Cloud Computing Security

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Abstract

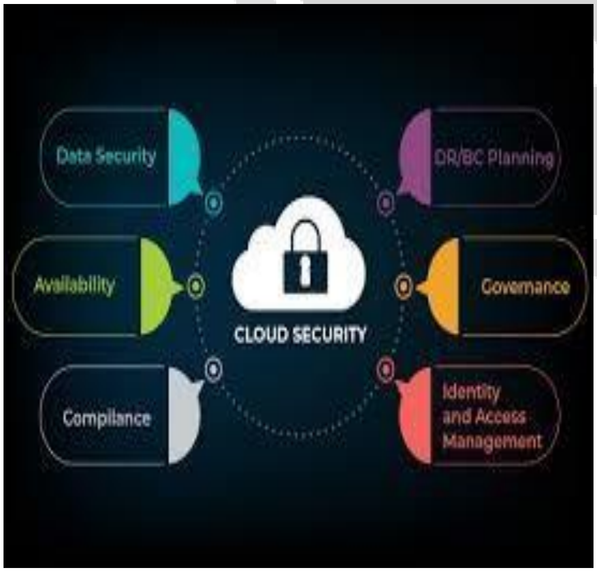
Cloud computing is now one of the pillars of online computing providing scalable and flexible services. Nevertheless, the growing cloud technology adoption has led to massive security challenges such as data breaches, unauthorized access, and susceptibility to cyber attacks. In particular, this review paper covers some of the latest literature that has been published from 2019 to year 2024 related to cloud computing security, including potential solutions based on encryption mechanisms, anomaly detection, trust models, as well as recent advancements and trends toward quantum and AI/ML-driven solutions. Through these studies, we intend to provide a holistic view of the progress, challenges, and future directions for cloud security.

Keywords

Cloud Computing Security, Data Encryption, Anomaly Detection, Zero-Trust Architecture, Privacy-Preserving Techniques, Quantum Encryption, AI-driven Security, Homomorphic Encryption, Blockchain Technology, Fog Computing, Intrusion Detection System (IDS).

1. Introduction

Cloud computing is a fast-growing technology that has changed the way data are stored and managed providing on-demand access to resources over the Internet. The cloud offers tremendous benefits but because resources are shared, security is still one of the top priorities in the enterprise and organizations go to great lengths to protect their sensitive data. In this paper, we systematically review the recent literature on cloud security to extract trends in emerging threats and solutions.



2. Formatting

Encryption is a critical method for securing data in cloud environments. Recent advancements include the use of Gaussian encryption and quantum encryption to enhance data protection:

- Chauhan et al. (2024) introduced Gaussian encryption for secure multi-party computations, highlighting its effectiveness in maintaining data privacy across cloud networks .
- James (2024) proposed the integration of quantum encryption for cloud-based e-commerce platforms, aiming to fortify security protocols against quantum computing threats .

These studies suggest that novel encryption methods are essential to tackle evolving cyber threats, especially with the advent of quantum computing capabilities.

3. AI-driven Anomaly Detection

Artificial intelligence (AI) has emerged as a powerful tool for enhancing cloud security through real-time anomaly detection:

- Nwachukwu et al. (2024) explored AI- driven approaches for detecting anomalies incloud environments. The research demonstrated improved security and reliability by identifying unusual patterns in real-time

First author et al.

- Javed et al. (2024) embedded a tree-based intrusion detection system (IDS) in IoT devices, increasing the accuracy of threat detection in smart cloud ecosystems

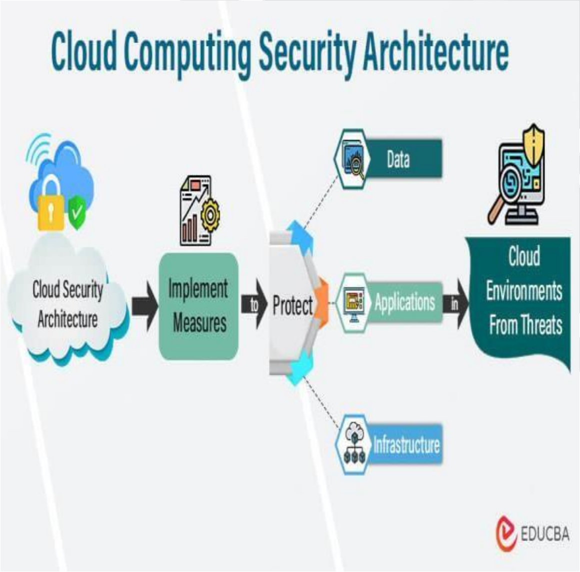
These innovations underscore the role of AI in proactive threat mitigation, enhancing the robustness of cloud services against sophisticated attacks.

4.Zero-Trust and Attribute-based Models

The concept of zero-trust architecture has gained traction as a means of strengthening cloud security by assuming no implicit trust:

- Syrotynskyi et al. (2024) analyzed network infrastructure as part of a zero-trust migration strategy. Their methodology emphasizes continuous verification, reducing risks associated with unauthorized access .
- Kapil et al. (2024) implemented attribute-based encryption combined with honey-based methods for securing healthcare data in cloud environments, ensuring enhanced access control .

Zero-trust models and attribute-based encryption methods provide a framework for minimizing security vulnerabilities by enforcing strict access controls and continuous authentication.


Cloud Computing Security Architecture
Cloud Security Architecture
Implement Measures
to
Protect
Data
Applications
Infrastructure
in
Cloud Environments From Threats
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5.Privacy-preserving Methods

With increasing data privacy regulations, there is a strong focus on developing privacy-preserving mechanisms:

- Zhang et al. (2024) discussed privacy-preserving fuzzy phrase search methods to protect sensitive cloud-based data. The approach ensures that searches can be conducted without compromising user privacy [7].
- Sadr (2024) introduced homomorphic encryption for secure search and retrieval in encrypted cloud domains, allowing computations on encrypted data without decryption [8].

These studies highlight the need for privacy-centric solutions, especially in the context of sensitive industries like healthcare and finance.

6. Integration of Emerging Technologies

Emerging technologies like blockchain and edge computing are being explored to address cloud security challenges:

- Mercy et al. (2024) examined the use of blockchain in edge computing for secure data fusion in smart grids, reducing latency and enhancing data integrity [9].
- Yadav et al. (2024) proposed a fog computing framework integrated with wireless sensor networks, aiming to enhance scalability, security, and collaboration in cloud environments [10].

The integration of these technologies promises to revolutionize cloud security by providing decentralized and tamper-proof solutions.

Paper Title	Year	Authors	Key Focus
Enhanced Secure Multi-Party Computation with Gaussian Encryption in Cloud Networks	2024	R. Chauhan	Gaussian encryption for secure multi-party computations, enhancing data privacy in cloud environments.
Securing Cloud-Based E-commerce Platforms with Quantum Encryption	2024	C. James	Utilization of quantum encryption to strengthen security protocols for cloud-based e-commerce.

AI-driven Anomaly Detection in Cloud Computing Environments	2024	C. Nwachukwu, K. Durodola-Tunde, C. Akwiwu-Uzoma	AI techniques for real-time anomaly detection, improving cloud service reliability and security.
Methodology of Network Infrastructure Analysis as Part of Migration to Zero-Trust Architecture	2024	R. Syrotynskyi, I. Tyshyk, O. Kochan, V. Sokolov	Zero-trust architecture for enhancing network security in cloud infrastructures.
Privacy-preserving Verifiable Fuzzy Phrase Search over Cloud-Based Data	2024	Y. Zhang, R. Hao, X. Ge, J. Yu	Techniques for privacy-preserving searches, ensuring confidentiality in cloud-based data retrieval.

7. Conclusion

The security landscape for cloud computing is changing quickly, with notable advancements in encryption, anomaly detection, zero-trust models, and methods that protect privacy. However, challenges still exist, particularly in managing the complex nature of cloud environments and dealing with increasingly sophisticated cyber threats. Going forward, researchers should look into integrating AI and quantum computing, enhancing privacy protection, and creating well-rounded frameworks for secure cloud computing.

References

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