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Energy Aware Green Computing Model for Data Centers

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Abstract

*Cloud computing is widely used era providing ITservices for 24*7. In IT service business expansion the data centers are playing a vital role. As business demands are expanding the data centers usage are increased. The energy consumption by these centers is focus for many research studies. The impact of energy consumption is affecting environment with carbon emission. The increase in temperature is another issue caused by Data centers. The energy management should be conducted properly with some techniques to reduce energy consumption. Green computing technologies will definitely support to step in reduction of energy consumption. Green cloud computing is the solution for the negative impacts of energy consumption and carbon emission.*

Keywords: *Green cloud computing, energy efficiency in Data Centers, Virtual Machine (VM), consolidation, Carbon Emission etc*

INTRODUCTION

Data centers have become a center of attraction because of its energy consumption and because of following factors (i) high expensive, (ii) environmental changes, and (iii) providing business application services. The growing IT sector, expanding businesses and overall digitization, popularity of E-commerce services, needs data center's to provide the processing power, memory spaces and computing infrastructure. Cloud computing is widely used technology to provide Iass, Pass, Saas services, Data center is the backbone for provision of these services. Many critical applications like banking services, Ecommerce are mostly depend on these data centers. Data centers provide geographically located at different places data base servers holding critical and important data to be available in case of any disasters. As well as data centers are providing services at run time, like providing necessary processing power, physical severs as a infrastructure, virtual machine instances, memory space. For this on demand service provision the data centers are running number of servers which are idle hosts most of the time. Due to these reasons there is large scale consumption of power, affecting environment due to increase in temperature. Energy efficiency of the data centers should be addressed, to solve the issues regarding high economic and negative impacts on environment. Thereare various technologies to achieve energy efficiency in data centers. Considering DVFS policy, resource utilization, job scheduling, prioritizing jobs, virtual machine allocations can help to form the green data centers.

The energy consumed by a data center can be broadly categorized into two parts: energy use by IT equipment (e.g., servers, networks, storage, etc.) and usage by infrastructure facilities (e.g., cooling and power conditioning systems) [8].

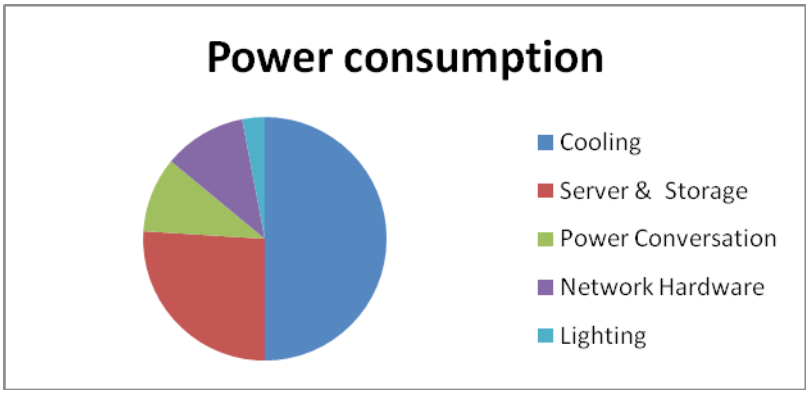


Fig: 1.*A breakdown of energy consumption by different components of a data center [8]. The cooling infrastructure consumes a major portion of the data center energy followed by servers and storage, and other infrastructure elements.*

Its a pie chart drawn with following data

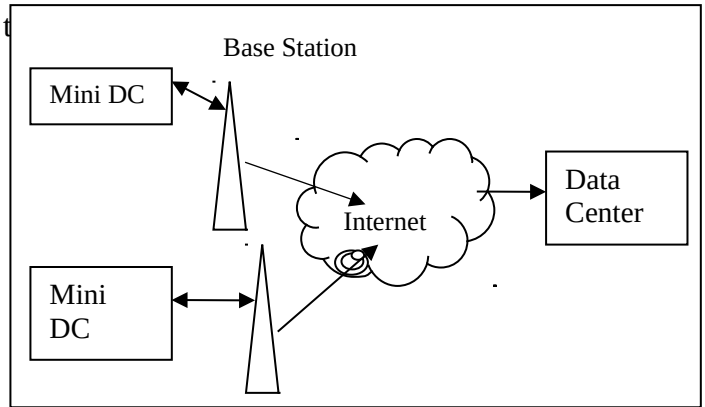
Cooling	50%
Server & Storage	26%
Power Conversation	10%
Network Hardware	11%
Lighting	3%

Different Techniques for Energy Efficiency in Data Centers

Green Cloudlet Network

In the existing Mobile Cloud Computing architecture the query raised by any user's equipments (mobile devices) is captured by Base station and then forwarded to processing data center. The query forwarded to processing center is travelled through Internet, generating End to End delays. To minimize these End to End delays the cloudlet, the mini data center is attached with every base station so that query raised by user's equipments (UE) will be processed at base station only instead of forwarding the same to processing data center. It is the technique of minimizing no of hops, to reduce the delays, which will reduce energy consumption as less energy will be needed to transfer the data in between hops. This technique is referred as Green cloudlet network [1].

In data center, t



implemented to minimize the no of hops. Thick client will perform basic operations that are not related to database (as database will need authenticated and authorized access to it) so that not every operation will be forwarded to server side. This will reduce network traffic and will reduce amount of energy to send the data.

The mini data center is attached every base station. For any query raised by UE will be processed at mini data center so that E2E delay will be reduced. This technique will also save energy needed to forward query to data center through internet.

The following figure 2 illustrates the thick client model. The Base station attached with cloudlet. The virtualization technique is implemented in mini data center to take care of moving user equipments. The migration is used for any user equipment moving from one base station perimeter to another base station'sperimeter.

Fig: 2. *The thick client model in MCC*

Virtual Machines' (VMs') allocation and consolidation

In the data center to provide resiliency characteristics the servers are always in running mode. In case of failure of any physical or virtual server the other replicated server will serve the cloud consumer. The scalability of resources is also served through these running servers. Though these servers are not serving for all time but are in running mode, so power is consumed with equal to other servers which are actually serving the cloud consumers.

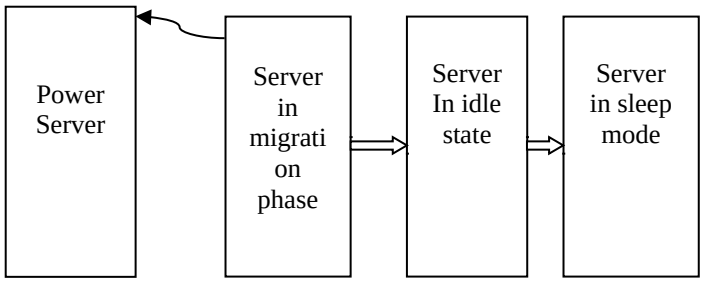


Fig: 3. *Powerful servers fetched VMs from least loaded servers [2]*

The article [2] has proposed the migration rule for servers.In this method the load is shifted to other running servers and idle servers will be shifted to sleep mode. This way energy consumption will be reduced and load will be balanced in servers. The following are the proposed migration rule in paper[2].

$$LMR = CAR \geq 0 \wedge PU \geq CT \quad (1)$$

The Global Migration Rule (GMR) is satisfied when the Utilised Resources (UR) in the Least Loaded Server (LLS) in the datacenter is less than or equal to Total Free Resources (TFR) in other servers (as in equation (2) and equation (3).

$$TFR = \sum_{i=0}^{\#of\,heavy\,loaded\,PS} Available\_resources_i \quad (2)$$

$$GMR = TFR \geq UR_{LLS} \quad (3)$$

Multi Objective Consolidations of Virtual Machines

Consolidation technique is utilized as a novel technique for energy saving in cloud data centers. Consolidation problem is decomposed into four sub-problems including (1) determination of overloaded PMs (Physical Machines), (2) determination of under loaded PMs, (3) Selection of VMs that should be migrated from overloaded PMs, and (4) placement of migratingVMs on PMs.since these kinds of optimization problems are NP-hard, heuristic algorithms are developed to address them [3].

In this technical article it is stated that while to minimize energy consumption in the processes of data center not only to consider the factors contributing to energy

consumption but needs to consider Service Level Agreement.

Multi-Objective Power-and-SLA (MOPS) policy is described to achieve less usage of power consumption as well to reduce CO2 emission.

Profile-based application assignment

If we already know the demands that have to be served in data center, then we can plan for better resource utilization. The technique for such a load aware data center is proposed here. To get information about loads the different profiles are created.

This technique is mainly focused on Building Profiles as a main objective. Following different profiles should be created.

1. Building PM profiles (Based on Logs)
2. Building VM profiles (From server's statistics)
3. Building Application profiles.
4. Profile-based application assignment model.

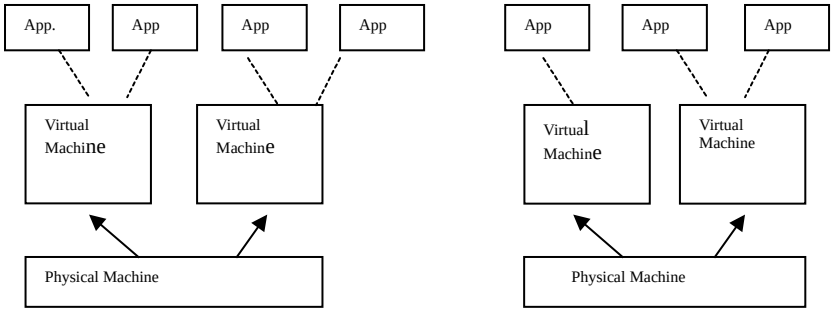


Fig: 4. *Energy Management architecture at Data Centers*

The energy management of a virtualized data center can be implemented at three layers: application, VM and PM layer, as shown in Fig. 4.The VM management layer is responsible for VM placement to PMs, VM sizing and VM migration. The PM management layer at the bottom layer is in charge of ON/OFF operations of PMs, sleep cycles, cooling and DVFS (Dynamic Voltage Frequency Scaling).

Profile-based application task system is planned. A profile-based direct programming model has been intended to recognize and do close ideal position of uses on VMs. The destinations incorporate asset use proficiency, application fruition time inside its due date and limited vitality cost. Test ponders have demonstrated that the profile-based application task approach is possible, adaptable and powerful in correlation with other existing methodologies, suggesting greener and more vitality proficient task arrangements with adequate CPU usage productivity and execution times inside their due dates.[4]

Efficient and scalable ACO-based task scheduling

The planning in cloud based requires evaluating the need of execution for assets portion for various application and administration models under various conditions. In addition, it is important to stay away from the nearness of controlled on machines when they are not being used. Thus, a great booking of errand in cloud based situations prompts vitality preservation and in this way, it might permit a green figuring worldview [9]

This paper contains an original contribution in the field of task scheduling in cloud based environment and highlights the adopted optimization scheme for maintaining a balanced load. The technology proposed in this technical article is as follows:

Detailing of the errand booking issue in the cloud based condition; Proposition of the plan dependent on the subterranean insect framework for planning employments; Simulation of the proposition with the end goal to feature it viability; Comparison of the CACO with different arrangements with the end goal to

demonstrate that, this proposed scheduler conveys a lessened makes length.[5]

The CACO algorithm uses a Max Min Ant system.

The array of jobs is created as MMAS system. The Emax and Emin values are set to avoid early stagnation in search. The list of available resources is maintained. The resources having less value than Emin are removed from list.

COMPARISION ANALYSIS

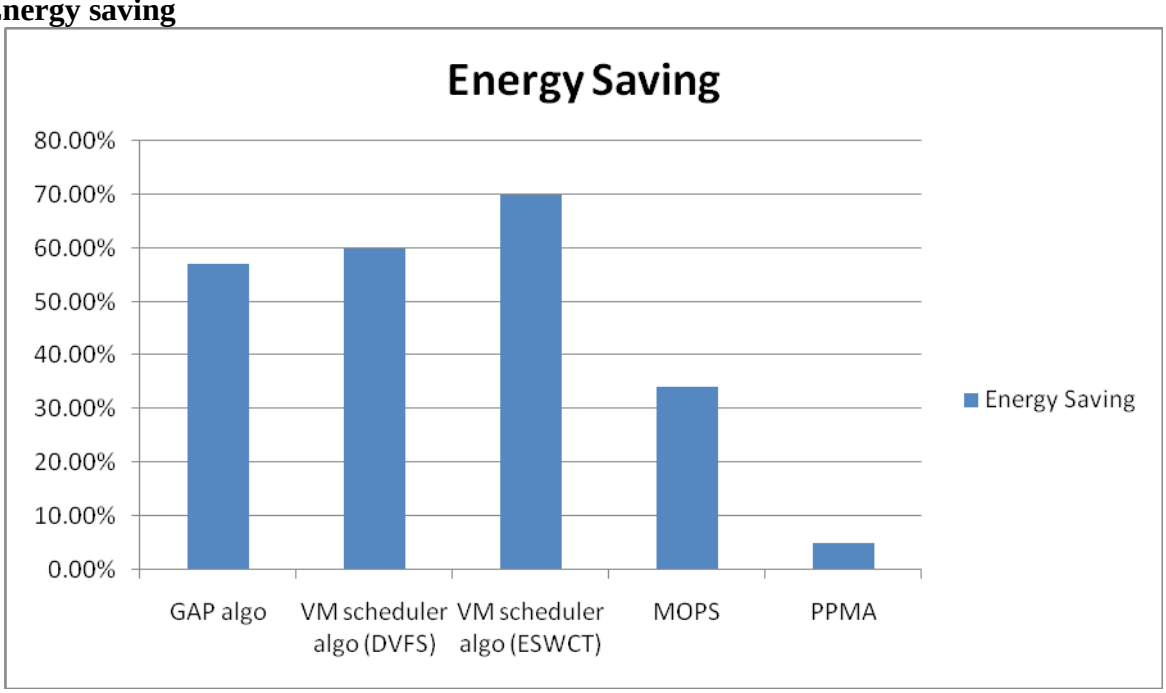
Comparison with respect to literature review

In mobile cloud minimizing the numbers of hops is supporting the less energy consumption, alternately reducing the carbon emission. The proposed GAP algorithm is giving better performance in grid. Inspired from this technique a thick client may be used in data center to minimize the no of hops.

In second article the proposed VM scheduler algorithm is giving better efficiency for 1000 servers than for 400 servers. The third technical article deals with 5 criteria: power increase (PI), Available Capacity (AC), No. of VMs (NV), Resource correlation (RC), Migration Delay (MD).It gives performance efficiency as 34.2%, 98.58%, and 71.29% reductions in energy consumption, SLA violation, and number of VM migrations, respectively. The fourth technical article is focused on data center with consistent behavior. Compared to historical approach the proposed PPMA algorithm is more efficient. The fifth article states that Job scheduling is very difficult task in cloud computing. Effective job scheduling may minimize the energy consumption It stated that comparing to GA the proposed CACO algorithm is more effective by doing job scheduling.

Note: VM scheduler performance is compared with DVFS and ESWCT algorithms.

Energy saving



Graph: 1. *Comparative analysis of Different Energy saving techniques proposed for data centers.*

CONCLUSION

Energy aware model for less power consumption may be implemented considering following techniques: Virtual machines allocation: VM migration, Resource Utilization: Maximum utilization of resources, Switching the idle servers to sleeping mode: Cut off the un-necessary

power consumption, Considering travelling distance of data: Try to minimize the distance, more distance more energy will be needed, Minimizing no of Hops byimplementing the thick client models. By applying any of the above technique Energy consumption may be reduced so does alternately CO2 emission, Complex structure to implement in data centers as already data centers are complicated in structure ,but implementing these techniques of green modeling will be definitely proved as cost saving and environment friendly.

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