

Cloud Computing and Big Data: The Path of Convergent Growth

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Abstract: In the contemporary era, the advancement of science and technology is proceeding at a rapid pace, accompanied by corresponding evolution and innovation in information technology. Technologies such as cloud computing and big data have witnessed corresponding developments. Therefore, this paper explores the convergence and development of cloud computing and big data. This paper presents a summary of the advantages and applications of the combination of cloud computing and big data based on literature reviews and data searches. It also identifies the challenges faced in this convergence. The study of the concepts and roles of cloud computing and big data revealed the existence of security problems related to information and data, including malicious attacks aimed at stealing information resources. In response, solutions were proposed, including the construction of firewalls and the establishment of public opinion monitoring. This technology has significant potential for future development and the capacity to drive social progress.

Keywords: Cloud computing , big data, cybersecurity challenges, virtualization technology.

1. Introduction

Big data, an emerging concept, is gradually penetrating into various industries and triggering profound changes. Scholars Xu Lishui and Xin Min defined it as a collection of data in their research on big data. This collection has certain attribute-related resources, including quantitative and qualitative resource data collections, collectively referred to as big data [1]. Cloud computing is a computational method and service model of modern information technology, which integrates technologies such as distributed computing, parallel computing, utility computing, and network storage [2]. Through a review of the literature, this paper primarily studies the advantages and applications of the combination of cloud computing and big data as an emerging technology, and explores its defects in application. Based on the applications of the combination of big data and cloud computing, as well as the information, data, and performance-related issues and challenges faced, this paper can assist enterprises and users in utilizing this technology rationally and minimizing losses caused by its defects. Besides, this paper also summarizes corresponding solutions that can enhance the technology's integration of big data and cloud computing. In the future, this technology will emerge as a new trend, penetrating into different fields.

2. Overview

2.1. Big data and cloud computing

Big data and cloud computing are the two cornerstones of modern information technology, and they play a vital role in promoting digital transformation and intelligent upgrading. Big data refers to the large, complex, and diverse collection of data collected through a variety of sources, often beyond the processing capacity of traditional database software tools. It encompasses the collection, storage, management, analysis, and visualization of data, with the aim of extracting valuable insights from massive amounts of information to support decision-making. At its core, big data technology is its ability to process structured, semi-structured, and unstructured data types, and to use machine learning and artificial intelligence algorithms to unlock the potential value of data[3].

Cloud computing provides a new way to obtain computing resources, allowing users to access shared computing resources, such as servers, storage, databases, networks, software, etc., on demand through the network, without directly owning or maintaining these physical resources. Cloud computing services are typically divided into three basic models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS provides basic computing resources, PaaS provides developers with development platforms and tools, and SaaS provides applications over the Internet. The advantages of cloud computing are its flexibility, scalability, and cost-effectiveness, allowing businesses to quickly adapt to market changes, reduce IT costs, and accelerate the pace of innovation. The combination of big data and cloud computing has revolutionized all walks of life, facilitating the depth and breadth of data analytics while also creating tremendous growth opportunities for cloud service providers[4].

2.2. Applications

Scholars Liu Pu and Quan Zherui summarized the applications of cloud computing platforms in big data processing, including elastic resource allocation, distributed computing frameworks, data storage and access, data preprocessing and mining, and real-time data analysis. Elastic resource allocation refers to the ability of cloud platforms to dynamically expand or compress, allocate and release resources based on big data analysis tasks, avoiding waste. Distributed computing frameworks are often utilized by cloud computing platforms to segment big data and then process it in parallel on multiple computer nodes to improve data processing speed and save processing time. Realizing dynamic data allocation and resource management requires cloud computing virtualization, which entails the virtualization of hardware resources, operating systems, and applications. In this way, multiple virtual machines can run on one physical machine.[5]

Cloud computing platforms offer data storage services, allowing users to retrieve, store, and analyze big data on these platforms. These platforms optimize network architectures and storage systems to enhance user experience. Big data storage encryption technologies have also gained more options through the empowerment of cloud computing technologies. Relevant technologies include: homomorphic encryption, which prevents unauthorized access to data and ensures data privacy. Users' fingerprints can serve as passwords to log into cloud platforms, with encrypted information uploaded to the cloud, minimizing the impact of spatial environments and enhancing data processing flexibility; and differential privacy, which involves adding appropriate noise to important and sensitive data to conceal individual information and prevent the leakage of critical data [6].

Cloud computing platforms host powerful data cleaning, mining, and transformation tools. By utilizing these tools, users can better process big data, leading to more accurate analytical results. The platforms also provide stream processing technologies to assist users in real-time data analysis. Cloud computing, through the Internet of Things (IoT) management model, can quickly establish

connections with data mining sub-modules. Users can leverage the cloud service model to mine data resources in a virtual environment, classifying, clustering, and identifying abnormal information. Incorporating a data governance system on the cloud platform, setting up big data resource audits, big data standards, data usage feedback, and data maps, can significantly improve data application efficiency [7].

In summary, these applications involve users processing big data using cloud computing platforms, which relies on the cloud service model. The cloud service model refers to the types and modes of services provided by cloud computing service providers based on cloud computing technology. This service model consolidates computing resources into a common resource pool and provides shared services to improve resource utilization. The cloud platform applications and infrastructure in this model are isolated to reduce dependencies and facilitate dynamic resource allocation. Users of cloud services can select the type and scale of services according to their needs and pay on demand, reducing the operational costs of the cloud service model [8].

3. Advantages

In enterprises, the combination of cloud computing and big data has become a ubiquitous and indispensable pairing. Big data serves as the raw material and is necessary for cloud computing technology applications. In contrast, cloud computing provides a flexible and elastic computational storage platform for big data. The analytical insights yielded by this combination assist enterprises in identifying and capitalizing on emerging business opportunities in a timely manner. Based on cloud computing's elastic resources and distributed processing capabilities, along with big data's ability to analyze and screen information, enterprises can predict market trends and seize business opportunities. The combination of big data and cloud computing also offers highly flexible computational capabilities, thereby facilitating more accurate and scientific decision-making by enterprises. The utilisation of big data within a cloud computing environment enables enterprises to analyse user requirements and identify novel innovation opportunities. The scalability of cloud computing allows for the storage of larger data sets, and when combined with big data analytics, it can help enterprises enhance their competitiveness, shorten product launch cycles, and improve user experience. Consequently, the integration and interactive application of big data and cloud computing is the choice of most enterprises.

Before the combination of cloud computing and big data, traditional data centers required enterprises to purchase and maintain hardware equipment, which necessitated substantial capital investment. Furthermore, traditional data centres not only required significant financial investment but also faced challenges in processing large volumes of data in a manner that met the specific needs of individual companies. The emergence of cloud computing provides enterprises with powerful and flexible computational storage resources. Enterprises are only required to pay for the cloud computing platforms based on their needs, without considering storage and operational maintenance costs. Big data analytics helps enterprises understand customer habits and other information, extract valuable information from massive data, and make more scientific decisions.

The integration and interaction of cloud computing and big data also provide enterprises with innovative tools and platforms, thereby promoting enterprise innovation. The combination of cloud computing and big data can facilitate the creation of a more open innovation environment for employees. Big data technology can help enterprises analyze large amounts of data to find business opportunities and provide new ideas for innovation. Cloud computing platforms can leverage virtualization technology to build new business models.

Furthermore, the integrated and interactive application of cloud computing and big data also enables the sharing of data resources. Enterprises can store data in a centralized location on the cloud computing platform, allowing all applications to access these data with proper permissions. This not

only permits the sharing of data resources among all applications but also streamlines the management of data.

4. Challenges

As the combination of cloud computing and big data represents a new trend, it has also brought new cybersecurity challenges with its development. Firstly, data security issues must be addressed. In the contemporary era of pervasive networking, the abundance of information and the capacity for real-time transmission and sharing of data and information have become hallmarks of our digital landscape. Information security faces issues such as tampering, theft, malicious cropping, and deletion during storage, transmission, and sharing on cloud computing platforms. During data calibration and processing, inaccuracies in data inspection techniques may lead to questionable computational results, allowing invalid or forged data to circulate within data resources. Ensuring secure access is crucial when using cloud computing technology for data transmission. Internal information storage and management must also strictly adhere to the company's security policies to avoid security breaches [9].

Cloud computing platforms provide virtualisation technology, which combines with data information to facilitate comprehensive analysis and the construction of resource sharing pools. Virtual monitoring devices ensure the operation of the virtual environment by utilizing virtual software combined with physical mechanisms to jointly apply multiple virtual devices. However, the virtual environment provided by cloud computing platforms is susceptible to external interference, leading to security issues. The security of data exchanged between virtual machines cannot be checked externally; therefore, access between virtual machines can be controlled, and data can be exchanged only after being inspected by security software.

Apart from data security issues, cloud computing environments also face cybersecurity challenges. In a cloud computing environment, resources can be shared and provided in parallel to users. Attackers can illegally obtain user rights when users transfer data from public to private clouds, known as cross-cloud attacks. Other attack methods include orchestration attacks, cross-tenant attacks, and cross-data center attacks. When users or companies are attacked, their information may not be fully protected, leading to potential privacy breaches for individuals and impacting their lives; corporate secrets may also be sold, posing a risk of bankruptcy for companies. Cloud computing stores a vast amount of user information in virtual environments. For those engaged in hacking activities, the successful attack and theft of data from cloud clients can provide access to significant information. With users' personal information, hackers can impersonate them and disseminate false information, posing the greatest challenge to the cloud environment [10].

Lastly, there are challenges related to performance and service capabilities. Cloud computing service environments require a fast and secure network with high performance to enhance user trust and loyalty. The transparency of cloud computing interfaces and migration standards also needs to be developed, as there are many cloud computing providers but no unified service standard. This means users incur significant costs when migrating data. Therefore, cloud computing requires a unified service standard to reduce user costs.

5. Strategies and solutions

In order to address these issues, it is imperative that enterprises construct robust cloud security platforms in order to mitigate the potential risks associated with cloud computing. For example, the cloud security protection module can set up firewalls to protect the security of cloud computing platforms. The cloud security monitoring module can conduct real-time monitoring of the cloud environment to detect threats and potential security issues promptly. The construction of cloud

security platforms also requires the integration of cloud computing and big data. Cloud computing technology can help enterprises build virtualized security protection devices, while big data technology can analyze log data in the cloud environment to identify potential threats and issue warnings in a timely manner. In the event of a cybersecurity incident, the synergy of cloud computing and big data can help enterprises effectively and rapidly reduce losses. Enterprises can leverage cloud computing platforms to quickly transfer and allocate resources, activate more security devices, and use virtualization technology to restore attacked systems, minimizing losses. Big data analysis can be used to quickly locate the attacker's IP address, predict attack paths, and assess the impact of the attack on the company. These belong to the design of cloud computing core architecture security, focusing on ensuring the security of virtualized servers, networks, and business management platforms [11].

Regarding the challenges encountered by cloud computing platforms with respect to performance and service capabilities, the primary concern pertains to user confidence in the cloud service model. The corresponding solution is to build and improve a safer cloud service environment. Firstly, a cloud security monitoring system can be set up and enhanced to collect information flows in the cloud environment, analyze and perceive security states, and provide comprehensive early warning and emergency response for cloud servers and terminals. Subsequently, a public opinion monitoring and analysis system can be established to monitor information and public opinion on the internet in real time, thereby ensuring effective control and guidance of public opinion and completing forensic analysis of negative public opinion promptly. Finally, a cloud Web security detection and analysis system should be arranged to monitor the service status of Web sites, webpage tampering, and website vulnerabilities. This ensures the security of internet Web sites and monitors sensitive information. In addition, users should sign detailed and legally binding service level agreements with cloud technology service platforms, clarifying the respective responsibilities and solutions for problems encountered, to reduce the risk of cloud technology service quality [12].

Cloud computing and big data technologies are still in their infancy in China, with numerous functions yet to be perfected. Therefore, they inevitably face many problems and challenges. By identifying corresponding solutions to address these issues and improving related technologies, a relatively secure service environment can be provided for users. By optimizing big data technology and cloud computing service models, user experience and user stickiness will improve, making this an emerging trend.

6. Conclusion

This paper presents a summary of the advantages of the emerging combination of cloud computing and big data, which can assist companies in achieving data resource sharing, providing innovative tools and platforms, offering innovative points, and exploring business opportunities through cloud computing. It also discusses the applications of cloud computing in processing big data, such as data storage and cleaning. As an emerging industry with immature technologies, it faces some security and performance challenges, mainly related to information and data security. In light of the above, this paper puts forward a series of solutions based on numerous literature reviews. In China, research on cloud computing and big data is still in its preliminary stage. In an information society, big data will become an important strategic resource. Consequently, research based on the combination of cloud computing and big data still offers considerable scope for further development. In the future, the integration of big data and cloud computing can not only assist enterprises and individuals but also be applied to the construction of smart cities, enabling efficient city management, providing convenient services for people's livelihoods, and achieving sustainable industrial development.

References

- [1] Xu, L., & Xin, M. (2016). *Big data and its application prospects*. *Enterprise Science and Technology & Development*, (06), 21-23.
- [2] Li, X. C. (2024). *Research on data security issues in the context of big data and cloud computing network environments*. *Network Security Technology & Application*, 8, 60-61.
- [3] Zhang, Y. (2024). *Computer big data analysis based on cloud computing technology*. *Information and Computers (Theoretical Edition)*, 11(1), 197-199.
- [4] Shi, Y. Q. (2024). *Discussion on network security protection technologies in cloud computing environment*. *Information Systems Engineering*, 10(1), 52-55.
- [5] Liu, P., & Quan, Z. R. (2024). *Application research of cloud computing technology in computer big data analysis*. *Information and Computers (Theoretical Edition)*, 36(11), 235-237.
- [6] Luo, H. (2024). *Research on big data analytics technology based on cloud computing*. *Telecom World*, 5, 157-159.
- [7] Zhang, Y. (2024). *Computer big data analysis using cloud computing technology*. *Information and Computers (Theoretical Edition)*, 11, 197-199.
- [8] Zeng, S. W. (2024). *Research on the integration application of cloud computing and big data in enterprise informatization*. *Network Security Technology & Application*, 9, 124-126.
- [9] Lu, Z. Y. (2022). *Research on cloud computing security issues from the perspective of mobile internet*. *Science and Technology Innovation and Application*, 10, 30-33. DOI: 10.19981/j.CN23-1581/G3.2022.10.007.
- [10] Guo, S. Z., Meng, F., Zhang, G. Y., & Tang, Y. L. (2023). *The development and challenges of cloud computing*. *Software*, 9, 5-7+48.
- [11] Liu, Y. (2015). *Framework analysis of cloud computing security risks and protection technologies*. *China Management Informationization*, 21, 183-184.
- [12] Liu, B. S., & Shi, Y. H. (2022). *Computer network security issues and countermeasures in the cloud computing era*. *Product Reliability Report*, 9, 73-74.