Comprehensive Analysis of Efficient Load Balancing Algorithms in Cloud Computing

Komal C. Patel[1], Keta R. Patel[2], Jayesh A. Patel[3], Amit G. Patel[4], Pankaj S. Patel[5]

Lecturer, Dept. of Computer Eng., Swami Sachchidanand Polytechnic, Sankalchand Patel University, Visnagar, India[1,2,3]
Sr. Lecturer, Dept. of Computer Eng., Swami Sachchidanand Polytechnic, Sankalchand Patel University, Visnagar, India[4]
I/C Head of CE/IT/ICT, Swami Sachchidanand Polytechnic, Sankalchand Patel University, Visnagar, India[5]

kcpatel.sspc@spu.ac.in[1] , krpatel.sspc@spu.ac.in[2] , japatelce.sspc@spu.ac.in[3],
agpatelce.sspc@spu.ac.in[4] , pspatel.sspc@spu.ac.in[5]

Abstract: In the distributed computing world, cloud computing has recently become a buzzword. Many people think that cloud computing will revolutionize the IT sector. It's provides us the means by which we can access the application as utilize our internet. Moreover, refers the manipulating configuring and accessing the application online. One paradigm for providing network access to a shared pool of reconfigurable computing resources that is universal, easy, and on-demand is cloud computing. (such as servers, networks, storage, apps, and services) that require no maintenance labor or communication with service providers and may be quickly provided and released. The pressure on the cloud is growing daily because almost every industry wants to use these services to lower infrastructure and maintenance costs. One of the main problems cloud computing is now facing is load balancing. This paper will discuss about balancing the load in cloud environment, need of load balancing, existing literature on load balancing algorithms, and widely used performance metrics for load sharing and a thorough examination of the algorithms found in the literature.

Keywords: Cloud Computing, Load Balancing, Static Load Balancing Algorithms.

I. INTRODUCTION

The technology that is becoming more and more popular these days is cloud computing. Since technology is advancing daily, it is truly impossible for a business to compete without maintaining its resources and technological capabilities. The adoption of these technologies requires significant infrastructure investment, which is not affordable for all businesses. These issues have been resolved by cloud computing, which offers pay-per-use, on-demand services that are accessible online. The flexibility and ease of use it offers for on-demand hardware or software services is the main reason why it is currently embraced by the majority of industries, academic institutions, and corporations. It can make cost-effective use of any type of resource, whether local or remotely accessible.

Since the greater part of businesses, today, wish to utilize these administrations to decrease foundation and support cost, the heap is builds step by step accordingly making load adjusting a difficult and significant territory of study for the researchers. The objective of this paper is to give a concise survey of well known burden adjusting procedures in distributed computing. The paper centers around need of burden adjusting and kind s of burden adjusting methods in area ii which followed by Literature study of existing algorithm proposed by different analysts with Analysis of calculations based on different boundaries called as execution measurements in segment iii and iv separately. At last, area v include with finish of the work.

II. DIFFERENT LOAD BALANCING ALGORITHMS

The implementation of the algorithm necessitates careful planning and process analysis because cloud computing is a vast collection of resources that must be managed properly. Load balancing algorithms can be categorized into different types, namely: Static, Dynamic, Centralized, Distributed and Hierarchical based on the type of algorithm used.

A. Static Load Balancing:

In static calculation the traffic is isolated uniformly among the workers. This calculation requires an earlier information on frame work assets the presentation of the processors is resolved toward the start of the execution, consequently the choice of moving of the heap doesn't rely upon the present status of framework.

Merit: Static load balancing is simple to implement, as tasks are pre-assigned, reducing runtime complexity and system overhead. It ensures fast execution, efficient resource use in homogeneous systems, and deterministic performance with predictable workload distribution. Without real-time monitoring, it also lowers computational overhead, making it energy-efficient for fixed workloads.
Demerit: Static load balancing lacks adaptability, making it inefficient for changing workloads or system failures. It cannot redistribute tasks dynamically, leading to potential overloading or underutilization, especially in heterogeneous environments. Its rigidity may cause bottlenecks and inefficiencies if the initial task allocation is suboptimal.

B. Dynamic Load Balancing:

These calculations are suitable for situation where heterogeneous assets are available. In this no earlier information is required. The provisioning is finished by present status of framework. The prerequisites may change at the show time to the clients. These calculations are hard to carry out however exceptionally reasonable for cloud climate.

Merit: Dynamic load balancing optimizes resource utilization by continuously adjusting workloads based on real-time system conditions. It enhances performance, prevents bottlenecks, and ensures efficient task distribution across heterogeneous environments. This adaptability improves fault tolerance, reduces response time, and maximizes system reliability, making it ideal for unpredictable or fluctuating workloads.
Demerit: Dynamic load balancing increases system overhead due to continuous monitoring and real-time decision-making. It adds complexity to implementation and may cause delays in task allocation. In high-load scenarios, frequent adjustments can lead to instability. Additionally, it requires efficient communication between nodes, which can consume extra network and computational resources.

C. Incorporated Load Balancing

In this situation the designation and de-assignment of assets on the organization is finished by a focal hub, for the most part called as organizer. The facilitator stores all the knowledge about the organization and applies calculation as indicated by the necessity.

Merit: Incorporated load balancing enhances efficiency by combining static and dynamic approaches, leveraging predictability while adapting to workload fluctuations. It optimizes resource utilization, improves fault tolerance, and reduces response time. This hybrid method balances stability and flexibility, ensuring smooth performance in both predictable and dynamic environments while minimizing overhead and bottlenecks.
Demerit: Incorporated load balancing increases system complexity by combining static and dynamic strategies, requiring sophisticated algorithms for effective implementation. It may introduce higher computational overhead due to real-time monitoring and decision-making. Additionally, improper integration can lead to inefficiencies, increased latency, or resource contention, reducing overall system performance in certain scenarios.
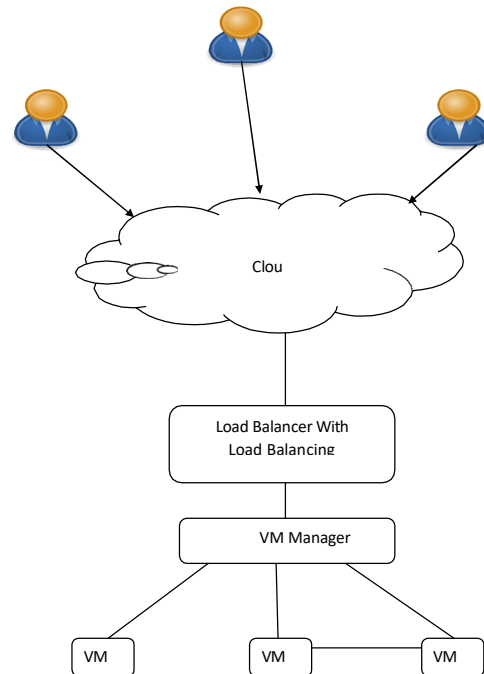
Fig-l Balancing the load in cloud computing

D. Circulated Load Balancing

In this calculations no single hub is able for load dissemination. Various facilitators in various paces are available to screen the organization and answerable for load adjusting. Each hub in every space keeps up the neighborhood information base and pass something similartotheorganizerwhichmakesworldwideinformationbasetoenvision the circumstance of the organization.

Merit: Circulated load balancing evenly distributes workloads across multiple resources in a cyclic manner, ensuring fair task allocation. It is simple to implement, reduces the risk of overloading any single node, and enhances system stability. This method works well in homogeneous environments, providing efficient resource utilization with minimal computational overhead.

Demerit: Circulated load balancing may lead to inefficiencies in heterogeneous environments where nodes have varying processing capabilities, as tasks are assigned without considering resource capacity. It lacks adaptability to dynamic workload changes, potentially causing bottlenecks. Additionally, it does not account for system failures, leading to possible performance degradation or task delays.

E. Various leveled Load Balancing

In this calculations cloud network is isolated in levels and each level takes an interest in load adjusting. These heap adjusting methods for the most part work in ace slave mode. The method imagines the cloud network as tree structure.

Merit: Various leveled load balancing optimizes resource allocation by considering different hierarchy levels, ensuring efficient workload distribution across diverse system architectures. It enhances scalability, improves fault tolerance, and adapts to dynamic workload changes. This approach balances efficiency and flexibility, reducing bottlenecks and improving overall system performance, especially in large-scale or multi-tier environments.

Demerit: Various leveled load balancing increases system complexity due to its hierarchical structure, requiring sophisticated algorithms for coordination. It introduces higher computational and communication overhead, potentially slowing down task distribution. Additionally, improper configuration or imbalance between levels can lead to inefficiencies, resource contention, or delays in processing, impacting overall system performance.

F. Static Round Robin Load Balancing Algorithm

In this calculation, fixed quantum time is given to the work. It designates occupations to all hubs in a roundabout style. Processors are allotted in a roundabout request and subsequently there is no starvation. It's gives quicker reaction on account of equivalent responsibility conveyance among measures.

Merit: Simple to implement and ensures fair workload distribution by assigning tasks cyclically. It reduces the risk of overloading a single node and works well in homogeneous environments. With minimal overhead and no need for real-time monitoring, it offers fast and efficient task allocation.

Demerit: It does not consider node capacity, leading to inefficiencies in heterogeneous environments where some nodes may be overloaded while others remain underutilized. It lacks adaptability to workload variations and system failures, potentially causing bottlenecks. Additionally, task switching may introduce unnecessary overhead.

G. Weighted Round-Robin Load Balancing Algorithm

In this algorithm, it created to improve the basic issues with cooperative calculation . In weighted cooperative calculation, every worker is appointed a weight and as indicated by the estimations of the loads, occupations are conveyed. Processors with more prominent capacities are relegated a bigger worth Consequently the most elevated weighted workers will get more undertakings. In a circumstance where all loads become equivalent, workers will get adjusted traffic.

Merit: The Weighted Round Robin load balancing algorithm improves efficiency by assigning tasks based on server capacity, ensuring better resource utilization in heterogeneous environments. It prevents overloading weaker nodes, enhances performance, and reduces response time. This method maintains fairness while adapting to varying processing power, leading to improved load distribution and system stability.

Demerit: It assumes static weight assignments, which may not reflect real-time system conditions, leading to inefficiencies. It does not account for sudden workload spikes or node failures, potentially overloading some servers. Additionally, improper weight configuration can cause imbalanced task distribution.
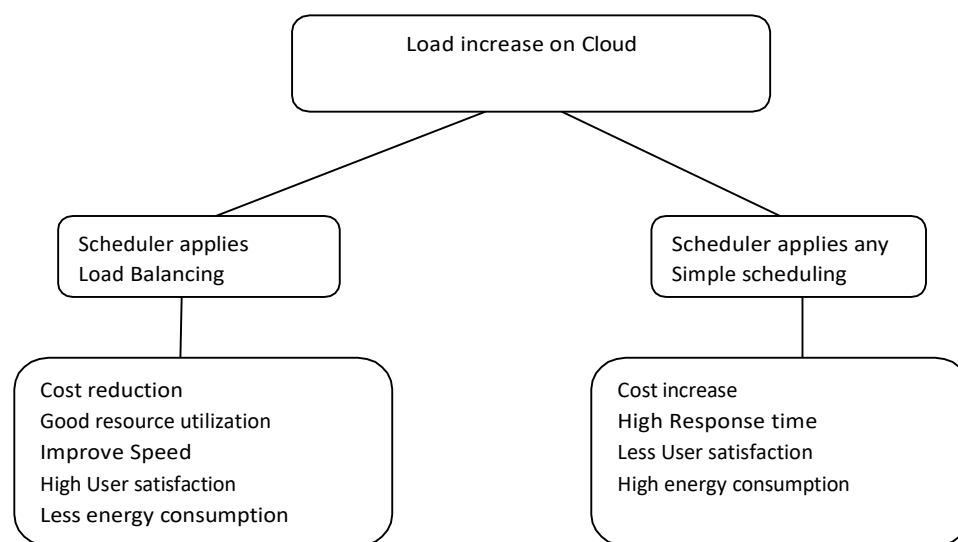

Fig-2 Benefits of load balancing

III.LITERATURE SURVEY

T. Dillon et al. [1] This study looked at the challenges and problems associated with cloud processing. We explained the relationships between Grid processing, Service-Oriented Computing, and Cloud registration. We broke down a couple of difficulties in transit towards receiving Cloud processing. The interoperability issue was featured and various arrangements are examined from there on for various cloud administration organization models.

P. Kumar et al.[2]load-adjusting techniques are energy saving, and errand load the executives, which requires growing new calculations. gets important to dissect recently evolved and recent load-adjusting procedures from various classifications on test systems dependent on different load balancing metrics to check the viability of these calculations before sending in the actual cloud climate.

A. Hota et al. [3]Cloud processing framework has generally been received by the business and scholarly. Be that as it may, there are numerous issues which exist in this climate like burden adjusting, In this paper, different burden adjusting calculations have been given their benefit and drawback. The review paper gives plentiful extension to scientists to create proficient burden adjusting calculations for cloud climate.

S. Shaw etal. [4]In this paper, we studied various calculations for load adjusting in Cloud Computing. Burden adjusting has two implication first, it puts countless simultaneous gets to or information traffic to various hubs individually to diminish the time clients holding up for response second, it put the estimation from a solitary hefty burden to the different hubs to improve the asset use of every hub.

N. Shah et al. [5] Load adjusting is vital in distributed computing if proficient and most extreme use of assets should be accomplished. In this paper, we have talked about the current static burden adjusting plans accessible for distributed computing. We have likewise distinguished the holes in current static burden adjusting calculations.

P.Samaletal.[6]The heap appropriation issue on different hubs of a conveyed framework is tackled in the current work to improve both asset use and occupation reaction time by examining the variations of RR calculation. The over-burdening and under loading circumstances are evaded. Subsequently, load adjusting guarantees that all the processor in the framework or each hub in the organization does roughly the equivalent measure of work whenever you want. When compared to other computations, the suggested calculation demonstrates a faster reaction time.

S.Pateletal.[7]Cloud Computing alongside research difficulties in load adjusting. It additionally center around benefits and faults of the distributed computing. A close examination of the aforementioned computations in distributed computing concerning steadiness, asset usage, static or dynamicity, helpfulness or non-helpfulness, and cycle relocation follows a significant push on the study of burden adjusting calculation.

S. Patidar et al.[8] In order to distribute the vocations into the most suitable virtual machines (VMs), the enhanced weighted cooperative computation in this paper takes into account the task duration of each requested occupation as well as the limitations of each VM.

D. Chitra Devi et al.[9] In this paper ,work had considered the general fruition time of all the taking an interest occupations in various calculations. All things being equal, in the future improvements, the consummation season of each job can be thought about in the diverse planning and burden balancing algorithms. The calculations can be tweaked further to achieve the better predictable outcomes on all the different perspectives. Essentially, the examination results ought to betaken for the distinctive occupation appearance designs on all the three different booking and burden adjusting calculations.

H. Shoja et al.[10] Load adjusting is the primary difficulties in distributed computing. It's needed to disseminate the powerful nearby responsibility equally across every one of the hubs to accomplish a high user satisfaction and asset usage proportion by ensuring that each processing asset is dispersed effectively and decently.

I .Saiduet al.[11]we propose another parcel booking calculation, load-mindful weighted cooperative effort (LAWRR), for 802.16 organizations in the downlink heading to enhance the productivity of WRR.

M.Kauretal.[12]In these paper , it has been reviewed that heap adjusting is a significant worry in distributed computing. In the essential intension of burden adjusting is to fulfill the client while conveying load among a few hubs. In addition, the legitimate use of assets with improved execution and utilized static and dynamic burden adjusting calculations.

Sajjan R.S et al. [13] In this paper, Load adjusting is quite possibly the main issue of distributed computingIt is a device that distributes accountability equally among all of the cloud's hubs. We are able to achieve high asset utilization and client fulfillment. These will enhance the framework's overall appearance and usefulness.

S. Mayur et al. [14] In present, Load adjusting is the significant difficulties in the distributed computing. In this paper we examines numerous as of now investigated load adjusting techniques, which depends essentially on overhead decrease, framework execution improvement, improved asset utilizes client reaction time and throughput advancement with cooperative effort and weighted cooperative calculation.

IV. PERFORMANCE METRICS AND ANALYSIS OF VARIOUS ALGORITHMS

- **Makespan:** Total length of the time table when all positions are done. This boundary ought to be least, since it the less time calculation will take for fulfillment great will be execution.
- **Throughput:** It is the measure of work to be done in the given measure of time.
- **Response time:** It is the measure of time used to begin satisfying the interest of the client in the wake of enrolling the solicitation.
- **Resource Utilization:** how much assets are used in effective way.
- **Overhead:** measure the overhead needed for correspondence between to hubs because of development of errands.
- **Fault tolerance:** It is the capacity of the heap adjusting calculation that permits framework to work in some disappointment state of the framework.
- **Scalability:** It is simply the capacity of the calculation to scale itself as per required conditions.
- **Performance:** It is the general check of the calculations working by thinking about exactness, cost and speed.
- **Waiting time:** A period taken by an action in the line to sitting active for finding the opportunity for execution in the wake of getting asset or machine.

TABLE-I:
TABULAR FORMATE OF LITERATURE VIEW

Paper title/ Journal	Author/year	Overall domain	Author contribution	Results	Further Improvements
Issues and Challenges Of load Balancing Techniques In cloud Computing: A survey[2], ACM Computing Surveys,	Pawan Kumar And Rakesh Kumar,2019	Load Balancing Technique S.	This Survey Presents State-Of-The-Review Of Issues And Challenges Associated With Existing Load-Balancing Techniques For Researchers To Develop More	This Study Will Be Helpful For Researchers To Identify Research Problems Working In The Load Balancing Field And Will Provide A Summary Of Available Load-Balancing	Developers And Researchers To Design And Implement A Suitable Load Balancer For Parallel And Distributed Cloud Environments.

			Effective Algorithms.	Techniques.	
Survey of Different Load Balancing Approach-Based Algorithms In cloud Computing: A Comprehensive review[3], Springer2019	Arunima Hot A, Subasish Mo Hapatraand Subhadarshini Mohanty, 2019	Load Balancing Techniques	This Survey Paper Presents A Comprehensive And Comparative Study Of Various Load Balancing Algorithms.	It Increases The Efficiency Of The System By Equally Distributing The Work Load Among Competing Processes.	The Study Also Portrays The Merits And Demerit So Fall The State-Of-The-Art-Schemes Which May Prompt The Researchers For Further Improvement In Load balancing Algorithms.
A survey on Scheduling and load Balancing Techniques In cloud Computing Environment [4],20145th International Conference on computer and Communication Technology (ICCCT)	Subhadra Boseshaw, Dr.A.K. Singh,2014	Scheduling And Load Balancing Technique	In This Paper, We Have Discussed Different Algorithms Proposed To Resolve The Issue Of Load Balancing And Task Scheduling In Cloud Computing.	To Balance The Load In Cloud The Resources And Workloads Must Be Scheduled In An Efficient Manner.	More Efficient Load Balancing Techniques Can Be Developed In Future.
Static load Balancing Algorithms In cloud Computing: Challenges &Solutions [5], International Journal Of scientific & Technology Research Volume4, Issue10, October2015	Nadeem Shah, Mohammed Farik,2015	Static Load Balancing Algorithms	The Aim Of This Review Paper Is To Understand The Current Challenges In Cloud Computing, Primarily In Cloud Load Balancing Using Static Algorithms.	The Aim Of This Review Paper Is To Understand The Current Challenges In Cloud Computing, Primarily In Cloud Load Balancing Using Static Algorithms.	Improve More Efficient Static Cloud Load Balancing In The Future.

Analysis of Variants in Round robin Algorithms For load Balancing In cloud Computing [6], International journal Of computer Science and Information Technologies ,Vol.4(3), 2013,416-419	Pooja Samal, Pranati Mishra,2013	load balancing in Cloud Computing	Improve resource utilization and job response time by analyzing the variants of RR algorithm.	This algorithm, which divides the traffic qually, is announced as round robin algorithm.	Improve the performance by balancing the load among various resources.
Implementation of load Balancing In cloud Computing Thorough Round robin &Priority Using Cloudsim[7], International Journal For rapid Research in Engineering Technology &Applied Science vol 3, Issue11 November 2017.	Shweta Patel, Prof. Mayank Bhatt,2017	Load balancing In Cloud Computing	Round Robin algorithm in different time slices to individual processes depending on their priorities.	Good load balancing makes cloud computing more efficient and improves user satisfaction.	The load balancing strategy to improve the efficiency in the cloud environment.
Load Balancing In cloud Computing Using Modified Round robin Algorithm [8], International Journal Of scientific Research& Engineering Trends Volume6, Issue4,July-Aug-2020,	Srushti Patidar , Assistant Prof. Amit Saraf, 2020	Load Balancing In Cloud Computing	Weighted round robin calculation considers the capacities of each VM and the errand length of each asked for occupation to allot the employments in to the most suitable VMs.	Basic to build up a calculation which can enhance the framework execution by adjusting the work stack among virtual machines.	Implement Weighted round Robin

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Load Balancing In cloud Computing Environment Using Improved Weighted Round robin Algorithm For Non preemptive Dependent Tasks[9], Ramanujam Computing Centre, Anna University, Chennai600 025,India, Received29 November 2015; Accepted21 December 2015.	D. Chitra Deviand V. Rhymend Ut Hariaraj, 2015	Load Balancing in Cloud Computing	Weighted round robin algorithm considers the capabilities of each VM and the task length of each requested job to assign the jobs into the most appropriate VMs.	Weighted round robin algorithm is most suitable to the heterogeneous/ho mogenous jobs with heterogeneous resources(VMs) compared to the other round robin and weighted round robin algorithms.	Improved weighted round robin algorithm.

TABLE-II:
TABULAR FORMAT OF PROPOSED TECHNIQUE, ADVANTAGES AND DISADVANTAGES

Paper Title/ Journal	Author/year	Proposed Technique	Advantages	Disadvantages
Issues And Challenges Of Load Balancing Techniques In Cloud computing: A Survey[2], ACM Computing Surveys, Vol. 51, No. 6, Article 120. Publication Date: February 2019.	Pawan Kumar and Rakesh Kumar, 2019	Distributed algorithm; Concurrent algorithm.	All the nodes in the distributed system are connected to each other, so node can easily share load.	It is difficult to provide security in distributed Systems.
Survey Of Different load	Arunima Hota, Subasish Moha	Round Robin algorithm	It works well with no of processes	Some of the nodes are heavily loaded and

Balancing Approach-Based Algorithms In Cloud computing A comprehensive Review [3], Springer2019	patra and Subhadarshini Mohanty , 2019			Some of the mare under loaded. Such situation can lead to poor performance of the system
A Survey On Scheduling And Load Balancing Techniques In Cloud computing Environment [4], 2014 5th International Conference On Computer and Communication Technology (ICCT)	Subhadra Bose Shaw, Dr. A.K.Singh,2014	Task Scheduling Algorithm	Manage all the system performance and Qos.	These algorithms cannot adapt to load changes during run-time.
Static Load Balancing Algorithms In Cloud computing: Challenges & Solutions [5], International Journal Of Scientific &Technology Research volume 4, Issue 10, October2015.	Nadeem Shah, Mohammed Farik ,2015	Round-Robin algorithm.	Faster task completion	Lost some process
Analysis Of Variants In Round Robin Algorithms for Load Balancing In Cloud Computing [6], International Journal Of Computer science And Information Technologies, Vol.4(3) ,2013,416-419	Pooja Samal, Pranati Mishra,2013	Round Robin (RR) algorithms.	A better distribution of the communication traffic so that the website availability is conclusively settled.	Long time system responses

Implementation Of Load Balancing In Cloud computing Thorough round Robin & Priority Using	Shweta Patel, Prof. Mayank Bhatt, 2017	Round Robin Algorithm	Round robin algorithm can be via far the easiest algorithms how to help distribute populate among nodes. Because of this reason it is frequently the first	Implementing a simple round robin architecture in cloud computing by introducing a concept of assigning different time
Cloudsim[7], International Journal For Rapid research in Engineering Technology & Applied Science Vol 3 Issue 11 November2017.			Preference when implementing a easy scheduler.	slices to individual processes depending on their are priorities.
Load Balancing In Cloud Computing Using Modified Round Robin Algorithm [8], International Journal Of Scientific Research &Engineering Trends Volume 6, Issue4, July-Aug-2020, ISSN(Online): 2395-566x	Srushti Patidar, Assistant Prof. Amit Saraf, 2020	Round Robin Algorithm	Easy to use and implement	Poor framework execution and looking after security
Load Balancing In Cloud Computing Environment Using Improved Weighted Round Robin Algorithm For Non preemptive Dependent Tasks [9], Ramanujam Computing Centre, Anna University, Chennai 600 025, India, Received29 November 2015; Accepted21 December2015.	D. Chitra Deviand V. Rhymend Uthariaraj , 2015	Weighted Round Robin.	The weighted round robin considers the resource capabilities of the VMs and assigns higher number of tasks to the higher capacity VMs based on the weightage given to each of the VMs	Higher response time

V. CONCLUSION

Today, load adjusting is the one of the greatest issue in distributed computing. The heap must be conveyed reasonably among every one of the hubs. The primary advantages of Load adjusting are ideal usage of assets and increment throughput with lesser energy utilization at last bringing about green registering, static calculation is created by joining the highlights of the weighted round-robin calculation load adjusting calculation to connect the holes of both.

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