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CloudVM: Evolution of Data Centers and Virtual Machine Technology

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Abstract:- With the growing demand for computing power, datacenters have witnessed a notable surge in energy consumption, heat dissipation, and server temperatures. This surge is largely attributed to the increased computational requirements of user workloads. This paper delves into diverse facets in the realm of cloud computing, the objective is to achieve thorough oversight and control over cloud resources. in a manner that is energy-efficient, dependable, and sustainable. It highlights various opportunities, acknowledges research hurdles, and outlines potential in new changes.

Keywords: Migration, Consolidation, Green Cloud, Cloud computing, Workload, Energy Utilization, Service Level Agreements, Energy Efficiency.

1. Introduction

It resulted in the existence of a pay-per-use service that ranges from infrastructure to platform and software services, which lets an organization reduce its data center footprint. The distributive computed technology has resulted in the banding of big server hubs accommodating vast computer types. Yet, these data centers warehouses don't only expend the massive volumes of electrical energy but also release the amounts of CO2 into the atmosphere. Existing literature highlights two crucial areas for energy conservation: maximizing computing processes and maintaining cool spirits. This comprises of load balancing, power savings, and the placement of virtual machines all strategized in a way where the energy consumption will be minimized. Furthermore, different methods of cooling and waste heat dissipation make the physical machines get their thermal management enhance.

A substantial portion of that expenses within data centers is attributed in primary field: cooling and computing are the most energy intensity services of data centers hence the most significant inherent environmental impacts. The servers which control the data consumption are powered by a major portion of the energy that is needed. The reduction of energy costs and the Carbon footprint is the requirement that had sourced the energy conservation demand. This further enhances the research of the ways to decrease power utilization in distributed computing but maintains high computation speed. High server density and power utilization as well, it's true that cooling needs get more and that temperature rises withing server farms can be noticed a lot. Heating conditions are damaging to server farm utilization as a number of factors observe the situation such as less reliability and effectiveness of the system. This means that the paper has succeeded in bringing about an adequate and informative opening chapter on power-saving ideas. Also, it is worth noting that compared to the high usage of the CPU, GPU, and storage, usefulness of the rest of the data center assets is frequently only around 30 percent. This further emphasizes the exploratory nature of task allocation as it concerns energy saving. Moreover, a considerable share of the power running in cloud computing is dissipated as machines are shifting their locations. Clouds servers running in the environment are facing an increasing power demand, as their number and size of data centers grow, this issue has become one of the major sources of concern from the environment. The ever growing number of data centers and the rapidly increasing needs of those energy-intensive operations bring to the fore the exact necessity to review carefully the energy input.

Broadly speaking, strategies for enhancing energy efficiency applied to several key fields: Network, Memory, Storage, and Servers as types of resources to keep in mind. Virtualization, Clustering, Scaling, and Dynamic Voltage Frequency Scaling offer the possibility to leverage the substantial power usage of servers better and save energy. In terms of the networking network, the strategy for saving energy include 1) shutting down systems when they are not in the operation mode, 2) put system components into sleep mode mode, and 3) route the network traffic only when it is needed. Energy saving measures in virtual network include 1) directing the virtual network traffic to particular physical network devices and 2) invoking the virtual network only when there is actual physical Moreover, keeping the effective cooling system is another vital thing in which the techniques and methodologies of raised flooring is used that conveys the warming air into cooler air by releasing the heat to the environment around outside the premises.

2. Literature Review

Sukhpal Singh Gill et al. [3] propose BULLET as a particle swarm optimization-rescheduling technique for the cloud environments. IT collects the jobs in an equalized manner compressing these to a single workload and optimizing Quality of Service (QoS) parameters such as cost, execution time, and energy consumption. Research findings confirm that BULLET is the most efficient model to be deployed in cloud environment by saving resources and improving overall performance.

Ching Hsu et al. [5] proposed reduces energy consumption by consolidating tasks in cloud computing. Lowering CPU intensive workloads and taking into account network latency, ETC results in the power block reduction of up to 17% in comparison with the Maxutil algorithm, as simulation shows. It answers the question of how to strike the balance between the amount of resources used and the amount electricity used in the cloud.

Inderveer et al.[6] systematically going through the cloud resource scheduling literature by more than 100 articles. This survey categorizes the scheduling of resources as algorithms, techniques and policies for distribution which helps researchers to make selection of the most appropriate algorithms for a specific workload. Further research pathways are to be considered which are also critical when it comes to implementing developments in cloud resource management.

Dzmitry et al. [7] provide introduction for an energy-aware cloud computing data center simulator employing details on the last energy consumption and the patterns of communication sing in every stage. Through the simulator, it is possible to measure the efficacy of the power system in use by applying various systems management techniques, for example, controlling the voltage and frequency. If we use different architectures, we shall be able to measure their performance and offer a comparison of them as well. The outputs of this tool show the relevance of it for dealing with soaring operations costs and providing higher energy efficiency of the cloud environment.

Sukhpal Singh Gill et al.[9] and other authors presented an SOCCER, a resource scheduling system with added energy-efficiency characteristics based on autonomic cloud system. SOCCER Vill apply the energy as a Quality of Service metrics, which improves energy efficiency of cloud resources and is equivalent to energy saving and mitigating C02 footprints. Obtained results prove performance supremacy of that approach in real cloud surroundings, demonstrating minimum energy consumption and optimum resource utilization.

Rajkumar et al. [10] offer the hierarchy of sustainable cloud computing that the current approaches are associated to like energy management or capacity planning. As a conclusion, a sustainable cloud computing conceptual model is proffered, whereby directions of future researches on these cloud services vital challenges are reflected. This strategy is aimed at containing the cost and carbon footprint implications that the increasing use of cloud data centers as been throwing to the country.

Yousri et al.[12] develop a VM scheduling system to balance energy consumption among virtual machines as well as to ensure that temperatures are uniformly distributed in Cloud Computing. As an example, during VM migration, the proposed mechanism is geared at perfect host utilization up to the limits of physical hosts temperatures that have been verified in two instances by CloudSim. This approach would take up to the mark the growing debates on energy efficiency of the Cloud data center.

Bindu et al. [14] undertake a statistical study on various job scheduling techniques for workstations in cloud computing scenarios. In the paper argument is presentation of diverse ways of load balancing and scheduling virtual machines and solutions of the problem of resource allocation question in cloud platforms. This in-depth research is going to contribute to the explanatory provision of the means and methods for efficient cloud-based services rendering.

Aruzhan et al. [15] and her coworkers are of opinion the requirement of "Greening" data centers to reduce the energy use. The situation where data centers are being over-provisioned is an illustration of the problem of inadequate resource allocation as resources are being exploited mere 30% of their potential, capacity is only 30%. Their review looks into green strategies such as efficient use of both infrastructure and resources in addition to addressing sustainability in data center practices.

Ehsan et al. [16] proposes an energy efficient way for optimizing power and thermal system designs in datacenters. A two-way strategy of workload forecasting and runtime policies has been developed in which each one balances power usage with high and temperature thresholds. The experimental outcomes underline the approach applicability in doing datacenter-wide energy efficient supplying through server consolidation and cooling well.

Eduardo et al. [25] offers a power efficiency technique for the processing of workstation clusters, switching off nodes at full capacity. The algorithm, implemented on both application and operating system levels, is robust enough to take care of peak load and think about power implications, and thus improves the energy efficiency by a big degree. Appropriate results indicate that their systems are more environmentally friendly in comparison with the outmoded approaches. The energy efficiency by a big degree.

3. Present State

A. Present state of cloud computing

To illustrate the current process flow and show the integration of new way with cloud computing which is in the reduction of power Utilization, Fig. 1 shows the procedure as a progression flow chart. This segment looks into the historical evolution of the energy related research progress refuting the factual elements of Focus (of the above) and Quality of the (Above) Service. Besides those diverse algorithms, the cloud computing environment has been made more ordered and QoS metrics such as usability, responsiveness, performance, etc. have been enhanced.

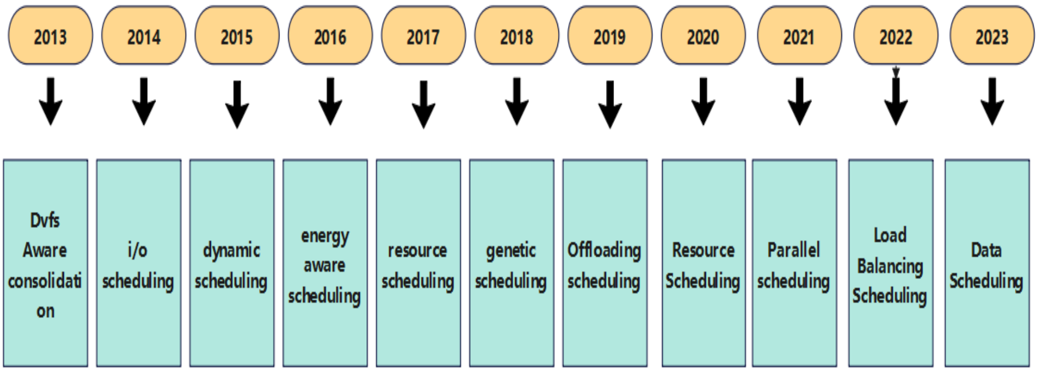

Fig.1 Evolution of Energy Efficiency

One of the most important power saving functions of voltage increase recurrence planning is Energy maximization that need to be considered. It is putting in place a settled effort to ensure that manpower is only used under certain circumstances. Mainly, by changing the scheduling algorithms of computing devices that lead to better utilization of resources by both - tasks and - energy saving if platforms need not to be powered[15].

The integration of workload scheduling and DVFS may be through two major directions that are workload scheduling and deadlines. At workload scheduling, processors powered with DVFS capabilities are scheduled for rerun on these processors and will be globally optimal in the sense of the workload energy consumption and given deadlines. [16] It determines how much resource is allocated to a task for decision-making process after the scheduling algorithm has accessed. The technique implements the DVFS functions which restricts the power consumption of a task from the schedule made by another scheduler.

In 2012, a study revealed the secret behind generating a smart VM migration algorithm team with the ultimate objective of minimizing power consumption and carbon emission done by R kathikeyan et al.[11].

In 2013, came together with an efficient migration algorithm and a management scheme consist of dynamic resources that are perfectly integrated with dynamic voltages frequency scaling and server consolidation. In this method, energy efficiency is the primary objective, and it is achieved by connecting incoming jobs to their application managers, also known as schedulers, and then using dispatching orders to control their paths. Consequently, loads are shifted to virtual machines using the round-robin round robin method with the aim of not only reducing carbon emissions and energy consumption, but maximizing energy efficiency done by yongqiang et al.[23]

In 2014 , set as a project to increase the energy productivity of data-intensive workflow execution in virtualized data centers, It is divided into two parts: the first one is replacing the old random virtual machine deployment scheme with the new active one, and the last one is the new logic of enterprise scheduling based on energy efficiency It adopts computations and an algorithm paying attention to both the accuracy rate and the energy use level done by Xiao et al.[24]

In 2015, energy efficiency and performance of VMs is much more important than migrating them. Moving VMs to different physical servers must be avoided. This is usually resorted to for repairing purposes, redeployment of VMs and discontinuance of unused nodes through migration. The aim is to avoid people just intrude into neighboring cells indiscriminately, a load prediction algorithm will be put forward to look into every case of migration necessity. After that comes choosing a host whose future external load is expectedly what is needed in some cases. A simulation where real-world workload traces are used in CloudSim that shows that the proposed algorithms decrease VMs movements and SLA target achievements nearly two times done by Shaw et al.[1].

In 2016, EATS model, a model that is specifically designed to work in Cloud environments and monitor power consumption, comes to light which concentrates on enhancing applications efficiency while saving energy. The validation of speed model is by experiments done that measure electricity consumption by servers under varying conditions of different kinds of workload. Data demonstrate that power consumption during the performance load is twice more than the idle state, which underlines the need for proficient performance resource governing without the decrease of performance. Thus, the approach proposed presented prove to be good demonstration. Therefore, Cloud vendors should adopt the solution which has been shown to lead to reduced energy consumption of data centers done by liela et al.[2].

In 2017, however, builds energy- conscious autonomic resource management system for cloud which depends on fuzzy logic-based scheduling system for achieving better energy performance from data centers. The assessment techniques follows then through scenario by simulations using CloudSim as well as in the real cloud environment. The proposed framework is more efficient in terms of resources usage, energy consumption than current techniques. The framework also maintains supreme value in other QoS parameters done by Singh et al.[8]

In 2018, the goal of the model anytime was to have dynamic workload scheduling mechanism working in the environment of cloud computing to make the power utilization a lot lower. tools usage and make the right timetable using an adaptive algorithm genetic programming is possible as well. This algorithm, instead, would decide and design the schedule for task allocation based on the situation not programmatically. The algorithms must first analyze the task submission list and create a similar order, based on both the required and available capacities that the resources capable of running each task possess done by Huda et al.[4].

In 2019, Milon Biswas et al [33] Execution Offloading is an example, which is done by moving the routines from the mobile devices to inaccessible cloud servers in order to accomplish efficiency. This is done either by moving or pushing it, which is supposed to address whether it is executed quicker or later and unfastens data using the advanced unjamming process.

In 2020, Davide Taibi et al [34] It is more about the efficiency of this technology and identifying best practices and design of the systems which will maximize its potential. Kick-starting the process, companies have been adapting their current practices and architectures from the set of existing advances like microservices and web services to fit the serverless context. In spite of this, as serverless computing evolves communication using blocks is becoming more commonplace.

In 2021,Maryam Shabbir et al [35] discern the need to provide security at all the levels, national, regional, and local for the smooth delivery of the health services. By focusing on demand-roll based security practices, it tries to avoid security breaches and vulnerabilities

In 2022, Tahir Alyas et al. [36] proposes things pertaining to stack insertions and deletions on database level. The differential requirements of sizes of companies across the progressive implementing of cloud database companies gives a priority to optimizing stack adjustment realize at this level for application development and business operations.

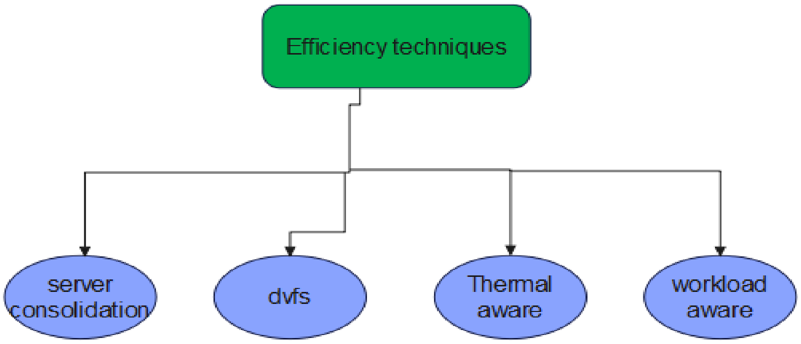

Fig.2. Energy consumption

In 2023, et al. [37] describe the integration process that would facilitate the implementation of the new cloud-based IoT ecosystem. The author emphasize the challenges, benefits, and engineering of the transformation. With the powerful devices of Cloud's provides, the IoT devices can enhance their functional capability and the cloud can leverage on the real-world assets connected to it in the network. In addition, it also discusses the potential innovative scenarios made possible by the integration of this resource and subsequently considers future selections of research topics to explore.

Gopala et al.[38] links AI-based Manufactured Insights (AIMI) and Cloud Computing issues which indicate mutualization or cloudification of business operations. AI has the super power of Machine Learning integrated from time to time.

For example, another typology of the techniques can be classified depending on the framework of many. The major size of the proposed scheduling algorithms is to node down the average energy consumption in the cloud center, but some of them are the better way to keep the working temperature of the physical host become so low. Further, a subsection of strategies are developed to negotiate the power of the head office, as shown in fig. 2.

4. Cloud Unified Server

Pooling workloads is the process of gradually blending two or more virtual machines onto a larger single physical machine, through this energy efficient virtualization process workloads are placed on a reduced number of physical machines and the rest of the machines are deactivated. Which these have been optimized to conserve energy, lighter platforms that can operate and run on a smallest possible physical systems available. Before the development of the technology, only the 'old-school' version were in use, where large VMs were physically transferred manually on to one specific physical server. While, It allows increasing or decreasing the number of physical hardware by as much as workload grows through the Cloud. By this method periodic load balancing arrangement is promoted across the hosts having either more or just standard jobs. It works on the key issue of identifying the unused and overburdened VMs within the data centers, then decide of the appropriate VMs to migrate, selecting the slots for migration and picking the proper locations to move them.

Migration can typically occur in two ways: the move "from one place to another" and the "gentle migration". That primary strategy way of doing the machine transfer is sending it from one system to the other that suspends primarily used machine and resume it on the destination server while duplicating its memory contents from the exclusively used one that has been already shifted. The second strategy does the same job without disrupting the operation of the server concurrently. Using that introduction, they created the structure concentrated on decision-making about machine virtualization. The presented Framework contained MAUD Virtual Machine placement policy as a core component. This policy essentially runs as a Virtual Machine placement application, given a host and Virtual Machine relocation task as inputs. The algorithm which effectively deals with these load balancing issues by devising a plan to optimize energy consumption involving the consideration of how host resources are used after accepting a request for a virtual machine as well as the data center's average occupation level.

Chun et al. [21] propose a hybrid server farm strategy composed of various servers that are in focus of the power consumption, and the optimization, best result can be achieved. In periods of underutilization when high-performance servers are not employed at full rate and demanding for workload shifts are not required the method entails distributing the workload from high-performance to old-fashioned servers.

R buyya et al. [31] explores the weight of migrating virtual machines application to the same virtual center. Interestingly, live migration provides an advantage of modern system architecture such as fail-over capability and manageability. Despite these benefits, the procedure could make downtime of services worse during the migration process. The approach focus on empirical study and concludes migration's positive impact on a performance increment. However, the researches prompt users and developers to be cautious when using migrating Upgrades in reserved applications that have strict SLAs. The study showed undeniable worth of these obstacles as well suggesting the big room for live migration in data centers storing internet application.

J Kaplan et al. [29] is right to say that while the main thing of the data center managers was always to ensure stability and cybersafety, there is a need to address the problem of inefficiency and high expenses now. a more globalized practice for data center resource consumption aimed at achieving mitigated CO2 emissions and reduced energy consumption.

A.D joseph et al. [28] state, cloud computing future will be here with us and grain on developers' approaches while as well. Whilst it is indeed abstractive what cloud vendors, like EC2, offer, the notion of customization and of resources you control should be at the very core of how we use these services.

A. Energy Effectiveness

Dvfs the process of setting different frequencies as well as power configurations for the tested devices, differs from Wfi in that it allows for assigning the required proportion of supplies for the given task and maximum power saving during the device's inactivity period. It is, however, the reactive energy usage method that is applied to maintain the usage of energy. Energy conservation by DVFS may be considered an onset of the clock frequency reduction of the processors consequently resulting in the provided voltage reduction. Often this approach is employed in the physical host machines with the additional virtual machines plus in the contradiction to algorithms or energy-saving mechanism which is aimed at decreasing the energy consumption. Getting a hold of the critical elements that surround the patterns can actually help in increasing the usage. It can be achieved by raising the rate of adoption of cloud evaluated services.

VFS in a more efficient manner, governs the consumption of power for multiple system components, multicore processors and RAM of the system. Workload planning can be integrated with its help the two primary methods can be slack recovery and the other one can be workload scheduling, Workload scheduling means arranging tasks on it. By using it, in an energy efficient way we can schedule a processor that can factor in both time constraint and energy usage as well. The slack scheduling technique implemented in a way after the completion of the task's processing algorithms that follow scheduling algorithms function as a form of the leeway to the time utilized by task in a schedule created by different or unknown scheduler.

This which implications of associating energy demand and generation are the main focus. Besides that, the setting up an algorithm which emphasizes frequency of moving cloud tasks was successfully made by them. It allows to combine tasks and result in restriction of the number of the hosts being run.

By doing this, a two-minute call to a friend over the internet that consumes close to 200 MW instead of monitoring his needs, the utility could have cut his electricity bills by as much as 28%. Moreover, the simple approach of individual server nodes implementation of dynamic voltage scaling is as comparable as even the most complex methods for specific workloads. Another technique taking into account the fact that the nodes reach peak or trough performance that correspond to workload.

This We will be highly dealing with the power usage dilemma by coding Dvfs\Algorithm Heuristic algorithm which is able to schedule tasks. In the starting stage they find the sort of task elongation and duration limitation and monitor the whole process using the method of the HEFT algorithm. The tool calculations follow: energy consumption identification of stand by processors, followed by reclaiming slack time and tasks distribution on to those processors is the done part. Through studied by Sharma et al. [18] a created to enable the system responding wherever on power restriction with a continuous mechanism. The algorithm employed in this real-time monitoring provides the assessment of frequency and voltage to keep usage as low as can be on the server side.

The calibration is a part of the Linux kernel for processors equipped if DVFS (Dynamic Voltage and Frequency Scaling) and it is at the same time provides support to the Service Level Agreements (SLA).Agreements

Unlike Chen et al.[32], who study with the vital considerations about the large electricity consumption of data centers by reducing its power consumption but maintaining quality of service, In order to provision green cloud service, GreenCloud architecture proposes features such as live virtual machine migration, real time monitoring and optimizing of virtual machine setup which together are aimed to achieve a goal.

A live-action on-line game experiment equivalent to a multidisciplinary cloud system use scenario, showed energy savings of up to 27% compared to the GreenCloud architecture.

B. Thermal Scheduling

The temperature of physical servers is used to trigger cooling processes; as a result, workload allocation is modified to improve the energy efficiency and minimize cooling expenses. This method would actually have two objectives: one is to cut down the server temperature average, and the other one is the reduction of cooling costs. At workload scheduling stage/phase, the operating system decides the server for the implementation of the specific/substantial workload that has been selected for implementation based on server environment history. Thermal-aware scheduling can be used to prevent headquarter locations becoming uninteresting and inaccuracy issues from such situations. There are lots of ways to track server environment for shorter or longer time spans .

Awareness arranging is conducted through thermal-aware monitoring and profiling. Along with that, focusing on details is important because thermal aware monitoring is a way of tracking component that deals with observing and analyzing the heat originating from data centers. Thermal-aware arrangements can be implemented through three strategies: also including pre-emptive, mixed-mode, reactive, while thermal profiling involves the definition of servers, microchips, and computational activities with the heat data. In the preventive mood, setup of altitude adaption arrangements exists for long former thermal anomalies arises In the reactive angle, loading schedules arrangements takes place following thermal anomalies develops.

It represents the heat profiles and forecasts data across the data center in order to distribute its workload in the same way, with the aim of minimizing the general heat intensity. [17] Chen used a virtual machine management platform that moves workloads as a response to thermal condition, moving tasks from overheated physical machines to ones operating on regular conditions, with an eye on temperature and resources utilization. Adopt a power saving strategy to sustain the capacity of computing that keeps thermals considered alongside criteria such heating and relocation duration are employed in the selection of virtual machinery and load processing during allocation.[13] Moore proposed two workload placement schemes, one is minimizing-heat- recirculation and the other one is zone-based discretization. The first one observes on the heat spots of the data center to perform a comprehensive management, while the second one acts on the minimization the heat recirculation and the improvement of server utilization rate by utilizing the cooling units effectively.

Table 1. Different aspects of management

S.no	Management aspect	Environment	SLA Agreement	Scope	Algorithm	Thermal efficient
1	Data scheduling	Dynamic	Yes	Server	Adaptive Genetic Algorithm	Low
2	Load balancing	Dynamic	Yes	Server, Storage	Adaptive Algorithm	High
3	Workload aware scheduling	Dynamic	no	Server, Storage, Network	Adaptive Genetic Algorithm	Low
4	Energy aware scheduling	Homogenous	Yes	Server	Scheduler	Low
5	Resource scheduling	Homogenous	Yes	Network, Server Storage	Dynamic algorithm	High
6	Dvfs aware scheduling	Dynamic	Yes	Server	Dynamic consolidation algorithm	Low

The composition of the table below contains of different planned arrangements able to respond to different conditions of nature and service performance expectation. Different methodology using particular pros algorithms is optimizing the resource exploitation and performance outcomes while considering parameters like energy efficiency (thermal efficiency) and the ability to adjust quickly for varying workloads.as shown in Table 1.

5. Conclusion

In this research, the problem of energy conservation in cloud computing environment was examined, and energy-conscious algorithm used in cloud data centers was treated as the core part of the research. Topics most often featured on research proposals are energy efficiency strategies for servers. The power concerns on high costs and carbon emissions come as a result of the focus on the environment in cloud computing. Over time, researchers will design specialized methods to provide higher power levels, but this will still have to be done while committing to fulfil service level agreements (SLAs). The project dimension emphasizes the energy coherent approaches in the cloud computing which are crucial for sensitive application of the practical means for energy coherent sensibility in data centers. To do this, next step is combining the aforementioned techniques in a manner that would lead to optimized energy savings in the end. This chapter as such makes attempt to find an in-depth study and solution of energy efficiency in cloud computing, and in turn answer the challenges presented by high power consumption, thermal conduction, and server cooling. Besides, it conveys that there is justification the development of the energy saving appliances in data centers, the immediate need to the energy saving technologies efficiency. Different ideas applied toward energy efficiency are included which are job allocation schemes, thermal aware scheduling, cooling systems and workload scheduling among others. The article presents this topic and shows important research efforts -server consolidations, Dynamic Voltage Frequency Scaling and thermal-aware virtual machine relocations. These are some of the notable ideas that call for strategies such as resource management in which these environments can achieve the objectives of energy efficiency, reliability, as well as sustainability.

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