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Optimizing Cloud Broker Profitability through Advanced Cloud Computing Techniques

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Abstract- *Cloud computing has gained significant traction as an efficient solution for delivering on-demand computing resources and services. For cloud service providers, ensuring profitability while maintaining service quality is crucial. However, the prevalent single long-term renting approach often results in compromised service quality and substantial resource wastage. To address this, our paper proposes a pioneering double resource renting scheme that integrates short-term and long-term renting. This innovative approach not only guarantees optimal service quality for all requests but also significantly minimizes resource wastage.*

We adopt an M/M/m+D queuing model to analyse the performance indicators affecting the profitability of our double renting scheme, including the average charge and the ratio of requests necessitating temporary servers. By formulating a profit maximization problem tailored to the double renting scheme, we derive an optimized cloud platform configuration. Comparative calculations between our proposed scheme and the traditional single renting scheme demonstrate that our approach not only ensures superior service quality for all requests but also yields increased profitability.

Key Words- *Cloud computing, Double resource renting, Service quality, M/M/m+D queuing model, Performance indicators, Profit maximization, Short-term renting, Long-term renting.*

1. Introduction

Enhancing Cloud Broker Profits through Advanced Cloud Computing Strategies entails striking a delicate balance between maximizing earnings for the cloud provider and ensuring a specific level of service quality for customers. This equilibrium necessitates meticulous resource management and the implementation of dynamic pricing strategies, potentially involving tiered pricing structures that align with distinct service quality levels.

The proactive monitoring of resources and real-time adjustment of usage patterns are vital to uphold the promised service quality. Service level agreements (SLAs) are employed to establish explicit service quality expectations for customers, backed by penalties for any unmet commitments. Continuous investments in infrastructure and technological advancements, such as AI and machine learning, play a critical role in optimizing resource allocation and pricing strategies while maintaining service excellence.

Ultimately, achieving a profitable framework with assured Quality of Service (QoS) in cloud computing demands a well- calibrated orchestration of resource oversight, pricing dynamics, and technological innovation. This approach enables cloud providers to maximize profitability while seamlessly delivering top-notch services to their clientele.

2. Existing System

In the typical scenario, a service provider acquires a set number of servers from infrastructure providers and establishes distinct multi-server systems for various application domains. Each multi-server system is designated to handle specific service requests and applications. Consequently, the cost of renting is directly tied to the number of servers within a multi-server system. The power consumption, meanwhile, correlates with the number of servers, server utilization, and the square of execution speed.

The revenue generated by a service provider hinges on both the volume and quality of service provided. In essence, a service provider's profitability is fundamentally shaped by how they configure their service platform.

To configure a cloud service platform, service providers traditionally rely on a single renting scheme. This means that all servers in the service system are committed to long-term rentals. However, due to the limited server capacity, some incoming service requests cannot be immediately processed. As a result, they are temporarily held in a queue until available servers become free to handle them.

3. Related Works

In this section, we present a highlight of the existing research relevant to the study stated in this paper.

1] This study highlights the critical role of cloud computing in delivering services and resources to clients anytime, anywhere. Emphasizing profitability for cloud service providers, it critiques the limitations of the prevalent single long-term renting approach that often compromises service quality and results in resource wastage. The proposed double resource renting scheme, however, effectively integrates short-term and long-term rentals, addressing these challenges comprehensively.

Using the M/M/m+D queuing model, the study evaluates the scheme's performance, emphasizing its role in profit maximization and ensuring service quality through the Double Quality Guaranteed (DQG) scheme. The findings underscore the scheme's ability to curtail resource wastage significantly while maximizing profitability, surpassing the outcomes of the traditional single renting scheme.

In conclusion, the research highlights the necessity of a dynamic and adaptable approach in the cloud computing sector. By seamlessly incorporating advanced technologies and strategic resource management, the proposed scheme offers a viable solution to the persisting challenges faced by service providers, ushering in an era of enhanced service delivery, customer satisfaction, and financial viability.

2] Cloud computing's popularity stems from its effective provision of on-demand computing resources. Profit maximization, crucial for cloud service providers, hinges on configuring a cloud platform to meet market demands. However, the prevalent single long-term renting approach often compromises service quality and leads to substantial resource wastage. This paper proposes a groundbreaking double resource renting scheme that seamlessly integrates short-term and long-term renting. This approach not only ensures top- notch service quality for all requests but also significantly reduces resource waste. Through an analysis of the M/M/m+D queuing model, the study examines key performance indicators affecting profit, such as the average charge and the ratio of requests necessitating temporary servers. By formulating a profit maximization problem tailored to the double renting scheme, the research establishes an optimized configuration, demonstrating that the proposed scheme outperforms the traditional single renting scheme in both service quality assurance and profitability.

3] With the increasing adoption of cloud services among businesses, the focus for cloud service providers is shifting towards configuring their systems for maximum profitability while ensuring customer satisfaction. This paper addresses this challenge by emphasizing the influence of customer satisfaction on the revenue of cloud service providers. Recognizing that customer satisfaction impacts service quality and request rates, the study proposes a formalized definition for measuring customer satisfaction in the context of cloud computing, building on established economic principles.

The analysis delves into the nuanced ways in which customer satisfaction impacts revenue generation, considering factors such as service-level agreements, renting costs, and energy consumption. By integrating customer satisfaction into the profit maximization problem, the study formulates an optimization model that balances various factors to derive an optimal configuration for maximizing profit.

Through this approach, the research contributes to a more comprehensive understanding of the dynamics

between customer satisfaction and profit maximization in the context of cloud service provision, providing a framework for providers to tailor their services to meet customer expectations while ensuring profitability.

4] Cloud computing facilitates the agile growth of computing enterprises, allowing them to operate on a pay-as-you-go basis, thus reducing overall operational costs. However, the success of cloud service provisions hinges on ensuring customer satisfaction. Several cost-conscious algorithms have been devised to manage workloads effectively on Infrastructure as a Service (IaaS) Cloud platforms, where clients can request Virtual Machines (VMs) with varying specifications and costs. Our study employs a practical application/platform model with stochastic workloads and VMs operating across a server farm.

Balancing rapid accessibility and scalable operations while maintaining service levels and cost-effectiveness poses a significant challenge for Cloud providers. Moreover, for businesses to sustain themselves in the long run, it's crucial for them to establish a stable revenue stream. To address these intricacies, we introduce novel strategy-based service assurance control models that aim to maximize the revenue of Cloud providers while accommodating uncertainties in resource requirements. The proposed Dynamic Budget Pricing Policy- based Workflow scheduling (DBPP) algorithm is designed to enhance overall revenue in the shortest possible time for cloud server farms.

5] Cloud computing, with its user-friendly accessibility and on- demand resource availability, has transformed the way data storage and computing power are managed. Its pivotal feature, the pay-as-you-go model, offers robust computational capabilities at a reduced cost. This model empowers users with limited computational resources to efficiently outsource extensive workloads, thereby leveraging massive computational power, bandwidth, storage, and software on a pay-per-use basis.

By providing access to shared pools of configurable system resources and higher-level services over the Internet, cloud computing has become a cornerstone of modern information technology. While service providers aim to optimize profits through pricing strategies, clients seek high-quality services at reasonable prices. Consequently, the central objective is to maximize profits for providers and ensure top-notch service quality at an affordable price for clients.

However, the complexity of selecting appropriate cloud services remains a challenge for customers. To streamline this process, the authors suggest the role of a cloud service broker. This intermediary automates the selection of suitable cloud services, guaranteeing superior performance, reliability, and cost efficiency for clients.

6] Along with the development of cloud computing, an increasing number of enterprises start to adopt cloud service, which promotes the emergence of many cloud service providers. For cloud service providers, how to configure their cloud service platforms to obtain the maximum profit becomes increasingly the focus that they pay attention to. We take customer satisfaction into consideration to address this problem. Customer satisfaction affects the profit of cloud service providers in two ways. On one hand, the cloud configuration affects the quality of service which is an important factor affecting customer satisfaction. On the other hand, the customer satisfaction affects the request arrival rate of a cloud service provider. However, few existing works take customer satisfaction into consideration in solving profit maximization problem, or the existing works considering customer satisfaction do not give a proper formalized definition for it. Hence, we firstly refer to the definition of customer satisfaction in economics and develop a formula for measuring customer satisfaction in cloud computing.And then, an analysis is given in detail on how the customer satisfaction affects the profit. Lastly, taking into consideration customer satisfaction, service-level agreement, renting price, energy consumption and so forth, a profit maximization problem is formulated and solved to get the optimal configuration such that the profit is maximized.

7] Along with the event of cloud computing, additional and additional applications area unit migrated into the cloud. a crucial feature of cloud

computing is pay-as-you-go. However, most users invariably ought to pay quite their actual usage thanks to the one-hour asking cycle. additionally, most cloud service suppliers give a precise discount for semipermanent users, however short users with little computing demands cannot get pleasure from this discount. to scale back the price of cloud users, we have a tendency to introduce a replacement role, that is cloud broker. A cloud broker is Associate in Nursing mediator agent between cloud suppliers and cloud users. It rents variety of reserved VMs from cloud suppliers with an honest value Associate in Nursing offers them to users on an on-demand basis at a less expensive value than that provided by cloud suppliers. Besides, the cloud broker adopts a shorter asking cycle compared with cloud suppliers. By doing this, the cloud broker will cut back an excellent quantity of price for user. additionally, to scale back the user value, the cloud broker additionally might earn the distinction in costs between on-demand and reserved VMs. during this paper, we tend to specialize in the way to tack a cloud broker and the way to cost its VMs specified its profit will be maximized on the premise of saving prices for users. Profit of a cloud broker is full of several factors like the user demands, the acquisition value and therefore the sales value of VMs, the dimensions of the cloud broker, etc. Moreover, these factors are affected reciprocally, that makes the analysis on profit additional sophisticated. during this paper, we tend to first-of-all provides a synthetically analysis on all the touching factors, associated outline an optimum multi-server configuration and VM rating drawback that is sculpturesque as a profit maximization drawback.

Secondly, combining the differential and

division search technique, we tend to propose a heuristic technique to resolve the improvement drawback. The near- optimal solutions will be wont to guide the configuration and VM rating of the cloud broker. Moreover, a series of comparisons are given that show that a cloud broker will save a substantial value for users.

8] They focuses on the problem of profit maximization for cloud brokers in cloud computing environments. Cloud brokers act as intermediaries between cloud service providers and consumers, helping consumers find and select suitable cloud services based on their requirements.

The authors propose a priority aware pricing mechanism to address the profit maximization problem for cloud brokers. The key idea is to assign different priority levels to consumers based on their service requirements and willingness to pay. By considering these priority levels, the cloud broker can allocate resources and determine prices in a way that maximizes their profit.

The paper presents a mathematical model for the profit maximization problem, considering factors such as consumer demand, resource allocation, and pricing. It formulates the problem as a nonlinear programming optimization, aiming to find the optimal resource allocation and pricing strategy that maximizes the broker's profit.

To solve the optimization problem, the authors propose a heuristic algorithm called the Priority Aware Pricing Algorithm (PAPA). This algorithm considers the priority levels of consumers and performs resource allocation and pricing decisions iteratively to converge towards an optimal solution. The authors also conduct experiments using simulation to evaluate the performance of the proposed algorithm. The results demonstrate that the priority aware pricing mechanism improves the profit of the cloud broker compared to traditional pricing approaches.

In conclusion, the paper presents a profit maximization approach for cloud brokers by introducing a priority aware pricing mechanism. The proposed algorithm considers consumer priorities and optimizes resource allocation and pricing decisions to maximize the broker's. The experimental results indicate the effectiveness of the approach in improving the profitability of cloud brokers in cloud computing environments.

9] The paper titled "Maximizing the Profit of Cloud Broker with Priority Aware Pricing" by Xinhou Wang, Song Wu, Kezhi Wang, Sheng Di, Hai Jin, Kun Yang, and Shumao Ou focuses on the optimization of profit for a cloud broker through the implementation of priority aware pricing. Cloud brokers act as intermediaries between cloud service providers and customers, helping customers select appropriate cloud services based on their requirements. One of the challenges faced by cloud brokers is determining the pricing strategy that

maximizes their profit while satisfying customers' demands.The proposed approach in the paper introduces priority aware pricing, which takes into account the priority of customers' tasks and the available resources in the cloud. The goal is to allocate resources efficiently while ensuring customer satisfaction and maximizing the broker's profit.The authors formulate the problem as a joint optimization of task scheduling and pricing. They propose a two-step algorithm to solve the problem. In the first step, an efficient task scheduling algorithm is designed to allocate resources to different tasks based on their priorities. In the second step, a pricing optimization algorithm is developed to determine the prices for different tasks, considering the resource allocation and the customers' willingness to pay.The paper also conducts extensive experiments and evaluations using real-world workload traces. The results demonstrate that the proposed priority aware pricing approach can effectively improve the broker's profit compared to traditional pricing strategiesIn conclusion, the paper presents a novel approach to maximize the profit of cloud brokers by incorporating priority aware pricing. By considering task priorities and resource allocation, the proposed approach enables cloud brokers to optimize their pricing strategies and enhance their profitability while meeting customer demands. 10] The paper titled "Profit Maximization for Cloud Brokers in Cloud Computing" by Jing Mei, Kenli Li, Zhao Tong, Qiang Li, and Keqin Li was published in the IEEE Transactions on Parallel and Distributed Systems in 2018. The paper addresses the problem of profit maximization for cloud brokers operating in cloud computing environments.

Cloud brokers act as intermediaries between cloud service providers and consumers, assisting consumers in selecting appropriate cloud services based on their requirements. The authors aim to develop a profit maximization strategy for cloud brokers by optimizing their resource allocation and pricing decisions.

The paper proposes a mathematical model for the profit maximization problem, taking into account various factors such as consumer demand, resource allocation, and pricing. The objective is to determine the optimal allocation of resources to different consumers and set appropriate prices to maximize the cloud broker's profit.To solve the optimization problem, the authors propose a two-step algorithm. In the first step, a resource allocation strategy is designed using an improved genetic algorithm, which considers the consumers' resource demands and the broker's available resources. The algorithm aims to allocate resources in an efficient manner.

In the second step, a pricing strategy is formulated to determine the prices charged to consumers based on their resource allocations. The authors consider both the consumers' willingness to pay and the broker's resource costs when setting the prices. The pricing strategy is designed to balance the consumers' satisfaction and the broker's profit.

The proposed algorithm is evaluated through simulations using real-world workload traces. The results demonstrate that the algorithm effectively maximizes the cloud broker's profit while satisfying consumers' resource demands. Comparisons with other existing approaches show the superiority of the proposed algorithm in terms of profit generation.

In summary, the paper presents a profit maximization strategy for cloud brokers in cloud computing environments. By formulating a mathematical model and proposing a two-step algorithm for resource allocation and pricing, the authors provide an effective solution to optimize the cloud broker's profit. The simulation results validate the effectiveness of the proposed approach in achieving higher profitability for cloud brokers.

11] "On the Economics of Infrastructure as a Service Cloud Providers: Pricing, Markets, and Profit Maximization" is a topic that explores the economic aspects related to Infrastructure as a Service (IaaS) cloud providers. The article likely delves into the pricing strategies, market dynamics, and profit optimization methods employed by IaaS cloud providers. IaaS is a cloud computing model where providers offer virtualized computing resources such as virtual machines, storage, and networking infrastructure to customers on-demand. The pricing strategies in the IaaS domain can vary and may include different models, such as pay-as-you-go, reserved instances, or spot instances. The article may discuss how cloud providers determine their pricing structures to remain competitive in the market while ensuring profitability. Factors such as resource costs,

utilization rates, demand elasticity, and competition among providers can influence the pricing decisions. Moreover, the article may explore the market dynamics of IaaS cloud services. This includes analyzing supply and demand relationships, market competition, customer preferences, and the impact of factors like scalability, reliability, and service quality on market share and customer acquisition. Additionally, the article may touch upon profit maximization strategies employed by IaaS providers. This could involve cost optimization techniques, resource allocation algorithms, capacity planning, and revenue management approaches to achieve the best possible financial outcomes while meeting customer demands. Understanding the economics of IaaS cloud providers is crucial for both providers and customers to make informed decisions regarding resource allocation, pricing options, and long-term sustainability.

4. Proposed System

Our proposed renting scheme for service providers represents a pioneering approach that serves the dual purpose of ensuring stringent quality-of-service standards while simultaneously maximizing profitability. By integrating cutting-edge technologies and strategic resource management, this scheme offers an innovative solution to the persistent challenges facing service providers in the contemporary digital landscape.

With a primary focus on optimizing resource allocation and enhancing service efficiency, our scheme is meticulously designed to cater to the dynamic and evolving demands of modern service provision. By striking an optimal balance between service quality and profitability, it enables service providers to not only meet but exceed customer expectations, thereby fostering long-term customer satisfaction and loyalty.

Through the seamless integration of advanced algorithms and comprehensive performance monitoring tools, our scheme empowers service providers to achieve unprecedented levels of operational excellence. By leveraging real-time data analysis and predictive modelling, it enables proactive decision-making, ensuring that resources are allocated judiciously to meet fluctuating service demands while maximizing revenue streams. Ultimately, our novel renting scheme serves as a cornerstone for the sustainable growth and success of serviceproviders, heralding a new era of enhanced service delivery and financial viability.

4.1. Advantages of Proposed System

- By assigning requests with waiting time D to temporary servers, all service requests can meet their deadlines, leading to increased revenue for the service provider under the SLA-based charging system.
- The scheme aims to enhance the quality-of-service requests and optimize the overall profits for service providers.
- Combining short-term renting with long-term renting, the scheme significantly minimizes resource wastage and effectively adjusts to the dynamic fluctuations in computing capacity demand.

4.2. Architecture Diagram

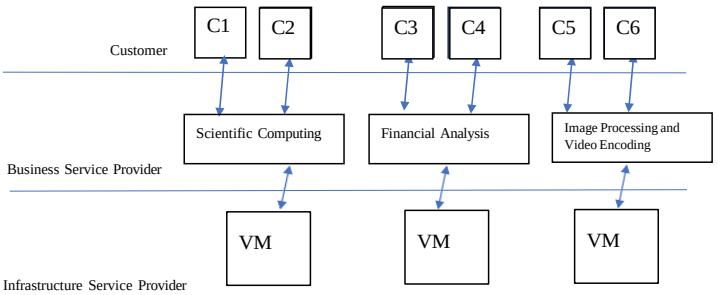

Fig.4.2 Architecture Diagram.

4.2.1. Customer

In the cloud market, there are various cloud service providers with distinct features such as capacity, price, SLA, and performance. Customers can obtain services and resources from cloud providers directly. However, it is a challenge for customers to find the best choice in terms of performance and price. In addition, the economic model of the cloud providers is to bill users solely for the time they have used the resources based on an atomic time unit that we call the Billing Time Unit (BTU), most often one hour. However, many customers might use the resources

for only several minutes and still be charged for one hour. Hence, the coarse-grained BTU leads to a lot of waste for customers in terms of resources or money.

4.2.2. Business Service Provider

A Business Service Provider within the domain of cloud computing serves as a facilitator, delivering a comprehensivesuite of cloud-based services and solutions to businesses. These providers act as intermediaries, enabling companies to access various computing resources and services through flexible subscription or pay-per-use models. Their offerings streamline operations and enhance the scalability of IT infrastructure, allowing businesses to effectively manage their computing needs.

Leveraging the flexibility and scalability of the cloud, Business Service Providers furnish an array of services, including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This allows businesses to access diverse computing resources and software applications without the necessity of maintaining extensive on-premises infrastructure. By providing these services, Business Service Providers empower organizations to concentrate on their core competencies while alleviating the complexities and costs associated with internal IT management.

4.2.3. Infrastructure Service provider

An Infrastructure Service Provider in the context of cloud computing refers to a company that offers fundamental computing resources and infrastructure components to businesses and individuals. These providers furnish essential services such as virtual servers, storage, networking, and computing power on a pay-as-you-go or subscription-based model. They enable users to build, deploy, and manage their applications and services without the need to invest in physical hardware or data centres.

Infrastructure Service Providers ensure that users can rapidly scale their computing resources up or down as per their requirements, providing flexibility and cost-efficiency. They often offer Infrastructure as a Service (IaaS) solutions, which empower businesses to access and manage fundamental computing resources remotely via the internet. These services eliminate the need for companies to manage their own complex and expensive hardware, allowing them to focus on their core business objectives and swiftly adapt to changing computing demands.

5. Methodologies

This paper introduces a novel double renting scheme merging long-term with short-term renting, effectively ensuring quality- of-service standards across varying workloads and significantly reducing resource wastage. Adopting an M/M/m+D queuing model for a multi-server system, performance indicators such as average service charge and the ratio of requests requiring short-term servers are analysed. The formulation of the profit maximization problem for service providers yields two types of optimal solutions: ideal and actual. Comparative analyses demonstrate that our Double-Quality-Guaranteed (DQG) renting scheme generates higher profits than the Single- Quality-Unguaranteed (SQU) renting scheme while fully guaranteeing service quality.

5.1. Modules Description

5.1.1. Cloud Broker

The cloud broker is an intermediary entity between cloud providers and customers, which emerges to help the customers with short-term workloads enjoying the discount provided for long-term customers. It buys a lot of reserved instances from cloud providers for long periods of time to configure its virtual resource platform and outsources them as on-demand VMs for a lower price and a fine-grained BTU such as 30 minutes with respect to what the cloud service providers charge for the same VMs. The customers could submit their service requests to the cloud provider or the cloud broker, and their decisions are affected by the gap between the on-demand VM prices of the cloud broker and the cloud provider.

5.1.2. Cloud Provider

Several prominent cloud providers, including Amazon EC2 and Windows Azure, offer two main instance options: on- demand instances and reserved

instances. On-demand instances involve payment for compute capacity on an hourly basis, allowing flexibility without long-term commitments or upfront costs. Users can adjust their compute capacity based on application demands, only incurring charges for the specific hourly usage.

In contrast, reserved instances offer substantial cost savings, with discounts of up to 75% compared to on-demand pricing. However, this discounted option is not accessible for certain customers who rely solely on on-demand instances for their short-term workloads, thereby missing out on the cost advantages associated with reserved instances.

5.1.3. Infrastructure provider's module:

In leading cloud computing platforms such as Amazon EC2, IBM Blue Cloud, and various private clouds, numerous work nodes are overseen by cloud managers like Eucalyptus, Open Nebula, and Nimbus. These clouds allocate resources for tasks through virtual machines (VMs). Users submit their tasks to the cloud, which employs a job queuing system such as SGE, PBS, or Condor.

The fundamental cloud-service model, as defined by the IETF (Internet Engineering Task Force), involves IaaS providers offering computers - physical or more commonly, virtual machines - alongside other resources. IaaS essentially encompasses online services that shield users from the intricacies of infrastructure, including aspects like physical computing resources, data partitioning, scalability, security, and backup.

5.1.4. Customers module:

A client sends a service request to an on-demand service provider, wherein the pricing strategy and service-level agreement (SLA) collectively define the revenue model. The two available renting schemes, namely long term and short- term renting, cater to the diverse needs of customers. To ensure quality-of-service adherence, a usage-based pricing approach is adopted, aligning with the on-demand service nature of cloud computing.

Given the finite server capacity, incoming service requests experiencing processing delays are queued until available servers can handle them. However, in line with the SLA, the waiting time for each request must remain within predefined limits, highlighting the emphasis on customer satisfaction and service quality. This widely adopted practice is instrumental in fostering positive customer experiences and facilitating fair price compensation mechanisms.

5.1.5. Queuing Model:

In situations where incoming service requests experience processing delays, they are initially queued and handled on a first-come-first-served (FCFS) basis, adhering to the queuing theory. As the service system's computing capacity remains fixed and limited, certain requests may encounter prolonged waiting periods before resolution. The M/M/m queuing system provides a theorem governing the waiting time, considering the specific characteristics of the queue dynamics.

5.1.6. Double Renting Scheme:

The integration of long-term and short-term renting ensures the fulfilment of quality-of-service demands across fluctuating system workloads, concurrently minimizing resource wastage. The innovative resource renting scheme, known as Double- Quality Guaranteed (DQG), merges the benefits of long-term and short-term renting. While long-term rented servers deliver the primary computing capacity at a lower cost, the short-term rented servers cater to additional capacity requirements during peak periods. Service requests are sequenced and processed on long-term rented servers in the order of their arrival, streamlining the operational efficiency of the system.

6. Conclusion

In conclusion, cloud computing has gained immense popularity as an effective and efficient means of delivering computing resources and services to customers on demand. However, traditional long-term renting schemes used to configure cloud platforms often fall short in guaranteeing service quality and lead to significant resource waste. This paper addressed these challenges by introducing a novel double resource renting scheme that combines short-term and long-term renting. The proposed double renting scheme offers several key advantages. Firstly, it effectively ensures the quality of service for

all customer requests by dynamically allocating resources based on their specific needs. This ensures optimal utilization of available resources and reduces instances of resource waste. Secondly, by considering the cloud service system as an M/M/m+D queuing model, the study analyses various performance indicators that impact the profitability of the double renting scheme, such as average charge and the ratio of requests requiring temporary servers.

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