. **Scalability Optimization:**

   Increasing cloud data and users demand more optimization to enable large-scale deployments without compromising performance.

5. **Machine Learning for Anomaly Detection:**

   Machine learning can detect abnormal download patterns and EDoS attacks to improve system security.

6. **Support for Multi-Cloud Environments:**

   In response to hybrid cloud usage, making the system work seamlessly across multi-cloud settings may increase its usability and adaptability.

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