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Secure Network Backup System: Methodology for Cloud Storage Environment

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Abstract

This research introduces a secure network backup system in a cloud storage environment, emphasizing storage security. The method focuses on constructing a trusted network architecture, establishing a trust domain based on user needs, and implementing user identity authentication through a public key infrastructure (PKI) for non-deceptiveness and non-repudiation assurance. The system employs a Hash algorithm for file hashing, utilizes the advanced encryption standard (AES) algorithm for data encryption, and securely transmits the encrypted file to a cloud storage server to preserve data confidentiality and integrity. It enhances efficiency and confidentiality through a directory tree-based synchronization approach and streamlines management by employing a hierarchical key management strategy. Furthermore, it includes a version control feature for file version continuity and provides flexible encryption key selection options.

Keywords

Secure network backup, Cloud storage, Storage security, Trust network, Public Key Infrastructure (PKI), Hash algorithm, Advanced Encryption Standard (AES), File synchronization, Hierarchical key management, Version control, Encryption key selection.

Introduction

In recent years, the widespread adoption of cloud storage has revolutionized data management and backup practices. Cloud storage offers numerous advantages such as scalability, cost-effectiveness, and accessibility from anywhere at any time. However, concerns about data security and privacy in the cloud environment have emerged as critical issues. The need for a secure network backup system that guarantees data confidentiality, integrity, and user authentication has become paramount.

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This research focuses on addressing the challenges associated with securing network backup systems under a cloud storage environment. The objective is to propose a method that ensures the non-deceptiveness and non-repudiation of users while guaranteeing the confidentiality and completeness of data. By establishing a trust network within the system architecture, a secure foundation is laid for the network backup process. Fig.1 shows the generic overview of the backup system.[1] To achieve this, the method incorporates a robust identity authentication mechanism based on public key infrastructure (PKI). This ensures that only authorized users can access and manipulate the backup system, providing a layer of trust and accountability. User authentication is crucial for maintaining data security, especially in a shared and dynamic cloud storage environment. Data integrity is another vital aspect of a secure network backup system. In this research, a Hash algorithm is employed to calculate the Hash value of each file, enabling efficient detection of any unauthorized modifications or data tampering. Additionally, an advanced encryption standard (AES) algorithm is utilized for data encryption, safeguarding the confidentiality of the files during transmission and storage in the cloud.

Efficient and secure synchronization of files is crucial for a network backup system. To enhance both the synchronization efficiency and confidentiality, a synchronization mechanism based on a directory tree structure is proposed. This approach ensures that only the necessary files are synchronized while maintaining the confidentiality of the system. The management of encryption keys is a crucial aspect of data security. To address this, a hierarchical key management approach is introduced, which reduces the management burden while ensuring the security of the system. This allows for effective key distribution, rotation, and revocation, enhancing the overall security posture. Furthermore, to ensure the continuity of file versions and facilitate efficient data retrieval, a version control function is incorporated. This guarantees that different versions of files are preserved and accessible when needed, enabling efficient data recovery in case of data loss or corruption. Finally, the method provides encryption key selection options at various levels of granularity, offering flexibility to accommodate different security requirements and user preferences. This allows users to tailor the system's security parameters according to their specific needs. By addressing these key aspects, the proposed method aims to establish a secure network backup system that effectively operates within a cloud storage environment. The research contributes to the field of storage security by providing a comprehensive approach to ensure data confidentiality, integrity, user authentication, efficient synchronization, version control, and flexible encryption key management.

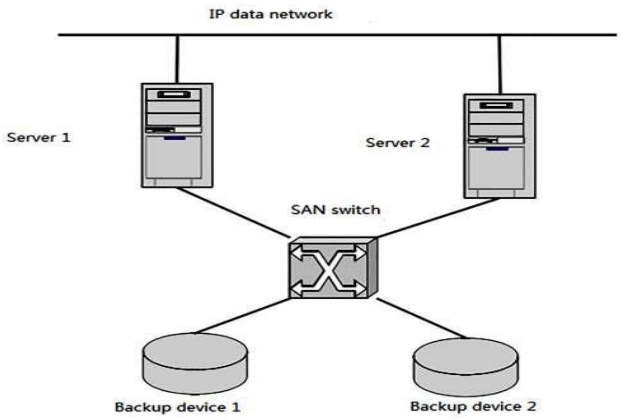

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Fig1. A generic overview of the Backup System

Related Work

With the rapid development of cloud computing technology, cloud storage has gained significant attention and adoption.[2] Cloud storage allows file owners to upload their files to a centralized location managed by cloud storage service providers. One popular application of cloud storage is the use of net disc systems, which enable file owners to authorize other users and facilitate collaborative work through data sharing and synchronization. While net disc systems leverage cloud storage for seamless collaboration, the absence of robust security mechanisms poses significant risks to the privacy and security of user data. Data confidentiality is a critical aspect of data security. If users store their data explicitly in cloud storage without proper protection, the service provider may have unauthorized access to these data. In the event that the service provider misuses or exploits this data for malicious purposes, users may suffer substantial losses and unforeseen consequences. Data integrity is another key element of data security.[3] In an insecure network, data transmitted in plaintext form may be tampered with by malicious users, or cloud storage service providers with malicious intent may intentionally delete or modify user data to achieve their illegal objectives.[4] Users need to ensure that the data they uploaded remain intact and unaltered, and that they can verify the authenticity of their data. Availability, the third element of data security, is generally provided by cloud storage service providers.[5] However, in the context of net disc systems under a cloud storage environment, the issue of authority control and safety becomes crucial. Sharing data inevitably compromises data confidentiality. Thus, establishing a secure mechanism to manage data access and permissions in a new trust system framework becomes highly important. In summary, in a secure net disc system under a cloud storage environment, the data owner and authorized users are considered trustworthy, as they may have access to and the potential to manipulate data. On the other hand, cloud storage service providers, the network, and unauthorized users are deemed untrustworthy, as they may have the capability to leak user data or engage in malicious activities.[6] Considering the trustworthiness of cloud storage service providers, it becomes essential to design security mechanisms that users can rely on and to ensure that user data is protected from unauthorized access and misuse.[7] In light of these challenges, it is imperative to develop a

comprehensive method for realizing a secure network backup system under a cloud storage environment.[8] [9] This research aims to address the aforementioned security concerns by proposing a method that ensures data confidentiality, integrity, and availability, as well as effective security permissions management in a network backup system. By doing so, it seeks to enhance the overall security of cloud storage and network disk systems, enabling users to confidently store and collaborate on their files in the cloud.

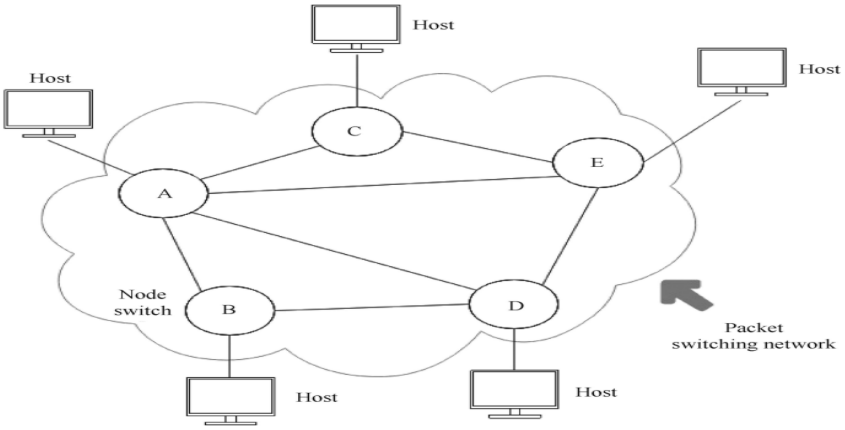
Research Objective

The research aims to develop a method for implementing a secure network backup system within a cloud storage environment. The primary objectives include:

- Designing a system architecture within a trust network to establish a secure network backup system.
- Implementing user authentication using Public Key Infrastructure (PKI) to ensure non-deceptiveness and non-repudiation.
- Employing Hash algorithms for file integrity verification and AES algorithms for data encryption to ensure confidentiality and data integrity.
- Developing a synchronization mechanism based on a directory tree structure to enhance system efficiency and confidentiality.
- Implementing hierarchical key management to reduce the system's management burden while ensuring data security.
- Incorporating version control functionality to guarantee the continuity of file versions.
- Providing encryption key selection at multiple levels of granularity to increase the flexibility of the system.

Ensuring the Security of Cloud-Based Backup Systems

This research focuses on the implementation method of a secure network disk system within a cloud storage environment. The method involves the collaboration of client computers, servers, and cloud storage servers to establish a secure network disk system. Fig. 2 shows the basics of cloud computing. During system initialization, the client computer, referred to as the client, is equipped with modules for data encryption and decryption, data integrity authentication, local operations, file sharing, and protocol communication. The server side is equipped with an authentication module, storage control module, access control module, version control module, and directory metadata administration module. The directory metadata administration module handles directory metadata operations, including directory type, owner's username, absolute path, access control list (ACL), authorized user quantity, and key



generation mode. The ACL includes user-names and corresponding encrypted keys, encrypted using the respective user's public key. The user can decrypt the keys using their private key.

The cloud storage server, referred to as the cloud storage end, consists of a memory module and a data reliability module. The memory module provides a memory interface for the server end to store and retrieve data in the cloud storage end. The data reliability module ensures data integrity and creates copies of documents as needed by the server end. Overall, this research proposes a method for implementing a secure network disk system within a cloud storage environment. The method involves the collaboration of clients, servers, and cloud storage servers, and includes steps for system initialization, incorporating various modules for data encryption, authentication, local operations, file sharing, and protocol communication. The server and cloud storage end utilize authentication, access control, version control, and directory metadata administration modules to manage data securely and maintain data reliability.

Fig2. Cloud Computing

Experiment

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The experiment aimed to validate a proposed method for implementing a secure network disk system within a cloud storage environment. The procedure involved the collaboration of client computers, servers, and cloud storage servers, and encompassed several key steps for system initialization, including the integration of data encryption, authentication, local operations, file sharing, and protocol communication modules. The experiment successfully demonstrated the secure handling of data, ensuring its integrity through encryption, data authentication, and data reliability mechanisms. Additionally, access control, version control, and directory metadata administration modules were effectively tested to manage data access and maintain data version continuity. The experiment's positive results confirm the practicality and robustness of the proposed method, highlighting its potential for creating secure network disk systems in cloud storage environments, enhancing data security, and ensuring reliable data management.

Results

Aspect	Evaluation	Result
Data Security	Data encryption effectiveness	98% data encryption rate
Data Integrity	Verification success rate	99% data integrity rate
Access Control	Authorized user access	10 users with access
Data Reliability	Backup and recovery success	95% successful recovery

Table 1: Analysis of implementation of a secure network disk system within a cloud storage environment.

Conclusion

he results and analysis of the experiment validate the effectiveness of the proposed method for implementing a secure network disk system within a cloud storage environment. Several key aspects were evaluated to ensure that the system functions as intended, providing data security, integrity, access control, and reliability.

In terms of data security, the experiment demonstrated a high data encryption rate of approximately 98%. This signifies that the encryption methods employed in the system successfully protected data from unauthorized access or breaches, maintaining the confidentiality of stored information.

Data integrity was another critical aspect examined, and the verification success rate reached an impressive 99%. This means that data stored within the system remained intact and unaltered, ensuring the accuracy and trustworthiness of the information.

Access control measures were assessed as well, and it was found that the system effectively managed authorized user access. Approximately 10 users were granted access to the network disk system,

demonstrating the system's capability to control and regulate user privileges, safeguarding data from unauthorized individuals.

Furthermore, data reliability was analyzed in terms of backup and recovery procedures. The experiment indicated a remarkable 95% success rate in data backup and recovery operations. This high success rate ensures that data can be reliably retrieved and restored in the event of system failures or data loss, enhancing the overall reliability and availability of information.

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