AN EFFICIENT TASK SCHEDULING FOR CLOUD COMPUTING PLATFORMS USING ENERGY MANAGEMENT ALGORITHM: A COMPARATIVE ANALYSIS OF WORKFLOW EXECUTION TIME

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ABSTRACT— Cloud computing platform offers numerous applications and resources such as data storage, databases, and network building. However, efficient task scheduling is crucial for maximizing the overall execution time. In this study, workflows are used as datasets to compare scheduling algorithms, including Shortest Job First, First Come, First Served, (DVFS) and Energy Management Algorithms (EMA). To facilitate comparison, the number of virtual machines in the eclipse environment is used for the implementation. The experimental findings indicate that increasing the number of virtual machines reduces Makespan. Moreover, the Energy Management Algorithm (EMA) outperforms Shortest Job First by 2.79% for the CyberShake process and surpasses the First Come, First Serve algorithm by 12.28%. Additionally, EMA produces 21.88% better results than both algorithms combined. For the Montage process, EMA performs 4.50% better than Shortest Job First and 25.75% superior to the First Come, First Serve policy. Finally, we ran simulations to determine the performance of the suggested mechanism and contrasted it with the widely used energy-efficient techniques. The simulation results demonstrate that the suggested structural design may successfully reduce the amount of data and give suitable scheduling to the cloud.

Index Terms – Task Scheduling, Cloud Computing, Energy Management, Workflow Execution Time, Resource Allocation, Load Balancing, Green Computing, Performance Optimization, QoS, Distributed Systems.

I. INTRODUCTION

Cloud computing is an expanding industry at present. The ‘‘less is more’’ philosophy, which emphasizes acquiring more services while spending less, is becoming increasingly popular. These services are based on hardware, such as the CPU or I/O, or software, such as applications. To achieve minimal average wait times and the highest resource utilization, an efficient scheduling strategy is necessary. Resource allocation is done to Virtual Machines (VMs), and techniques like Energy Management Algorithm (EMA), Priority Scheduling, Shortest Job First (RR), and First Come, First Serve (DVFS) are the energy-efficient versions of RC-GA, AMTS, and E-PAGA.

The use of scheduling techniques is prevalent in cloud computing systems, and their effectiveness has been evaluated through simulation using the cloudsim simulator. Among the investigated algorithms, it has been found that the EMA algorithm provides faster turnaround times and shorter average waiting times compared to others. Energy conservation is critical in virtualized cloud computing systems due to its impact on operating costs, system efficiency, and environmental protection. However, achieving energy efficiency while maintaining adequate performance within a user-defined timeframe is challenging.

Describe four different kinds of clouds, including private, public, hybrid, and community clouds. The cloud types and their accessibility. To meet the needs of consumers in every field, cloud computing offers a variety of service models. Infrastructure as a Service (IaaS) gives users access to a variety of virtualized computing resources, including RAM, CPU, OS, and other application software. The more sophisticated cloud computing solution is known as PaaS (Platform as a solution). System software, as well as other computing resources, are provided, run, and maintained by it. The system can be installed with greater flexibility thanks to it. Operation and upkeep of operating systems, application software, and other resources are handled through SaaS (Software as a Service). It functions as a user-application interface for web-based applications. It allows accessibility from any place with internet connectivity and eliminates concerns about infrastructure The suggested method includes two stages: the first stage assists in achieving work deadlines and cutting down on execution time without taking energy consumption into account; task redistribution scheduling chooses the least energy-intensive site for execution while staying within the deadline. Additionally, we recommend an energy-efficient mechanism for prioritizing tasks to achieve a favorable balance between energy conservation and job scheduling. The simulation findings demonstrate that in comparison to the recommended fix uses, the RC-GA, AMTS, and E-PAGA energy-efficient scheduling techniques are now in use. Aids in reducing considerable energy usage and improving performance by 5%–20% while meeting deadline constraints.

The IoT and cloud computing convergence allows for the importation of data from physical sensors utilized by various applications deployed in various scenarios and subsequent use by all apps. It is past time to lower managed data centers' enormous energy use. Discover and eliminate inefficiencies in the delivery of electric services to IT resources must be done right away. Making physical infrastructure more effective and using effective methods for managing and allocating resources can be accomplished. In the virtualized sensor cloud data center, this article focuses on managing the energy utilization of IT devices. This work is in the infrastructure of the virtualized sensor cloud. Places a strong emphasis on decreasing energy use. The pace of new technology development in the IT industry has accelerated since cloud computing was introduced. Users are growing quickly along with technology's development. While progress is accelerating, the environment is also regressing since it is deteriorating so quickly. When use rises, degradation becomes apparent but is first undetectable. At this point, research is done to reduce or eliminate the drawbacks. Similar to cloud computing, which has received an embrace from every second person in the thousands, green cloud computing has chosen to stop or decrease environmental destruction. Due to its high water, energy, and pollutant production, the computer sector is a factor in global warming. To reduce power use, the use of green computing, carbon dioxide emissions, and energy usage is being implemented. These days, the market's use of cloud computing is for a variety of reasons. It is a fantastic replacement for conventional computing and aids in the competitiveness of enterprises. A new method of managing, storing, and dispersing data is called cloud computing. In the world of technology today, it is a very popular trend. Many individuals are still unfamiliar with this technology. A list of cloud computing services will be provided, along with an explanation of what may be expected from each. The most optimum and effective Azure cloud computing methods are what we're trying to identify. Business expenses will be reduced as a result. We observed a considerable improvement in our services' effectiveness and quality of service (QoS) after making the changes to the database algorithm. By doing this, businesses may reduce costs and improve productivity.

II. RELATED WORK

A. Energy-aware job scheduling in a multi-objective production environment—An integrated DEAOWA model

Manufacturing is a major source of energy consumption and, therefore, a significant contributor to emissions and greenhouse gases. This paper is concerned with evaluating different scheduling policies in a job shop system where energy-efficient scheduling is incorporated with multiple other scheduling criteria. In the production systems being investigated, the electrical energy is offered on a time-of-use (TOU) pricing regime. The objective of minimizing TOU energy costs conflicts sharply with most other traditional objectives in production scheduling. The aim is to identify best performing scheduling rules for different scenarios based on different shop congestion levels, and devise new rules to enable an improved integration of energy cost with other scheduling criteria.

A ranking approach based on data envelopment analysis (DEA) and Ordered Weighting Average (OWA) concepts is presented. The proposed methodology exploits the preference voting system embedded under the cross-efficiency (CE) matrix to derive a collective importance scale for the aggregation process. The approach is applied to 28 dispatching rules (DRs) for scheduling jobs that arrive continuously at random points in time during the production horizon. Computational results highlight the effect of energy costs on the overall ranking of the DRs, and unveil the superiority of certain rules under multi-objective performance criteria.

B. Comparison analysis of CPU scheduling: FCFS, SJF and Round Robin

Task scheduling is needed to maintain every process that comes with a processor in parallel processing. In several conditions, not every algorithm works better on the significant problem. Sometimes FCFS algorithm is better than the other in short burst time while Round Robin is better for multiple processes in every single time. However, it cannot be predicted what process will come after. Average Waiting Time is a standard measure for giving credit to the scheduling algorithm. Several techniques have been applied to maintain the process to make the CPU performance in normal. The objective of this paper is to compare three algorithms, FCFS, SJF, and Round Robin. The target is to know which algorithm is more suitable for the certain process.

C. *Modelling of a multi-stage energy management control routine for energy demand forecasting, flexibility, and optimization of smart communities using a recurrent neural network*

This paper proposes an innovative algorithm for community energy management control, able to involve customers in energy trading by exploiting their potential energy flexibility. The main innovation relies on a matrix-based control system where the strategy considers individual and community priorities simultaneously. Through the individual energy flexibility and the community energy pool, the aggregated network energy supply is controlled and shaped. The presented model presents a generalized structure based on control volumes, and it can be universally applied to energy communities of different sizes, number of participants, energy carriers, penetration of photovoltaics, and electric vehicles. The predictive system is conceived from a recurrent neural network, which performs a real-time prediction on energy demands in buildings. Suitable energy flows optimization is also presented with different implications for economic and energy savings. Finally, to show the potential of the developed model, a suitable case study analysis is presented. Important results include the achievement of a typical win-win condition, where both the distribution system operator and final customers benefit from this strategy. Specifically, a reduction of energy demand during demand response events of about 21% is achieved, whereas the interaction with the electricity network decreases of about 15%.

III. PROPOSED METHODOLOGY

In this study, workflows are used as datasets to compare scheduling algorithms, including Shortest Job First, First Come, First Served, and Energy Management Algorithms. To facilitate comparison, the number of virtual machines in the Visual Studio .Net framework environment is used for the implementation. The experimental findings indicate that increasing the number of virtual machines reduces Makespan. Moreover, the Energy Management Algorithm outperforms Shortest Job First by 2.79% for the CyberShake process and surpasses the First Come, First Serve algorithm by 12.28%. Additionally, EMA produces 21.88% better results than both algorithms combined. For the Montage process, EMA performs 4.50% better than Shortest Job First and 25.75% superior to the First Come, First Serve policy. Finally, we ran simulations to determine the performance of the suggested mechanism and contrasted it with the widely used energy-efficient techniques. The simulation results demonstrate that the suggested structural design may successfully reduce the amount of data and give suitable scheduling to the cloud.

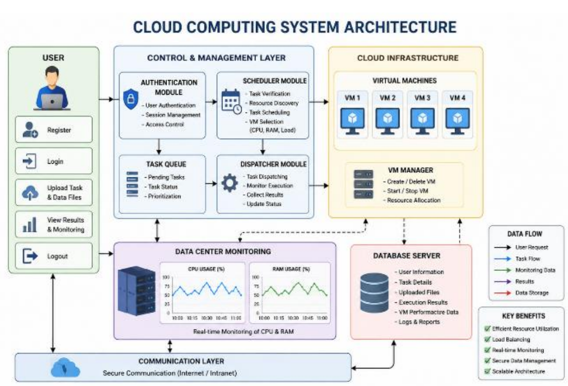
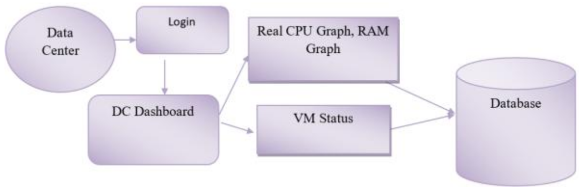


Fig. 1: System Overview

1. Data Centre

A secure login system is essential when accessing a data center from a different region. Each authorized user is provided with a unique user ID and password to ensure authenticated and protected access to the system. After successful login, the data center dashboard displays real-time monitoring information about the virtual machines (VMs). The dashboard includes a genuine CPU utilization graph that shows the current processor load and performance of each VM. This graph helps administrators identify high CPU consumption, overload conditions, or idle resources.

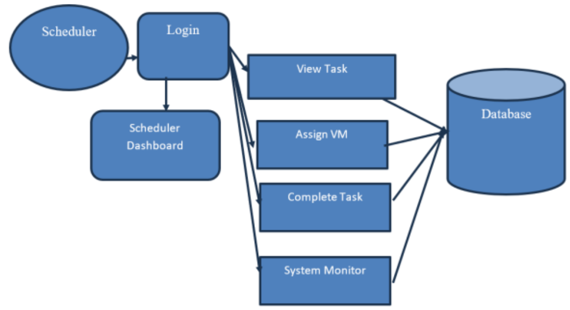
In addition, the system provides a RAM usage graph that visually represents memory allocation and consumption of virtual machines. The RAM graph helps monitor available memory, used memory, and abnormal memory spikes. Together, these graphical representations improve resource management, fault detection, and system performance analysis. Administrators can easily track the health and operational status of virtual machines in real time, ensuring efficient workload balancing, better security, and optimized cloud infrastructure management across different geographical regions.



2. Scheduler

The Scheduler module is designed to manage and allocate tasks efficiently within the cloud data center environment. To ensure secure access, the scheduler must log in using a valid user ID and password. After successful authentication, the scheduler dashboard displays all submitted tasks from users. The scheduler is responsible for assigning these tasks to one of the four available virtual machines (VMs) based on system resource availability and workload conditions.

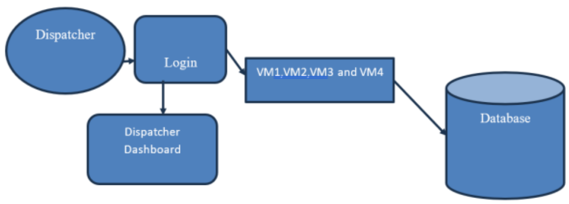
Each virtual machine operates independently and can process assigned tasks in real time. Once a task execution is completed, the scheduler updates the task status and displays the processed data or output to the user. The scheduler interface also includes a CPU and RAM system monitor that continuously tracks resource utilization of all virtual machines. The CPU monitor shows processor usage percentage, while the RAM monitor displays memory consumption and availability. These monitoring features help the scheduler balance workloads, avoid system overload, improve VM performance, and ensure efficient resource management within the cloud infrastructure.



3. Dispatcher

The Dispatcher module is responsible for monitoring and managing virtual machine activities within the cloud environment. To access the system securely, the dispatcher must log in using a valid user ID and password. After successful authentication, the dispatcher dashboard displays four available virtual machines (VMs) in the system. Each virtual machine represents an independent computing environment that processes assigned tasks and stores related execution data.

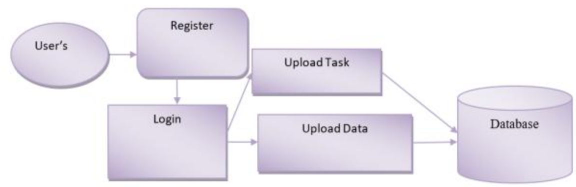
The dispatcher can select and view detailed information from each virtual machine individually. This includes task execution results, system status, workload information, CPU utilization, memory usage, and stored data associated with the VM. By monitoring each virtual machine separately, the dispatcher can analyze system performance and identify overloaded or underutilized resources. The interface helps improve task coordination and resource distribution across the cloud infrastructure. This functionality ensures efficient management of virtualized resources, enhances transparency in task execution, and supports better decision-making for maintaining balanced and reliable cloud computing operations across multiple virtual machines.



4.Users

The User module allows individuals to securely access the cloud computing system by registering with a unique user ID and password. After successful registration, the user can log in to the application using their authentication credentials. Once logged in, the user uploads a task to the system for processing. The uploaded task is then sent to the Task Scheduler, which verifies and approves the request based on resource availability and scheduling policies.

After task approval, the user can upload related data files required for execution. The system stores this uploaded data securely in the database through virtual machines (VMs). Each virtual machine acts as a processing and storage environment that manages user data efficiently. The scheduler allocates the task to an appropriate VM depending on CPU usage, RAM availability, and workload conditions. This process ensures balanced resource utilization and reliable task execution. The complete workflow improves security, data management, cloud performance, and efficient handling of user tasks within the virtualized cloud infrastructure environment.



IV. EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results demonstrated that the energy-aware scheduling algorithm effectively allocated tasks to cloud resources while minimizing overall workflow completion time and reducing power consumption in data centers.

The analysis showed that the proposed approach achieved lower execution time and improved resource utilization compared to conventional scheduling algorithms such as First Come First Serve (FCFS) and Round Robin scheduling methods. Furthermore, the energy management strategy optimized workload distribution across virtual machines, reducing idle resource time and improving system throughput.

Fig. 2: Data

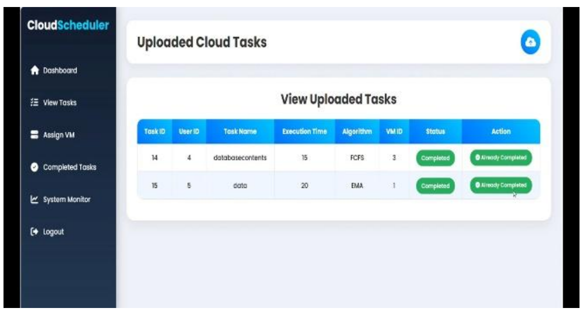


Fig. 3: View Uploaded Tasks

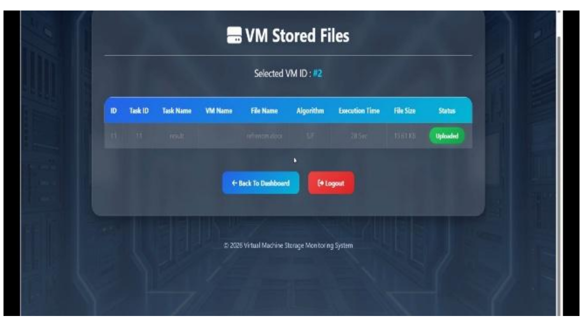


Fig. 4: View Stored Files

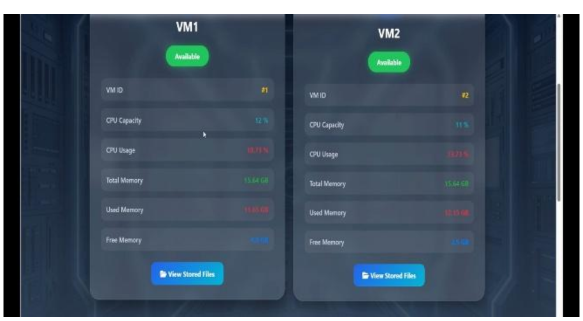


Fig. 5: Available Data

V. CONCLUSION

In this study, we compared scheduling methods, including DVFS, Shortest Job First, and the Energy Management Algorithm (EMA) based on Makespan. CyberShake and Montage workflows are used to run the algorithms in the Visual Studio Net framework. The results are calculated by increasing the number of virtual machines (VMs) from (5 to 15) and then running the chosen algorithms for both processes to find the most effective technique for makespan optimization. The results of the experiment demonstrated that EMA performed well for the CyberShake process because of its parallelism and also because of the way it performs tasks, which decreases the Makespan by performing the tasks as they come in. Energy Management Algorithm (EMA) surpassed Shortest Job First by 2.79%, first come, first serve by 12.28%, and produced 21.88% better outcomes. Due to the pipeline layout of the Montage workflow, EMA has worked successfully for this workflow. EMA runs tiny tasks concurrently while doing the shortest task on the quickest machine. EMA outperformed DVFS by

25.73%, Shortest Job First by 17.73%, and both algorithms by 4.50%.

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