A COMPARITIVE ANALYSIS OF CLOUD COMPUTING RESOURCE SCHEDULING ALGORITHMS

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ABSTRACT - As an on-demand computing service with which users pay as they go using a utility computing paradigm, cloud computing systems have seen a recent and considerable increase in popularity. One of the key objectives of cloud computing is to maximize profit while enabling effective remote access to resources. So, scheduling—which focuses on allocating activities to the available resources at a specific time—is the main challenge in developing cloud computing systems. In this research, we present a simulation analysis that compares the three most frequent and widely used resource scheduling algorithms for cloud computing: Round Robin (RR), improved max-min, and Selective algorithms.CloudSim evaluated the methods while taking into account the time- and space-sharing scheduling allocation policies. These algorithms' propensity to deliver high-quality service for the tasks and ensure fairness among the jobs served has been simulated. The characteristics of the specific cloud must be taken into account. We must evaluate algorithms based on those parameters, simulate each method, and select the best outcome from the outcomes produced by each algorithm.

KEYWORDS-Resource Scheduling Algorithms,Parameters,CloudSim.

1. INTRODUCTION

For giving on-demand access to computing resources over the internet, cloud computing has grown in popularity. To meet the service-level agreements (SLAs) of their clients while utilizing available resources to the fullest, cloud providers must master effective resource management**.**Algorithms for resource scheduling are essential for guaranteeing effective resource use. In accordance with predetermined policies and constraints, resource scheduling algorithms oversee allocating computing resources to user demands. These algorithms choose which virtual machines (VMs) should do particular tasks and when to allocate or release such VMs. To address various facets of the resource management problem, various cloud computing resource scheduling techniques have been suggested. The majority of resource scheduling techniques are designed to accomplish two main aims: Improving the standard of service in job execution and delivering the anticipated results on schedule. The second is to continue to treat all jobs equally and efficiently.By building a virtual computer, the cloud environment offers a different platform that helps customers complete their tasks affordably and quickly without compromising service quality. We will use the CloudSim for this project. An open-source framework called CloudSim is used to model cloud computing infrastructure and services. The way computing resources are managed and used has been completely transformed by cloud computing. It provides a convenient and affordable method of gaining access to computing resources over the internet. To guarantee that cloud providers adhere to their service-level agreements (SLAs) and make the best use of their resource pool, effective resource management is essential. In order to achieve effective resource usage in cloud computing, resource scheduling techniques are crucial. These algorithms oversee allocating computing resources to user requests in accordance with predetermined rules and limitations. There are various resource scheduling algorithms that each have their own benefits and drawbacksIn this comparative analysis, an evaluation and comparison of some of the widely used resource scheduling algorithms in cloud computing. An analysis of their strengths and weaknesses and examine how they perform in different scenarios. The aim of this analysis is to provide a comprehensive understanding of the different resource scheduling algorithms **and** help cloud

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providers choose the right algorithm that meets their specific requirements**.**

2. RELATED WORK:

Some of the popular resource scheduling strategies in cloud computing are assessed and contrasted in this study. The advantages and disadvantages along with how they perform in various situations are illustrated.The purpose of this analysis is to give readers a thorough understanding of the various resource scheduling algorithms and to assist cloud service providers in selecting the one that best suits their unique needs.A workload generator, a resource manager, and a performance assessor are some of the common components of the current architecture. In order to simulate a real-world workload, the workload generator generates a set of jobs with various resource requirements and processing times.Based on the testing scheduling method, the resource management distributes computer resources to the jobs. To assess the efficacy of the scheduling algorithm, the performance evaluator examines the system's performance, including reaction time, resource utilization, and throughput.Typically, the current model models a cloud computing environment with a certain set of resources and limitations. The model can be used to assess how well the algorithms function in a variety of conditions, including heavy workload, resource constraints, and varied scheduling policies.The objective of the current model is to give a fair comparison of various scheduling algorithms and identify the method that performs the best in various scenarios. This makes it easier for cloud service providers to select the ideal scheduling algorithm for their unique requirements, assuring optimal resource utilization and SLA compliance.In conclusion, the current approach is a comparative study of cloud computing resource scheduling algorithms is a framework that mimics a cloud environment to assess and compare the effectiveness of various scheduling algorithms under various circumstances. The model aids cloud service providers in selecting the optimum algorithm that fulfils their unique needs and optimizes resource usage.According to their point of interest and their nature, an attempt is made to categorize the existing algorithms On the basis of three parameters important to resource scheduling, a comparison of existing resource scheduling methods is also being done. This analysis has shown that no single algorithm can satisfy all three of the fundamental criteria used in the investigation.

RESOURCE UTILIZATION: The amount of computer resources, such as CPU, memory, storage, and network bandwidth, that are being used by a cloud-deployed application or service are referred to as resource utilization in cloud computing.Users who use cloud computing can scale up or down their resource utilization in accordance with their demands because they can rent computer resources on demand. To improve resource allocation and guarantee effective use of cloud resources, cloud service providers can monitor and manage resource utilization.Cloud service providers can pinpoint possible bottlenecks and optimize resource allocation by evaluating resource use data in order to guarantee optimal performance and reduce expenses. In order to enforce resource quotas or limitations and avoid resource abuse or overuse, resource utilization metrics may also be used to monitor the resource usage of specific users or applications.

LOAD BALANCING:

n a cloud context, load balancing is the process of dividing incoming network traffic among several servers or resources in order to maximize resource usage, increase availability, and guarantee high performance and scalability.Between the client and the server, load balancers function as an intermediary, taking inbound requests and distributing them among a pool of servers according to various criteria such server capacity, resource availability, and server health. The network, transport, and application layers of the cloud architecture are just a few places where load balancing can be used.In order to maintain optimal resource use and avoid individual servers being overwhelmed or experiencing downtime, load balancing is crucial in cloud computing. Load balancing is often provided as a service by cloud service providers and can readily scaled up or down in response to shifting resource demand.

VIRTUAL MACHINE:

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A key component of cloud computing, virtual machines (VMs) enable users to build and operate virtual versions of computer hardware, such as CPU, memory, storage, and network connectivity, on top of a physical infrastructure. Depending on the type of VM, how long it will be used, and the cloud service provider, the cost of using VMs in the cloud can vary. The following variables frequently affect how much virtual machines cost:

- VM Type
- Usage Type
- StorageN
- etwork Usage

2.1 PROPOSED APPROACH

The three resource scheduling algorithms Round Robin (RR), Improved Max-Min, and Selective will be simulated in this study based on four different quality of service parameters: processor power, RAM, band width, and time taken, using the CloudSim tool. With Eclipse IDE, we will set up CloudSim for simulation.

2.2 CLOUDSIM:

esearchers and developers can study and simulate cloud computing infrastructures andapplications using the simulation tool CloudSim. The modelling, simulation, and experimentation of cloud computing systems and services are supported by this open-source platform. Users can build virtual computers, set up cloud apps, and simulate a variety of cloud scenarios with CloudSim. For modelling various cloud computing components, such as data centers, virtual machines, apps, and network topologies, it offers a variety of modules. To mimic various cloud settings, users can adjust a number of characteristics, including computing power, memory, storage, and network bandwidth.Java-based CloudSim is frequently used in academic and research environments to assess various cloud computing methods, regulations, and architectures. Industry professionals also use it to create and test cloud apps before putting them into use in actual environments.All things considered, CloudSim is a strong and adaptable simulation tool that may aid researchers and professionals in better comprehending and enhancing cloud computing systems and applications.

SCHEDULING ALGORITHMS:

The following are the three different scheduling algorithms that are used in this paper named as follows:

I. Round Robin

II. Enhanced Max-Min

III. Selective

ROUND ROBIN:

The resource scheduling mechanism known as round robin is quite popular in cloud computing. It is a preemptive scheduling technique that gives each work an equal number of time slices in a circular pattern. This technique is employed in cloud computing to distribute resources among various jobs operating on several virtual machines (VMs).The round robin resource scheduling mechanism in cloud computing operates as follows:

1. Distribute the resources equally among all the virtual machines.
2. Give each virtual machine (VM) a time quantum, or the maximum length of time it can consume the resources before being pre-empted.
3. With each job being given a time slice equal to the time quantum allotted to the VM it is operating on, begin executing tasks on the VMs in a circular order.
4. The following task in the cyclic order is scheduled to run on the same VM if a task completes earlier than its time quantum expires.
5. The next task in the circular sequence is scheduled to run on the same VM if a task does not complete before its time quantum expires.
6. A VM is skipped in the circular order if all of its tasks have been completed before a new job

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can be scheduled on it.

7. Up till all tasks have been completed, the procedure is repeated.

The round robin resource scheduling approach ensures equitable resource distribution to all jobs running on the VMs and is easy to implement. However, under other circumstances, such as when some projects have stringent deadlines or demand more resources than others, it might not be the most effective algorithm. Other scheduling strategies might be more suitable in such circumstances.

RESULT:

```
========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID    Time    Start Time    Finish Time    waiting time
     3         SUCCESS        2             3       8.89       0.1         8.99          0
     7         SUCCESS        2             3       12.22      0.1         12.32         0
     5         SUCCESS        2             1       13.5       0.1         13.6          0
     6         SUCCESS        2             2       16.66      0.1         16.76         0
     9         SUCCESS        2             1       20.5       0.1         20.6          0
     2         SUCCESS        2             2       34.33      0.1         34.43         0
     8         SUCCESS        2             0       38.17      0.1         38.27         0
     4         SUCCESS        2             0       39.99      0.1         40.09         0
     1         SUCCESS        2             1       44.49      0.1         44.59         0
     0         SUCCESS        2             0       67.27      0.1         67.37         0
RoundRobin finished!
```

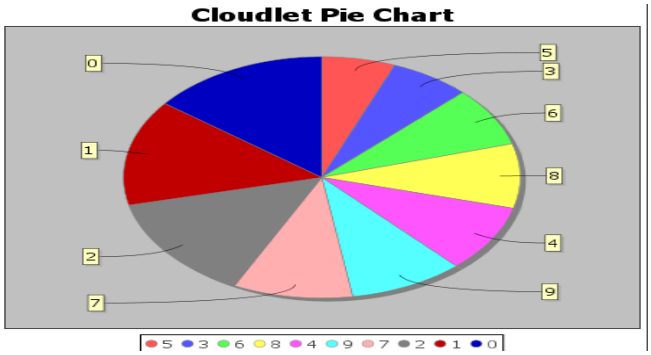

Fig: Graph indicating the time occupied by each cloudlet using round robin algorithm

ENHANCED MAX-MIN:

In the cloud, the Enhanced Max-Min (EMM) resource scheduling technique is frequently used to allocate resources to numerous workloads operating on various virtual machines (VMs). It is an extension of the well-known distributed systems resource allocation heuristic approach known as Max-Min (MM) resource scheduling.The EMM algorithm takes system usage and fairness into account as it works to maximize the least amount of resources allocated to each activity. As to how it operates:

1. Distribute the resources equally among all the virtual machines.
2. Based on the resources needed and the importance given to each task, determine its weight.
3. Arrange the jobs in descending order of weight and round-robin distribute them among the VMs.
4. Regardless of whether the task's resource requirements exceed the VM's available resources, allocate as many resources as you can for each task.
5. Whenever more resources are allocated to a task than are necessary, the extra resources are added to a pool of resources that are available for the remaining tasks.
6. If a task cannot be given the minimal amount of resources necessary, it is skipped and the work behind it in the sorted order is taken into consideration.
7. Continue repeating steps 3-6 until no more resources are available after all tasks have been considered.By considering the weight of each work and the resources that are available in the pool, the EMM algorithm outperforms the MM algorithm in terms of resource use and fairness. In addition to guaranteeing that all activities receive a minimum allocation of resources, it makes sure that tasks with greater priorities and resource requirements are given resources first.

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RESULT:

```
========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID    Time    Start Time    Finish Time
     3         SUCCESS         2             3       8.89        0.1         8.99
     7         SUCCESS         2             3       12.22       0.1         12.32
     5         SUCCESS         2             1       13.5        0.1         13.6
     9         SUCCESS         2             1       20.5        0.1         20.6
     6         SUCCESS         2             2       25          0.1         25.1
     8         SUCCESS         2             0       25.45       0.1         25.55
     4         SUCCESS         2             0       26.36       0.1         26.46
     1         SUCCESS         2             1       44.49       0.1         44.59
     2         SUCCESS         2             2       60.33       0.1         60.43
     0         SUCCESS         2             2       64.33       0.1         64.43
EnhancedMaxMin finished!
```

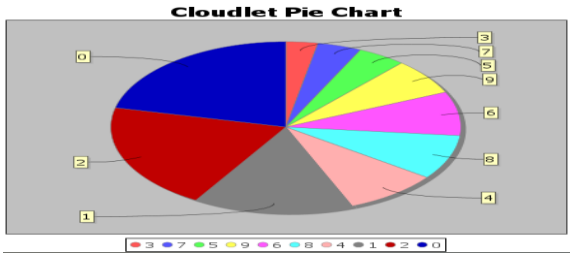

Fig: Graph indicating the time occupied by each cloudlet using Enhanced Max-Min algorithm

SELECTIVE RESOURCE SCHEDULING ALGORITHM:

The dynamic resource allocation technique known as the "selective resource scheduling algorithm" is used in cloud computing to optimize the distribution of resources among various tasks according to their resource needs, importance, and execution characteristics. It is an adaptive algorithm that continuously assesses the performance of each task and the resource utilization, and then modifies the resource distribution as necessary.Te algorithm for selective resource scheduling operates as follow

1. Determine the least amount of resources that should be assigned to each task based on its requirements and priority.
2. Real-time monitor each task's performance and resource utilization.
3. Determine which tasks need more resources or are performing poorly owing to a lack of resources.
4. Based on these jobs' resource needs, priority, and the system's resources, provide more resources to them.
5. Keep track of how the resource allocation is affecting the overall system performance and change it as needed to achieve optimal resource use.
6. Regularly assess the resource needs and task priorities, then alter the allocation as necessary.

By dynamically altering the resource allocation based on the shifting resource requirements and task priorities, the selective resource scheduling algorithm optimizes the resource allocation. It makes sure that the resources are distributed in a way that meets the needs and priorities of each activity while also maximizing the system's performance and usage. The technique is particularly suited for cloud computing environments where the workload and user demand can significantly and dynamically change the resource requirements and prioritization of jobs.

OUTPUT

```
========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID    Time    Start Time    Finish Time    Algo
     3         SUCCESS         2             3       44.44       0.1         44.54       Max-min
     6         SUCCESS         2             3       54.43       0.1         54.53       Max-min
     4         SUCCESS         2             3       63.32       0.1         63.42       Max-min
     7         SUCCESS         2             3       71.09       0.1         71.19       Max-min
     5         SUCCESS         2             3       77.76       0.1         77.86       Min-min
     9         SUCCESS         2             3       83.32       0.1         83.42       Min-min
     0         SUCCESS         2             3       87.76       0.1         87.86       Max-min
     8         SUCCESS         2             3       91.09       0.1         91.19       Max-min
     1         SUCCESS         2             3       93.32       0.1         93.42       Max-min
     2         SUCCESS         2             3       95.64       0.1         95.64       Max-min
Selective Algorithm finished!
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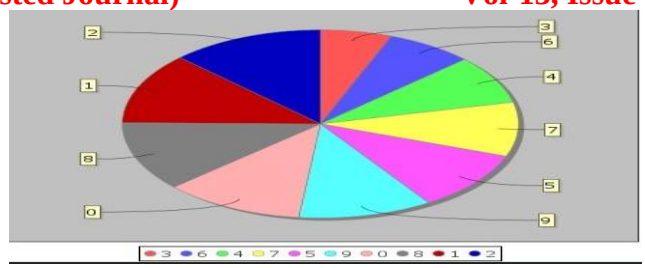

Fig: Graph indicating the time occupied by each cloudlet using selective resource scheduling algorithm

2.3PARAMETERS USED:

'The following are the four different quality of service parameters used they are:

- Processing Power
- RAM
- Band
- WidthTime
- Taken

PROCESSING POWER: Processing power in cloud computing refers to the quantity of computer resources that are accessible for carrying out computational operations. Processing power is often given via virtual machines or containers in cloud computing, which are hosted on actual servers in data centers.Several levels of processing power are available from cloud computing providers, and these levels are often determined by the quantity and kind of CPUs (Central Processing Units) or VCPUs (Virtual CPUs) assigned to a certain virtual machine or container. In general, more demanding workloads, like those involving data analysis, machine learning, or scientific simulations, may be carried out more rapidly and effectively when there is more processing power available.A variety of computing resources, such as storage, networking, and memory, are frequently available in the cloud, along with processing power. When it comes to processing power and other computing resources, cloud computing companies offer various tiers to accommodate the various demands of their clients, who range from tiny businesses to major corporations.**RAM:**RAM (Random Access Memory) in cloud computing refers to the amount of memory that is accessible to a virtual machine or an instance on a cloud server. RAM is a sort of computer memory that enables speedy access to data in any order rather than sequentially.

Users in cloud computing can decide how much RAM their virtual machines or instances will need based on the demands of their applications. The amount of RAM allotted to a virtual machine or instance controls how much data can be stored in memory and how many processes can be performed at once.An application's speed can be enhanced by adding additional RAM to a virtual machine or instance since more processes can run concurrently and data can be accessed more quickly. But, greater Memory also entails higher costs, thus it's crucial to allot the proper amount of RAM to satisfy the needs of the application without squandering resources.

BAND WIDTH:

In the context of cloud computing, bandwidth describes the volume of data that may be sent back and forth between a user and a cloud service provider in a predetermined amount of time. In cloud computing, bandwidth is crucial because it governs how rapidly data can be uploaded to or retrieved from the cloud, which may have an impact on how well cloud-based apps work.Depending on their clients needs, cloud computing providers often offer a range of bandwidth options. For instance, a provider might provide a specific amount of bandwidth without charge while charging extra for more. It is common to measure bandwidth in bits per second (bps) or bytes per second (Bps), and it might vary depending on the user's location, the network's congestion, and the quality of their internet connection.In general, faster data transmission rates are associated with higher bandwidth, which can

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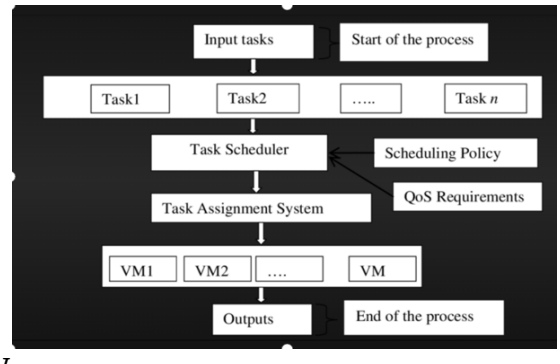
improve the performance and responsiveness of cloud-based applications. When choosing a cloud computing provider, it's crucial to combine performance requirements with cost considerations because increased bandwidth can also be more expensive.

TIME TAKEN:
The time taken parameter in cloud computing often refers to the length of time needed to complete a certain job or operation in the cloud environment. The scale and complexity of the task, the resources available in the cloud environment, and the functionality of the underlying hardware and software are just a few examples of the variables that can affect this parameter.
The time taken parameter for instance, could be used to describe how long it takes a compute-intensive application operating in the cloud to do a particular operation, such creating a 3D cartoon or processing a sizable dataset. You might think about adopting strategies like load balancing, parallel processing, and modifying your code for the cloud environment to improve the time taken parameter in cloud computing. You can watch and analyse the performance of your cloud applications using technologies like monitoring and analytics to find areas for improvement.
Overall, because it directly affects the effectiveness and performance of your cloud applications, the time required parameter is a crucial factor to take into account in cloud computing.

WORK FLOW:
The several steps that we used in our paper are listed below:

- Initialize the CloudSim Library first
- Establish data centres and brokers
- Making a VM list and submitting it to the broker for management of VM allocation.
- Then, take the input tasks that need to be completed (tasks 1, 2, etc.).
- The task scheduler, sometimes referred to as the broker, will receive the tasks. Broker is an entity that represents the user and informs us of the channel through which policy scheduling should take place.
- With a task assignment system, tasks will be assigned to several virtual machines, such VM 1, VM 2,....., and VM n.
- Following the task assignment to the several VM's. As soon as the task is finished, the simulation begins and outputs the results.
- The tasks will be carried out sequentially by the VM's, and the outputs will be produced as a result.



GENERAL WORKFLOW:
This part of the paper describes the general workflow for performing a comparativeanalysisofcloudcomputing resource scheduling algorithms:**Problem Definition:** Provide the issue you are trying to resolve, such as resource allocation optimization in a cloud computing context.Algorithm Selection: Determine which resource scheduling strategies are best for the given scenario before comparing them. These algorithms might be more recent machine learning-based ones as well as more established ones like Round Robin (RR), Improved Max-Min, and

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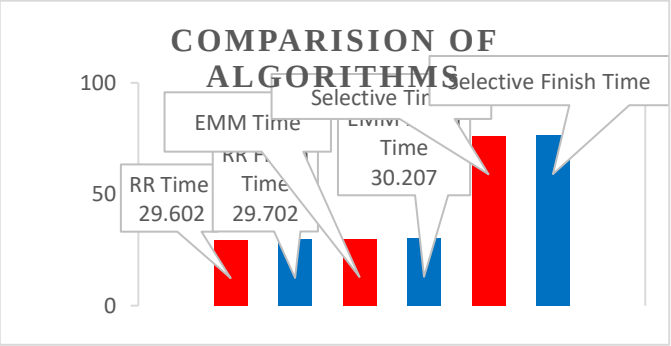
Selective.Data Collection: Run simulations in a controlled setting to get information on the performance of each algorithm. This may entail creating fictitious workloads or using actual traces.Performance Metrics: Choose relevant performance indicators, such as processor speed, RAM, storage capacity, and time taken, to compare the methods.Data Analysis: Determine each algorithm's performance by analysing the collected data using statistical methods. In doing so, it may be necessary to compute the performance measures' means, variances, and confidence intervals.Visualization: Create visualizations of the data to help understand the results of the analysis. This could include plots, graphs, and charts.Conclusion: Identify any limits or potential areas for further investigation after drawing conclusions from the analysis. The pros and cons of each algorithm as well as the applicability of various algorithms for various cloud computing environments could be covered in this discussion.In general, a comparative analysis of cloud computing resource scheduling algorithms entails identifying the problem, choosing appropriate algorithms, gathering data, analysing the data, and making inferences from the finding

3. RESULT AND DISCUSSION

Round Robin (RR), Enhanced Max- Min, Selective are three resource scheduling algorithms for cloud computing that may be compared based on a number of factors, including processor power, Memory, storage, and bandwidth. In this research, 10 tasks have been distributed among 4 virtual computers, and the tasks to which we have assigned them will determine the output. We can also observe in the output which virtual machine is assigned to which task and how long it takes each virtual machine to accomplish a task.Below is a comparison of the working times and completion times of the algorithms Round Robin (RR), Enhanced Min-Max (EMM), and Selective for a variety of tasks



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