Optimization of Resource Utilization using Proposed Hybrid TLPD-ALB-RASA Scheduling Algorithm for Cloud Environment

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Abstract. The hybrid TLPD-ALB scheduling algorithm is a commonly used approach in cloud computing, but it fails to meet the multi-objective requirements for effective load balancing. Although its primary aim is to distribute tasks among available resources and minimize relative imbalance, it is insufficient to achieve optimal resource utilization and minimize makespan. To address this shortcoming, a resource-aware scheduling algorithm has been integrated with the hybrid TLPD-ALB algorithm. End-users prefer a fair scheduler that allocates tasks without starving any particular task while aiming for the shortest task completion time possible. In response to these concerns, the hybrid TLPD-ALB-RASA algorithm has been developed as an improved solution.

Keywords: RASA, Adaptive Load Balancing (ALB), Hybrid TLPD, Cloudsim, Max-Min, Min-Min

1 Introduction

The cloud computing sector is currently in a state of growth and encounters multiple issues. The primary obstacle is to satisfy consumer expectations for improved services while efficiently utilizing computer resources. Consequently, scheduling has become a crucial factor that is increasingly gaining traction [1]. The fundamental approach to scheduling entails allocating processing tasks to resources based on the task's attributes. Throughout these efforts, it has been imperative to ensure the effective utilization of all available resources.

R. Murugan et al. (eds.), *Proceedings of the International Conference on Signal Processing and Computer Vision (SIPCOV 2023)*, Advances in Engineering Research 239,
https://doi.org/10.2991/978-94-6463-529-4_30

The primary objective of this paper is to improve performance by mitigating the workload on virtual machines (VMs) via load balancing techniques [2][3]. The study culminates in the utilization of the Resource-Aware-Scheduling-Algorithm, which merges the Min-Min and Max-Min approaches, to optimize resource allocation [4][5][6]. The paper also delves into the definition of scheduling algorithms for cloud computing, the timeframe of analysis, and the tools employed for assessment.

This study strives to surpass the limitations of prior algorithms and enhance the Quality of Service (QoS) outcomes in every situation. The Hybrid TLPD algorithm exhibited several instances where its results fell short of traditional methods [7]. In contrast, the Hybrid TLPD-ALB algorithm yields better outcomes than the Hybrid TLPD algorithm, although there is still room for improvement in some scenarios.

This paper assesses the efficacy of the Hybrid TLPD-ALB-RASA algorithm by testing different combinations of cloudlets and virtual machines. The study investigates five distinct scenarios, gauging Quality of Service (QoS) metrics, such as makespan [8]. The outcomes of conventional algorithms, prior hybrid algorithms (Hybrid TLPD and Hybrid TLPD-ALB), and the recently proposed Hybrid TLPD-ALB-RASA algorithm are compared and scrutinized.

2 Literature Review

Ali, S. A., & Alam, M. (2018), Resource Allocation (RA) is a crucial aspect of cloud computing, enabling users to access cloud resources as metered services. Effective cloud resource management involves the allocation of available resources to tasks in a manner that enhances system performance, minimizes response time, reduces the total time to completion, and optimizes resource utilization. To achieve these objectives, an efficient task scheduling system is imperative. The RAMM Algorithm is designed to reduce task waiting times and maximize resource utilization [5].

P. Akhilandeswari et al. (2017) load balancing is a vital consideration in cloud computing. The study outlines the Max-Min and Min-Min algorithms for load balancing, originating from the research on the Cloud Resource Aware Scheduling Algorithm (CRASA). CRASA combines the strengths of both algorithms while minimizing their drawbacks. One disadvantage of the Min-Min algorithm is that larger tasks may face resource allocation issues, while smaller tasks may experience similar problems with the Max-Min algorithm [4].

Haladu, M., & Samual, J. (2016), The primary goal of cloud computing is to offer external users internet-based access to software programs, data storage, and processing resources, enabling them to pay only for the services they utilize. In cloud computing, task scheduling is a significant challenge since numerous tasks must be executed effectively using available resources to meet user demands. To achieve optimal performance, reduce total completion time and response time, and increase resource efficiency, these issues must be addressed. This paper examines various job scheduling techniques and proposes an enhanced Min-min algorithm [9].

Devi, D. C., & Uthariaraj, V. R. (2016), aim to introduce and assess a scheduling and load balancing system that considers virtual machine capabilities, job request duration, and inter-task dependencies. The study evaluates the efficacy of the proposed algorithm by comparing it with existing methods [3].

3 Research Gap

Upon reviewing multiple research papers, it has been revealed that only a small number of researchers have focused on developing efficient resource utilization scheduling algorithms for cloud computing. Thus, further investigation is necessary to enhance resource utilization in cloud computing. Several researchers and academics who have developed task scheduling algorithms for cloud computing have primarily concentrated on a limited set of scenarios and Quality of Service parameters, which has resulted in inadequate evaluation and suboptimal resource utilization. Consequently, it is imperative to consider a wider range of scenarios and QOS parameters to enhance system performance and maximize resource utilization.

4 Problem Statement

In recent times, cloud computing has emerged as a pivotal aspect of resource computing, offering services on demand to meet the user's requirements. In situations where there is a significant influx of user requests for resources, the scheduler in cloud computing employs task scheduling and resource allocation algorithms to facilitate efficient load balancing of workloads across cloud resources, thereby improving the overall performance of the cloud system. However, cloud providers are constrained by the finite amount of resources available to them and are thus compelled to optimize their resource utilization to the fullest extent possible.
SIMULATION TOOL

This paper describes the implementation and analysis of simulation results using Cloudsim and NetbeansIDE8.0 to evaluate the proposed hybrid TLPD-ALB-RASA scheduling algorithm [10] [11]. The focus of the high-level view of CloudSim's design, which simulates a cloud environment, is on the resource scheduling approach. A Processing Element (PE) is defined as a CPU unit in terms of million instructions per second (MIPS) [12]. To create multi-core processors, multiple PE elements are included in the processing component list. All processing components in the same system have the same processing capacity (MIPS). Each virtual machine has its own host, and each cloudlet has a corresponding virtual machine (VM). Both the cloudlets running on the VMs' hosts and the VMs themselves share processing resources.

5 Methodology Of Proposed Hybrid TLPD-ALB-RASA Scheduling Algorithm

The proposed hybrid TLPD-ALB-RASA algorithm addresses the issues of load balancing, resource utilization optimization, and minimizing completion time [13]. It has been used to achieve efficient resource usage by combining the Max-Min and Min-Min algorithms. This algorithm performs well in several optimization metrics, including reducing makespan, optimizing resource utilization, and evenly distributing workloads across available resources [14][15].

After calculating the average task length (AvgTaskLen), the algorithm generates two counters- TaskLenCountMIN, for tasks with a length less than or equal to the average, and TaskLenCountMAX, for tasks with a length greater than the average. Next, the algorithm chooses a task Ti from the MyQ queue, compares its length with the average, and increments either TaskLenCountMIN or TaskLenCountMAX accordingly. This procedure is repeated for all tasks in the MyQ queue. Afterward, the scheduler implements either Max-Min scheduling if TaskLenCountMIN is greater than or equal to TaskLenCountMAX, or Min-Min scheduling if TaskLenCountMIN is less than TaskLenCountMAX. Upon scheduling a task Ti, it is removed from the MyQ queue, and the completion times and resource readiness times of any remaining tasks are updated. This process continues until the MyQ queue is empty.

5.1 Algorithm Hybrid TLPD-ALB-RASA:

• The Cloudsim package is initialized by creating the datacenter, broker, virtual machines, and cloudlets [10].

• The first step is to set up the datacenter, broker, virtual machines, and cloudlets by initializing the Cloudsim package [16].

• Prepare the list of virtual machines and tasks.

• Sort the virtual machines based on Quality of Service (QoS) parameters such as MIPS and granularity size [17].

• Determine task priorities by calculating credits and sorting the task list accordingly using the given method:

The credit assigned to this task is based on three factors, namely task length, task priority, and task deadline.

The proposed algorithm, Hybrid TLPD-ALB-RASA, consists of the following procedures:

Procedure 1: The credit assigned to a task is calculated based on its length [18].

Procedure 2: Priority credits are assigned to tasks based on their priority level [18].

Procedure 3: Deadline credits are assigned to tasks based on their deadline time [19].

Procedure 4: Adaptive Load Balancing (ALB) is used to balance the load among resources [20].

Procedure 5: Resource-Aware Scheduling Algorithm (RASA) is implemented to optimize resource usage [4].

The total credit assigned to a task (Total-Crediti) is calculated by multiplying the three credit factors (Credit-Lengthi, Credit-Priorityi, and Credit-Deadlinei). These procedures are combined to form the Hybrid TLPD-ALB-RASA algorithm, with the addition of the RASA procedure to optimize resource scheduling.

1. Compute the average task length (AvgTaskLen) of all tasks in MyQ.

2. For each task Ti in MyQ, compare its length to the average task length.

3. If the length of the task Ti is less than or equal to the average task length, add it to the list of tasks with minimum length (TaskLenCountMIN). Otherwise, add it to the list of tasks with maximum length (TaskLenCountMAX).

4. Once all tasks in MyQ have been compared, determine whether TaskLenCountMIN is greater than or equal to TaskLenCountMAX. If so, perform Max-Min scheduling. If not, perform Min-Min scheduling.

5. After scheduling a task Ti, remove it from the MyQ queue and update the completion times and resource readiness times of any remaining tasks.

6. Repeat steps 2-5 until the MyQ queue is empty.

The proposed hybrid TLPD-ALB-RASA algorithm incorporates adaptive load balancing from hybrid TLPD-ALB and total credits calculated from the hybrid TLPD algorithm. Therefore, the flowchart of the proposed algorithm is added after the previous flowcharts.

5.2 Flowchart of Hybrid TLPD-ALB-RASA:

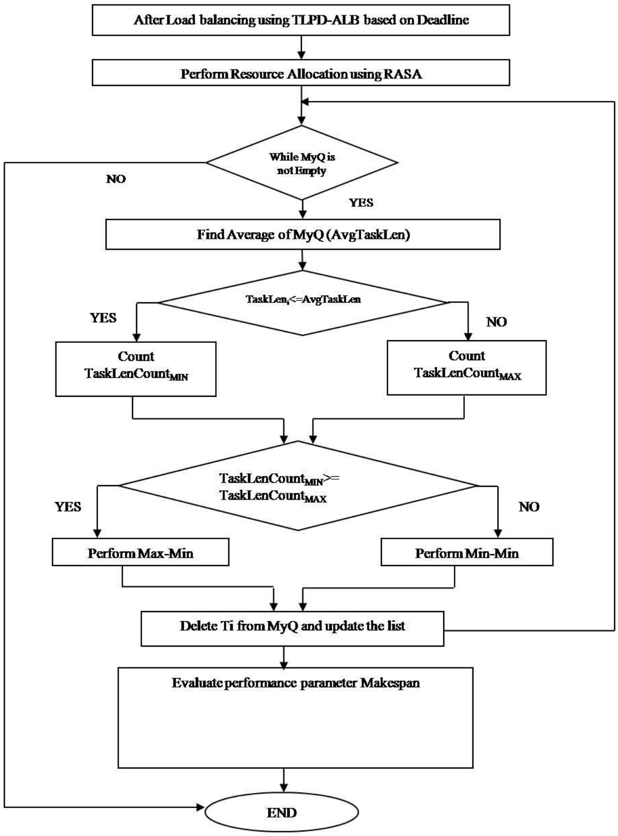

Fig. 1. Flowchart of proposed Hybrid TLPD-ALB-RASA scheduling algorithm

6 Simulation Setup

The hosting system is composed of 5 hosts, each equipped with a processing speed of 5000 MIPS and a RAM of 5048 MB. The virtual machine configuration ranges from 5 to 30, with each machine designed to handle different numbers of cloudlets, including 30, 50, 100, 150, and 200. The experiment's QOS metric, "Makespan," was utilized to evaluate the results. A table and graph were used to present the findings.

7 Results and Analysis

Table 1 displays a performance comparison of several scheduling algorithms, which includes traditional algorithms (FCFS, SJF, and Task Length & Priority Scheduling) and proposed scheduling algorithms (hybrid TLPD, hybrid TLPD-ALB, and hybrid TLPD-ALB-RASA). The algorithms were tested using various task-to-virtual machine mappings [18] [21] [22], and the table showcases the resulting "Makespan" values for each algorithm. This provides valuable insights into their effectiveness.

Table 1. Makespan in Different Scenarios

Makespan						
Scenarios	**FCFS**	**SJF**	**Task Priority**	**HYBRID TLPD**	**HYBRID TLPD-ALB**	**HYBRID TLPD-ALB-RASA**
[30,5]	405.63	405.64	405.88	405.65	401.93	372.31
[50,10]	996.31	910.41	888.07	806.85	812.96	566.15
[100,20]	5288.73	4640.97	4158.03	3013.09	2996.11	946.12
[150,25]	6090.75	6670.7	6618.01	5147.34	5103.96	1508.78
[200,30]	10145.4	9643.88	9027.98	7612.7	7582.25	2259.24

The table displays the results of the "Makespan" parameter for each algorithm, in relation to different tasks assigned to various numbers of virtual machines. The performance analysis was conducted to optimize the allocation and utilization of resources, as well as load balancing, for the requesting tasks [23] [24] [25].

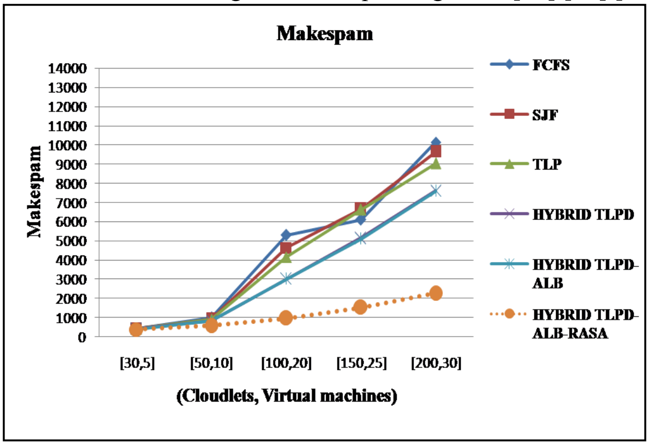

Fig. 2. Graphical representation of Makespan in different scenarios

In this study, we assessed the effectiveness of new algorithms relative to traditional ones, focusing on the minimum makespan metric. Our findings indicate that the inclusion of the RASA algorithm in the hybrid TLPD-ALB scheduling algorithm led to significant improvements in minimum makespan compared to conventional scheduling algorithms (such as FCFS, SJF, and Task length & Priority scheduling algorithms) and previous hybrid algorithms (hybrid TLPD and hybrid TLPD-ALB). These results suggest that resource allocation and utilization were optimized for the requested tasks. The line graph clearly illustrates the superior performance of the proposed hybrid TLPD-ALB-RASA scheduling algorithm in terms of minimum makespan, compared to traditional scheduling algorithms, across a variety of scenarios.

8 Conclusion & Future work

In this paper, the performance of the proposed hybrid TLPD-ALB-RASA algorithm is evaluated through various combinations of cloudlets and virtual machines. Five different scenarios are considered, and the quality of service (QoS) metric makespan is measured. The results of traditional algorithms, previous hybrid algorithms (hybrid TLPD and hybrid TLPD-ALB), and the new proposed hybrid TLPD-ALB-RASA algorithm are compared and analyzed. The results show that the new algorithm outperforms traditional and previous hybrid algorithms in all scenarios, with improved QoS results.

Further exploration into additional QoS parameters can aid researchers in enhancing resource utilization in cloud computing. This could lead to improved efficiency in resource usage. The design and comparison of additional hybrid algorithms with the results of this study has the potential to yield even better results.

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Author's Biography

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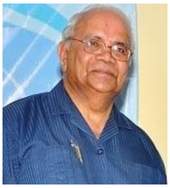

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Prof. (Dr.) Y. S. Shishodia was a Former Pro_Vice-Chancellor of Jagannath University, Jaipur, Rajasthan. Professor Shishodia obtained Bachelor's Degree (B.Sc.) in 1964, Master's Degree in 1966 (M.Sc. Physics) and Doctorate degree in 1972 from University of Rajasthan, Jaipur. He is recipient of Gold Medals from Maharaja College Jaipur for B.Sc and from University of Rajasthan for M.Sc Degree. Prof. Shishodia has also been awarded FIRST PRIZE, by the American Association of Physics Teachers, at the Eleventh Biennial Apparatus Competition held in New York, USA in 1979. Professor Shishodia has been recipient of SAREC (Swedish Agency for Research and Cooperation) Fellowship in 1972-73 and SIDA (Swedish International Development Authority) Fellowship in 1984-85 for post-doctoral work at University of Uppsala, Sweden. He is also a recipient of UNU-ICTP (United Nations University - International Centre for Theoretical Physics) fellowship for post-doctoral work as University of Malaya, Malaysia. Professor Shishodia has been a consultant to SBBJ (State Bank of Bikaner and Jaipur) and Bank of Rajasthan (now ICICI) for their all IT related matters. He has also been a Member (94-2006) of Governing Council of RAJCOMP, which is chaired by Chief Secretary, Govt of Rajasthan.