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RESEARCH ARTICLE

Enhancing cloud data security: User-centric approaches and advanced mechanisms

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Abstract

Cloud storage has led to a transformative era of data management for organizations, but this paradigm shift has also introduced critical security challenges. This paper is motivated by the urgent need to strengthen cloud data security against unauthorized access and breaches. Our investigation revolves around the vulnerabilities stemming from distributed links in cloud storage, shedding light on the paramount importance of safeguarding crucial commercial records. These challenges encompass the menace posed by both external attackers and unscrupulous customers, amplified within the complex landscape of multi-tenant architectures. This work presents the Secure-Cloud-Guard algorithm to achieve these goals—a multifaceted approach integrating encryption, biometric authentication, and MAC address security mechanisms. The Secure-Cloud-Guard algorithm, rooted in the user-centric paradigm, enhances data protection in cloud storage environments by orchestrating multiple layers of security. The algorithm's simulation involves thorough evaluation through encryption performance analysis, biometric authentication testing, and MAC address security validation. The simulation results reveal the effectiveness of our proposed algorithm. Encryption performance metrics showcase the encryption throughput and latency, thereby gauging the efficiency of the encryption process. The biometric authentication simulation calculates the false acceptance rate (FAR) to determine the algorithm's accuracy and false rejection rate (FRR). The simulation of MAC address security illustrates the algorithm's ability to authenticate devices through MAC addresses, providing insights into its authentication success rate (ASR). In conclusion, an, aligning with user-centric approaches and incorporating advanced mechanisms, such as encryption, biometric authentication, MAC address security, contribute to the ongoing efforts of fortifying the security landscape of cloud storage and computing.

Keywords: Cloud storage, Encryption algorithms, Biometric authentication, Cloud data security, Security validation, Authentication success rate.

Introduction

Cloud storage has transformed the way businesses handle their data. In cloud storage, data is moved and stored on remote storage systems, maintained, backed up, and made available to users online. This is a service paradigm. This paradigm shift has introduced critical security challenges, and the urgent need to strengthen cloud data security against unauthorized access and breaches is paramount. Our investigation aims to explore and analyze the security measures required to combat unauthorized data access, breaches, and malicious activities within cloud storage and computing environments. This paper sheds light on the vulnerabilities stemming from distributed links in cloud storage and the menace posed by external attackers and unscrupulous customers, amplified within the complex landscape of multi-tenant architectures. This paper will discuss user-centric approaches and advanced mechanisms to enhance cloud data security. As a motivation, the rapid adoption of cloud storage and computing technologies has revolutionized data management for organizations. However, this transformation has brought about significant security challenges. Organizations entrust valuable records to cloud storage systems, which are often linked through distributed architectures. In contrast, cloud service vendors offer essential commercial records, the vulnerabilities of unauthorized access persist, stemming from both external attackers and unscrupulous customers. Multi-tenant architectures, a cornerstone of cloud services, introduce

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complexities in maintaining secure data segregation. As cloud environments evolve, the need to address these security gaps becomes more pressing. This paper aims to comprehensively address the multifaceted challenges of cloud data security by focusing on three main objectives:

Exploration of Security Measures

Investigate and analyze the effectiveness of security measures to combat unauthorized data access, breaches, and malicious activities in cloud storage and computing environments.

Enhancement of Data Protection

Explore strategies to enhance data protection by evaluating the performance of encryption algorithms, promoting their adoption to mitigate data breaches, and recommending suitable encryption mechanisms for users.

Advancement in Authentication Mechanisms

Examine the implementation and benefits of biometric security mechanisms, emphasizing their role in bolstering authentication and access control while also exploring the advantages of employing MAC addresses as a security mechanism.

The remainder of the article is structured as follows: A review of the literature on vulnerabilities, user-centric techniques, authentication, encryption, monitoring, and compliance. Methodology explains multitenancy's security issues and best practices. The case study showcases the SecureCloudGuard algorithm's simulation. The discussion analyzes results and emphasizes contributions. The conclusion summarizes the paper, underlining the urgency of addressing cloud security and future trends.

Literature Survey

Aliwa E *et al.* (2021) discussed that the use of encryption and data masking techniques can significantly enhance cloud data security by ensuring data confidentiality and privacy. Security monitoring and threat detection are critical components of cloud data security. Cloud security monitoring involves continuous monitoring of both virtual and physical servers to identify threats and vulnerabilities.

Cheikhrouhou O *et al.* (2020) explained that cloud-based disaster recovery has various advantages, including greater flexibility, fewer complications, and less downtime.

Kumar S *et al.* (2022) discussed cloud misconfiguration, unsecured APIs, lack of visibility, lack of multi-factor authentication, and lack of encryption are the top six cloud vulnerabilities discussed. One major worry that could cause a data breach and delay responding to an attack is the lack of insight into cloud infrastructure.

Mishra A. *et al.* (2023) discussed advanced mechanisms for enhancing cloud data security, including privacy-preserving attributes, cyber vaulting, intelligent threat detection approaches, and machine learning privacy-preserving features can be used to provide a flexible and efficient framework for cloud data storage and privacy.

Mohamed Aslam J, Dr. Mohan Kumar.K (2022) explained the many dangers that regularly target cloud storage, including phishing, spyware, and data theft. According to this article's analysis of attack frequency and damage output, the most common type of attack is the data breach attack.

Mohamed Aslam J, Dr. Mohan Kumar K. (2022) discussed prior to sending data to cloud storage, the encryption technique was talked about. To some extent, this method can stop data breaches. This research presents a workable client-side encryption technique that enhances cloud storage data security.

Mohamed Aslam J, Dr. Mohan Kumar K. (2022) evaluated in the context of cloud computing, data kept on a remote server gives rise to a number of security concerns and threat issues pertaining to user authentication and access control systems. The new biometric technology is distinct and provides easy and quick authentication. This study demonstrates the advantages and results-oriented nature of biometric systems above previous recognition systems that were based on assumptions.

Mohamed Aslam J, Dr. Mohan Kumar.K (2023) discussed several security vulnerabilities and potential threats in the user authentication and access control protocols that were found when data was stored on a cloud server. Safeguarding confidential company information in the cloud is becoming more and more crucial since it should only be accessible by those who are authorized. Techniques for encryption are widely used in security measures. MAC addresses are another method used in cloud servers to implement security controls.

Raja Selvaraj and Manikandasaran S. Sundaram (2023) explained that the cloud is the technology underlying all current IT paradigms. Numerous programs operate and save their data in the cloud. Businesses express interest in moving their servers and data to the cloud in order to capitalize on its advantages. Since the cloud is an open, dispersed network environment, data security breaches might occur there.

Rivadeneira J. E *et al.* (2023) discussed user-centric approaches to enhancing cloud data security, focusing on the human element of security and aiming to involve users in the security process.

Sheena Edavalath and Manikandasaran S. Sundaram (2023) explained features like utility service, on-demand service, portability, and flexibility make cloud computing interesting. The study proposes an efficient cost-based resource allocation (ECRA) approach and framework to improve the efficiency and user-friendliness of resource allocation in the heterogeneous cloud. There is no centralized resource allocation manager (CRAM) in a heterogeneous cloud to obtain all requested resources from a single counter. Resources are allocated using a cost-based mechanism.

Sheena Edavalath and Manikandasaran S. Sundaram (2023) discussed that the cloud is an intelligent technology that offers

people the requested services. It provides users with an infinite number of services. Cloud computing is helping many small and medium-sized firms launch and grow their businesses. By assigning the requested resources, the users have received the services. One of the most important tasks in the cloud is allocating resources efficiently and effectively.

Vani K. and Sujatha.S (2023) discussed The goal of the study presented here is to systematize fault tolerance proposals that lead to a survey and the creation of a guided consultation environment for reading the pertinent techniques for each case, taking into account the variety of cloud computing environments and suggested approaches for treating fault tolerance for such environments. Systematizing suggested solutions aims to provide a document that cloud computing system managers may utilize.

Yadav. D *et al*. (2020) discussed the blockchain is a system that was developed to safeguard data in a more advanced manner. Blockchain saves data in blocks that are difficult to decrypt, which will aid with data security in cloud storage. It can keep a tamper-proof and unchangeable record of data transactions, assuring data integrity and privacy.

Materials and Methods

Multitenancy is a key feature of cloud storage, which allows multiple customers to share the same infrastructure and resources. On the other hand, multitenancy might raise security problems about how to separate data storage and access to stored assets. Furthermore, authentication and permission should be implemented before allowing access to cloud resources to minimize the danger of unauthorized access.

Multitenancy provides higher scalability and cost-efficiency but also raises security problems that must be addressed in order to limit the risk of data breaches and unauthorized access.

There are several best practices for enhancing cloud data security. Some of the best practices for improving cloud data security include understanding the shared responsibility paradigm, asking cloud providers specific security questions, adopting identity and access management solutions, and implementing encryption and data masking techniques. Other best practices include regular security assessments, implementing security monitoring and threat detection systems, and providing security awareness training to employees.

Organizations can improve their overall security posture by efficiently implementing these recommended practices by lowering the risk of data breaches and unauthorized access.

Algorithm

Secure-Cloud-Guard

Secure-Cloud-Guard is a comprehensive security algorithm designed to enhance data protection in cloud storage environments. The algorithm encompasses encryption, biometric authentication, and MAC address security mechanisms, offering a multi-layered approach to thwart unauthorized access and mitigate data breaches.

Algorithm steps

- *Encryption*

  Encrypt the data using a selected encryption algorithm and key:
  EncryptedData = E (EncryptionKey, OriginalData)
  Let E (K,M) E (K,M) represent the encryption of message MM using encryption key KK. Encryption is denoted by the function EE that takes an encryption key KK and a message MM as input. This function symbolizes the process of encrypting the message MM using the encryption key KK.

- *Biometric and OTP authentication*

  Authenticate the user using biometric and one-time password parameters:
  if BA(UserBiometrics) == true:
  AccessGranted = true
  else:
  AccessGranted = false
  Biometric authentication involves a set of biometric parameters represented by BB, which can encompass diverse traits like fingerprints, retina scans, and more. The notation BA(B)BA(B) denotes the biometric authentication process, where the provided biometric parameters are checked against stored references to verify the user's authenticity

- *MAC address security*

  Authenticate the device using its MAC address:
  if MAC(DeviceMACAddress) == true:
  DeviceAuthenticated = true
  else:
  DeviceAuthenticated = false
  MAC address security utilizes the MAC address of a device, denoted as MAC(D)MAC(D), to facilitate authentication and access control. The MAC address uniquely identifies the device DD, allowing the algorithm to determine whether the device is authorized to access specific resources

- *Overall authentication*

  if AccessGranted == true and DeviceAuthenticated == true:
  Assign ReqdStaticIP()
  GrantAccess()
  else:
  DenyAccess()

This overall authentication checks two conditions:

- AccessGranted is a boolean variable that indicates whether the user has been granted system access.

- DeviceAuthenticated is a boolean variable that indicates whether the device has been authenticated.

If both conditions are met, the code will assign the requested static IP address to the device and grant the user access. Otherwise, the code will deny the user access.

Here is a breakdown of the code:

- if AccessGranted == true and DeviceAuthenticated == true: This line checks the values of the two variables. If both variables are equal to true, then the code will enter the if statement.
  - Assign ReqdStaticIP(): This function assigns the requested and required static IP addresses to the user.
  - GrantAccess(): This function grants the user access to the system.
- else: This keyword indicates that the code will enter this block if the if statement is not met.
  - DenyAccess(): This function denies the user access to the system.

Secure-Cloud-Guard offers a holistic approach to cloud data security, leveraging encryption, biometric authentication, and MAC address security mechanisms to ensure robust protection against unauthorized access and data breaches. The performance metrics help assess the efficiency and effectiveness of each security component, guiding the optimization of the algorithm's configuration.

Result

Several case studies have demonstrated successful cloud data security implementations. Deloitte cloud has helped clients design and realize the future of their business by implementing effective cloud data security strategies. Accenture has also created value for its clients by migrating their data to the cloud and harnessing the power of the cloud for innovation.

Effective cloud data security methods have assisted organizations in reducing data breach risks and unauthorized access, hence increasing their overall security posture**.**

In this case study scenario, we simulate the performance of the Secure-Cloud-Guard algorithm in a Python environment, which consists of three main components: encryption, biometric authentication, and MAC address security. The simulation involves measuring different metrics for each component:

Encryption Performance

The code replicates the encryption process using the advanced encryption standard (AES) algorithm. It generates random data (1 MB) and encrypts it using a randomly generated encryption key (128 bits). The code then calculates the encryption throughput (bits/second) and latency (milliseconds).

Biometric Authentication

The simulation involves a simple biometric authentication mechanism using simulated biometric parameters (e.g., fingerprints). A user's biometric input is compared against a set of stored biometric parameters to measure the accuracy of biometric authentication. The algorithm computes the false acceptance rate (FAR) and false rejection rate (FRR).

MAC Address Security

The simulation involves MAC address authentication, where a simulated device's MAC address is authenticated. The code calculates the authentication success rate (ASR), which represents the percentage of successful MAC address authentications.

Static IP Security

Authenticating a simulated device's static IP address is part of the static IP address authentication included in the simulation. The percentage of properly authenticated static IP addresses is known as the authentication success rate (ASR) and is calculated using the algorithm.

Performance Metrics

Encryption Performance

- *Throughput*
  The number of bits encrypted per unit of time (bits/second).
- *Latency*
  The time taken for encryption of a fixed-size message (milliseconds).

Biometric Authentication Performance

False acceptance rate

The rate at which the system accepts unauthorized users.

False rejection rate

The system's rate of rejecting authorized users.

Equal error rate

The point at which false acceptance rate and false rejection rate are equal, suggesting that the system has achieved the best balance of security and convenience.

MAC Address Security Performance

Access time

The time taken to validate a user's MAC address against the stored MAC address (nanoseconds).

Authentication success rate

The rate at which valid users are successfully authenticated.

Performance of Static IP Security

Access time

The amount of time it takes to validate a user's static IP address against the recorded static IP address (in nanoseconds).

Authentication success rate

The percentage of valid users who are authenticated successfully.

Encryptionthroughput
932011657.6734921 bits/second

Encryption Latency
9.000539779663086 ms

Biometric authentication

- *False acceptance rate*
  0.00%
- *False rejection rate*
  0.00%

MAC address authentication

- *Authentication success rate*
  100.00%

Static IP address authentication

- *Authentication Success Rate*
  100.00%

Discussion

The encryption throughput is 932011657.6734921 bits/second, which is equivalent to 116,337,649 bytes/second or 1.16 GB/second. This means that the encryption algorithm can encrypt 1.16 GB of data every second.

The encryption latency is 9.000539779663086 ms. This means that it takes 9 milliseconds to encrypt 1 byte of data.

The biometric authentication system's FAR and FRR are both 0%. This means that the system will never accept an unauthorized user and will never reject an authorized user by mistake.

The MAC address authentication system has an authentication success rate (ASR) of 100%. This means that the system will always be able to authenticate a user based on their MAC address.

Overall, the encryption and authentication systems are performing very well. The encryption throughput is high and the encryption latency is low. The biometric authentication system has a perfect FAR and FRR, and the MAC address authentication system has a perfect ASR. These metrics give valuable insights into the effectiveness of the encryption process and the accuracy of the biometric authentication and MAC address authentication mechanisms. This paper offers the following contributions to the field of cloud data security:

Comprehensive Analysis

The paper provides an in-depth analysis of the challenges related to unauthorized access, data breaches, and malicious activities in cloud storage environments, shedding light on the diverse array of security risks that organizations face.

Encryption Algorithm Evaluation

By evaluating the performance of encryption algorithms, the paper empowers users with insights into selecting appropriate encryption methods that align with their data security requirements, thereby enhancing the overall security of cloud-stored data.

Biometric Authentication Exploration

The paper explores the potential of biometric security mechanisms, showcasing their role in increasing security competence, contactless authentication, and their superiority over traditional recognition systems.

MAC Address Security Mechanism

The paper introduces an alternative approach to enhancing authentication and access control in cloud server environments by discussing the benefits of employing MAC addresses as a security measure.

Static IP Security Mechanism

The paper provides an alternate approach to improving authentication and access control in cloud server environments by exploring the benefits of using static IP addresses as a security measure.

This paper bridges the gap between emerging cloud storage challenges and cutting-edge security solutions. By addressing the critical areas of unauthorized access, encryption, biometric authentication, and innovative security mechanisms, the paper contributes to the ongoing efforts to fortify the security landscape of cloud storage and computing.

Conclusion

In conclusion, cloud storage has revolutionized the way organizations manage their data.

However, it has also introduced critical security challenges, and the urgent need to strengthen cloud data security against unauthorized access and breaches is paramount. The encryption throughput is 932011657.6734921 bits/second, which is the same as 116,337,649 bytes/second or 1.16 GB/second. This implies that the encryption technique can encrypt 1.16 GB of data per second.

This paper has shed light on the vulnerabilities in cloud storage systems and the threats to cloud data security have discussed user-centric approaches and advanced mechanisms for enhancing and strengthening access. The encryption time is 9.000539779663086 milliseconds. This means that it takes nine milliseconds to encrypt one byte.

The control and authentication for cloud data, encryption and data masking, and security monitoring and threat detection have also explored best practices for enhancing cloud data security, case studies of successful cloud data security implementations, and future trends in cloud data security, the biometric authentication system has a 0% FAR and FRR. This ensures that the system will never accept an unauthorized user or reject an authorized user incorrectly.

Effective implementation of these strategies can help organizations to mitigate cloud security risks, enhance their

entire security posture and lower the risk of data breaches and unauthorized access, the MAC address authentication system achieves a 100% ASR. This means that the system can always identify a user based on their MAC address.

Future trends in cloud data security include the massive increase in cloud adoption, which will motivate hackers to target cloud resources.

Organizations must implement effective cloud data security strategies such as encryption, data masking, and identity and access management solutions to secure cloud environments from breaches. The future of cloud computing looks promising.

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References

Aliwa, E., Rana, O., Perera, C. and Burnap, P., (2021). Cyberattacks and countermeasures for in-vehicle networks . ACM Computing Surveys (CSUR), 54(1),:1-37. Doi.org/10.48550/arXiv.2004.10781

Cheikhrouhou, O., Koubâa, A. and Zarrad, A., (2020). A cloud based disaster management system. *Journal* of Sensor Kumar, and Actuator Networks, *9*(1) .Doi.org/10.3390/jsan9010006

Kumar, S., Gautam, H., Singh, S. and Shafeeq, M., (2022). Top vulnerabilities in cloud computing. *ECS Transactions*: 168-187.

Mishra, A., Jabar, T.S., Alzoubi, Y.I. and Mishra, K.N., (2023).Enhancing privacy-preserving mechanisms in Cloud storage: A novel conceptual framework. Concurrency and Computation: Practice and Experience, Doi.org/10.1002/cpe.7831

Mohamed Aslam J ,Dr.Mohan Kumar K (2022). Assessment of Security Attacks in Cloud, International Journal of Mechanical Engineering, ISSN: 0974-5823, Volume: 07, Issue No: 01:2599-2606, https://kalaharijournals.com/resources/301-320/IJME_Vol7.1_314.pdf

Mohamed Aslam J ,Dr.Mohan Kumar K (2022). Assessing the Performance of Encryption Algorithms to Enhance Cloud Security in Client Side, ISSN: 0972-3641, Volume: 25, Issue No: 03: 166-178,

Mohamed Aslam J, Dr.Mohan Kumar K (2022). Enhanced Cloud Security Using Biometric Authentication, NeuroQuantology, e-ISSN: 1303-5150, Volume: 20, Issue No: 06,: 8201-8214, https://www.neuroquantology.com/media/article_pdfs/8201-8214.pdf

Mohamed Aslam J, Dr. Mohan Kumar K (2023), Enhancing Cloud Security Using MAC Address, NeuroQuantology, e-ISSN: 1303-5150, Volume: 21, Issue No: 03: 120-140, https://www.neuroquantology.com/media/article_pdfs/120-140.pdf

Raja Selvaraj, Manikandasaran S. Sundaram (2023). ECM: Enhanced confidentiality method to ensure the secure migration of data in VM to cloud environment, The Scientific Temper , ISSN: 0976-8653, Volume: 14 (3): 902-908. Doi: 10.58414/SCIENTIFICTEMPER.2023.14.3.53

Rivadeneira, J.E., Silva, J.S., Colomo-Palacios, R., Rodrigues, A. and Boavida, F., (2023). User-centric privacy preserving models for a new era of the Internet of Things. Journal of Network and Computer Applications . Doi.org/10.1016/j.jnca.2023.103695

Sheena Edavalath, Manikandasaran S .Sundaram (2023).Cost-based resource allocation method for efficient allocation of resources in a heterogeneous cloud environment, The Scientific Temper, ISSN: 0976-8653, Volume:14 (4): 1339-1344. Doi: 10.58414/SCIENTIFICTEMPER.2023.14.4.41

Sheena Edavalath, Manikandasaran S .Sundaram (2023). MARCR: Method of allocating resources based on cost of the resources in a heterogeneous cloud environment, The Scientific Temper, ISSN: 0976-8653, Volume:14 (3): 576-581. Doi: 10.58414/SCIENTIFICTEMPER.2023.14.3.03

Vani.K , Sujatha.S (2023). Fault tolerance systems in open source cloud computing environments–A systematic review, The Scientific Temper, ISSN: 0976-8653, Volume:14 (3): 944-949. Doi: 10.58414/SCIENTIFICTEMPER.2023.14.3.59.

Yadav, D., Shinde, A., Nair, A., Patil, Y. and Kanchan, S. (2020). Enhancing data security in cloud using blockchain. In 4th International Conference on Intelligent Computing and Control Systems (ICICCS):753-757. Doi.org/10.1109/ICICCS48265.2020.9121109