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Energy Aware Resource Scheduling in Multi Cloud Data Centres Using Renewable Integration and Workload Classification

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Abstract--- The exponential growth of pall computing has resulted in a significant to increase in energy as consumed and carbon emigrations in data centers. The conventional resource scheduling approaches primarily to optimize performance and cost, with limited consideration for energy both effectiveness and sustainability. This paper proposes an energy-apprehensive resource scheduling frame formulate-cloud data center surroundings that integrates the renewable energy sources and workload bracket way. The proposed model classifies incoming workloads grounded on resource characteristics and Quality of Service (QoS) conditions, to enabling the effective allocation of computational coffers. In order to resemblance and the framework incorporates real time monitoring of renewable energy vacuity, and similar to solar and wind, across geographically distributed pall architectures.

Keywords--Energy Aware Scheduling, Multi Cloud Computing, Renewable Energy, workload Classification, Green Data Centers Allocation

I. INTRODUCTION

Pall computing has surfaced as a dominant paradigm for delivering scalable and on- demand computing coffers over the internet. still this growth has also replied in a substantial increase in energy consumption that making data centers one of the major contributors to global carbon emigrations. As a result perfecting energy effectiveness in pall data centers that has come a critical exploration challenge. Accordingly, there's a growing need for energy alive scheduling strategies that can reduce power operation without slighting system performance. The integration of renewable energy sources, similar as solar and wind, into data center operations has surfaced as a promising result to addresses sustainability Concern. still the intermittent and position-dependent nature of renewable energy introduces new challenges in workload operation and resource allocation. In this terrain the multi-pall surroundings where multiple geographically distributed pall providers are employed — offer an occasion to roundly shift workloads to locales with advanced vacuity of renewable energy. In addition to workload type plays a vital part in perfecting scheduling effectiveness.

By grading tasks rested on their resource conditions and time perceptivity, similar as CPU-ferocious, memory-ferocious, or quiescence-critical workloads, the system will make further informed scheduling opinions.

This paper proposes an energy alive that resource scheduling frame formulti- pall data centers that integrates the renewable energy vacuity with further workload type. The ideal is to minimize the overall energy consumption with carbon footmark while maintaining QoS conditions

II. LITERATURE REVIEW

Energy-effective resource operation in pall data centers has been extensively studied due to the adding demand in sustainable computing. Early work in this sphere concentrated on energy apprehensive scheduling and dynamic resource allocation. Beloglazov et al. introduced energy-effective resource operation ways using virtual machine connection, which reduces power consumption by stoutly migrating the workloads and turning off idle waiters. also, Buyya et al. proposed request- acquainted in pall computing models that consider both the cost and energy effectiveness in resource provisioning. While these approaches the enhancement throughout energy application they primarily calculate on traditional power sources and don't incorporate the renewable energy integration. Zhang et al. proposed a green data center frame leverages solar and wind energy to power computing coffers. developed energy with apprehensive of scheduling algorithms that acclimatize to workload distribution grounded on real- time renewable energy vacuity. The concept of multi-cloud surroundings is also gained attention in recent times. Multi-cloud strategies allowing workload distribution across geographically distributed data centers to perfect trustability and performance. exploration by Grozev and Buyya demonstrated that the multi pall resource provisioning can be optimize both the cost and vacuity. still the most livingmulti-cloud scheduling ways do n't explicitly consider the energy effectiveness or renewable energy application with some impact.

Another important aspect in optimizing pall performance is workload bracket. and others will show that classifying workloads grounded on their characteristics similar as CPU-ferocious, memory- ferocious, and quiescence-sensitive systems can allocate the coffers more effectively and reduce the gratuitous energy consumption. utmost being results may be address these aspects singly, leading to sour performance in terms of energy effectiveness and sustainability

III. WORKLOAD CLASSIFICATION

Sharma et al. (2024) cluster Google Cloud trace jobs (attributes: CPU, memory, duration) using unsupervised ML (K-Means with elbow method, spectral/hierarchical clustering). They find clusters by resource profile, suggesting that “energy-efficient workflow management should be performed prior to load delivery”. The ArXiv (2026) study above also classifies big-data jobs by resource dominance (CPU vs I/O) to guide VM placement. Older work by Sumbaly et al. (2011) and others show that telemetry and semantics improve scheduling; these motivate modern data-driven profiling.

IV. METHODOLOGY

The proposed exploration presents an energy-apprehensive resource scheduling frame formulti-cloud data centers by integrating renewable energy vacuity with workload bracket ways. Contemporaneously, the system continuously monitors the energy status of each data center, including the vacuity of renewable energy, current energy consumption, and resource application situations. Themulti-cloud terrain enables the aggregation of coffers from different data centers into a unified pool, allowing workloads to be stoutly distributed grounded on energy effectiveness considerations. Priority is given to data centers with advanced renewable energy vacuity to reduce dependence onnon-renewable sources. also, the frame supports dynamic workload migration to acclimatize to changes in energy vacuity and system cargo

V. SYSTEM ARCHITECTURE

The proposed system architecture consists of multiple interconnected modules designed to support energy-aware scheduling in a multi-cloud environment. At the top layer, users must submit their workloads to the system, which are first processed by the workload manager.

This module is responsible for collecting and analyzing incoming tasks and forwarding them to the workload classification unit sector. The classification module will categorize tasks based on their computational needs, such as workloads that require a lot of CPU power, those that use a lot of memory, or those that are sensitive to latency.

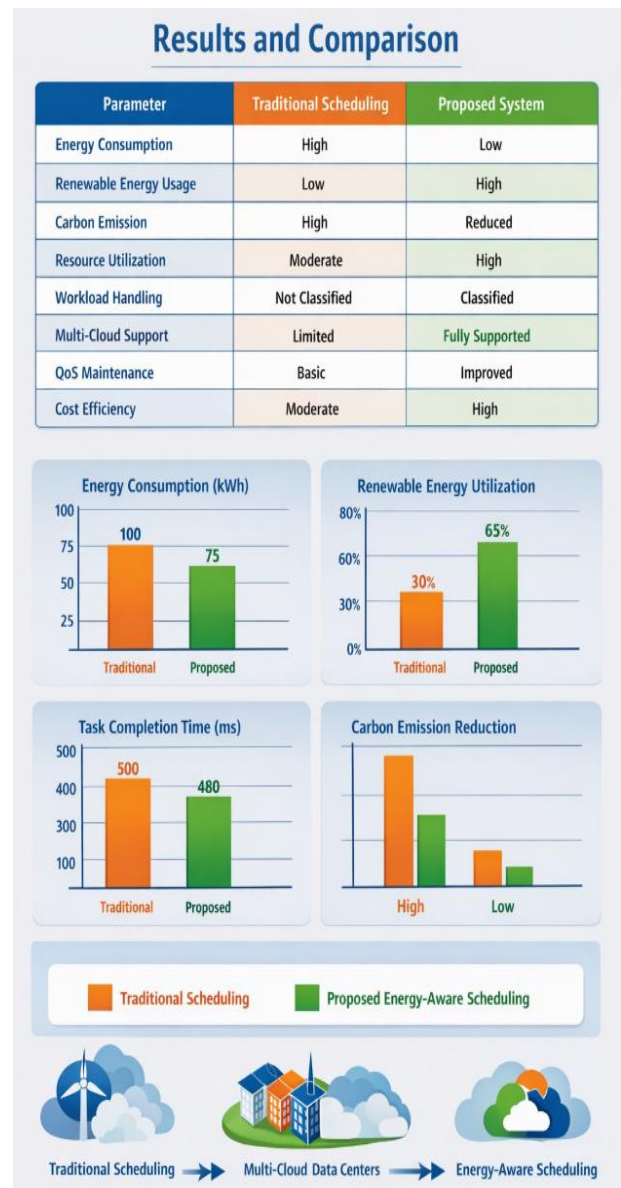


TABLE I
Graph pointers

Metric	Traditional System	Proposed System
Energy Consumption (kWh)	100	75
Renewable Energy Usage (%)	30	65
Task Completion Time (ms)	500	480
Carbon Emission (kg CO ₂)	50	30
Resource Utilization (%)	60	85
Operational Cost (\$)	200	150

VI. RESULTS AND DISCUSSION

The proposed energy aware resource scheduling framework was evaluated using the simulation based analysis to measure its effectiveness in optimizing energy with consumption and improving renewable energy utilization in multi-cloud data centers. The system performance was analyzed by comparing it with traditional scheduling approaches that do not consider renewable energy integration or workload classification.

The experimental evaluation also shows an increase in renewable energy utilization and a noticeable reduction in carbon emissions compared to conventional methods. Furthermore, the proposed system maintains acceptable Quality of Service (QoS) levels, including response time and task completion time, thereby ensuring that performance is not compromised while achieving energy efficiency.

TABLE II
Comparison of existing vs proposed systems

Parameter	Traditional Scheduling	Proposed System
Energy Consumption	High	Low
Renewable Energy Usage	Low	High
Carbon Emission	High	Reduced
Resource Utilization	Moderate	High
Workload Handling	Not classified	Classified
Scheduling Efficiency	Basic	Intelligent
Multi-Cloud Support	Limited	Fully Supported
QoS Maintenance	Yes	Yes (Improved)
Cost Efficiency	Moderate	High

VII. FUTURE WORK

In this work, we focused on solving one of the major problems in cloud computing, which is high energy consumption in data centers. Instead of only concentrating on performance, our approach ties up with the system more environmentally friendly by using renewable energy sources like solar and wind. We introduced a smart scheduling method that not only looks at available in resources but also considers how much green energy is available at different data centers. By classifying workloads based on their requirements, the system is able to make better decisions about where to run each task. This helps in reducing unwanted energy usage and improves overall management structure. The use of multiple cloud data centers also gives flexibility, allowing workloads to be shifted to places where energy can be used more effectively. From the results, it is clear that the proposed system can reduce energy consumption, increase the use of renewable energy, and still maintain good performance. Overall, this approach moves cloud computing towards a more sustainable and cost-effective future while ensuring that user requirements are still met

VIII. CONCLUSION

In this work, we focused on solving one of the major problems in cloud computing, which is high energy consumption in data centers. Instead of only concentrating on performance, our approach ties up with the system more environmentally as usual as friendly by using renewable energy sources like solar and wind. We introduced a smart scheduling method that not only looks at available in resources but also considers how much green energy is available at different data centers. From the results, it is clear that the proposed system can reduce energy consumption, increase the use of renewable energy, and still maintain good performance. Overall, this approach moves cloud computing towards a more sustainable and cost-effective future while ensuring that user requirements are still met.

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