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Green cloud computing: reduced overload with a better architecture

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ABSTRACT

Software systems architects had been continually facing challenges of scaling up software systems architectures. Scaling up the architectures to meet these needs certainly introduces additional energy cost. Improvement of applications, algorithms, energy efficient hardware has been done to achieve energy efficiency. Reducing the energy demands in such architectures is always challenging. The greatest environmental challenge today is e-wastes and energy crisis, bringing green computing in the limelight. Green computing requires algorithms and mechanisms to be redesigned for energy efficiency. In accordance to the state of art for distributed software architectures, are not aware on green cloud computing while the implementation needs, changing the whole infrastructure cost effectively.
Software architectures don't provide the primitives for reasoning and managing power consumption. In present work, an energy efficient resource management system for virtualized Cloud data centers that reduces operational costs and provides required Quality of Service (QoS) has been proposed and fulfilled. Our proposal towards software engineering demands to be green aware, where the software engineering and design activities should not only be judged by their technical merits, but also by their contributions to energy savings. In particular, the software system architecture seems to be adequate to address green-aware concerns but need revival. Software architectures should be green-aware, providing power management mechanisms as part of the architecture. The results of present work improvised that the proposed technique brings substantial energy savings, while ensuring reliable QoS. This justifies further investigation and development of the proposed resource management system.

Keywords- Green Cloud computing; Energy efficiency; Energy consumption; Software Resources management; Virtualization.

I. INTRODUCTION

The new term "cloud computing" appeared from Google's CEO Eric Schmidt in 2006 .This new idea has since become the most important technique in network services. Nowadays cloud computing services are everywhere, e.g., Google Gmail, Google document, Microsoft Hotmail, Amazon EC2, and Facebook. These services have been the most important for our world. Cloud computing is a large-scale distributed computing paradigm. Green Computing is defined as the study and practice of designing, manufacturing, using and disposing of computers, efficiently and effectively, with minimum or no impact on environment.[1]

According to NIST's (National Institute of Standards and Technology) definition for cloud computing: "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".[2][3]
In an article, on Green design principles, Kevin Francis and Peter Richardson tell us about computing based delivery models. These models have the remarkable potential to reduce the scaled data centers, in which services are hosted and the shared resources such as servers, storage, etc. can be efficiently used.[4][5][6][7][8]
Today the major challenge in green computing is for businesses and all architects. The biggest challenge facing the environment today is global warming. According to a report by Energy Information Administration, 87% of all CO_2 can be referred to energy consumption. The trend to pay carbon tax has started. So we can see that the reduction in energy consumption can be a real financial payback.

Here, we focus on how to build architectures to reduce the impact of energy consumption in cloud computing models, the reason remaining the greatest environmental challenges. The energy crisis brings the need of green computing and

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this further initiates the development of algorithms and phenomena to be restructured for energy efficiency.
The cloud computing principle is to make computing assigned to large number of distributed computers rather than local servers or remote servers. We can refer cloud computing as an extension of Grid computing, Distributed and Parallel computing. The idea is to provide quick secure and convenient data storage and computing services across continents over the Internet.[9][18]

The current phenomena of cloud computing emits huge amount of CO_2, therefore it triggers the need to significantly reduce pollution and hence lower energy usage. The use of green algorithm can enable more energy efficient use of computing power bringing a revolution in the IT world, making it GREEN IT.

II. Related work

Early work in energy management was devoted to mobile devices on how to improve battery lifetime. With time the concern shifted to data centers and virtual computing environments such as clouds. A number of practices can be applied to achieve energy efficiency, such as improvement of applications, algorithms, energy efficient hardware, virtualization of computer resources etc. Virtualization helps to create virtual machines and thus reduces the amount of hardware in use, thereby improving the utilization of resources. [19]
The cloud computing is beneficial as it provides streamline processes and are used by many businesses holding significant energy consumption due to its hardware, software, data centers, servers, wired/wireless networks, virtualizations. The cloud computing, now we know affects environmental eco-balance by releasing greenhouse gases.[18]

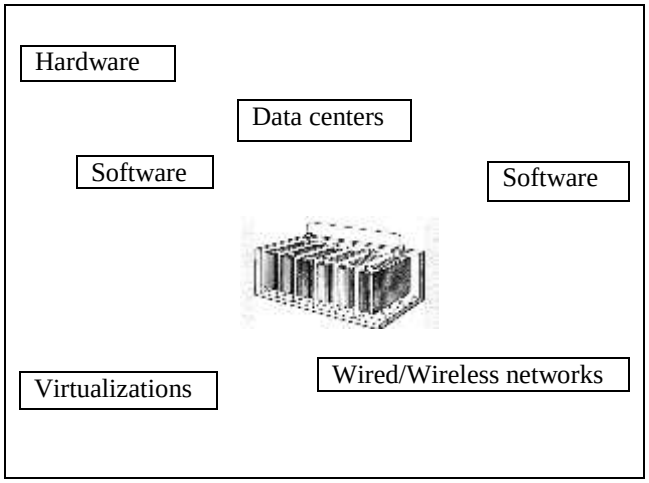

Fig 1.Energy Consumption representation

The companies have shifted to cloud technology in huge number as known up to January 2015, according to IBM cloud transformation. Therefore, keeping in view these discussions the need of the hour is to manage the energy consumption across the entire information and communication (ICT) sector.

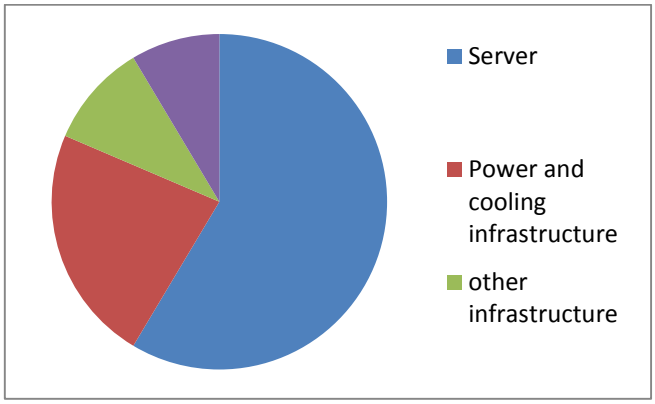

Fig 2.Energy Consumption in data center

The illustrated figure 2 depicted by Amazon.com shows the expense of cost and operation for 53% of the total budget which was based on 3 year amortization schedule. The energy cost -42% of the total including cooling infrastructure- 23% and direct power consumption -19%. [19][20]

Cloud data centers are the house for millions of servers, and have now become the major part in the energy consumption. The difference between the cloud data centers and traditional data center can be judged from the ratio of worker and server 1:1000 which depicts highly automation in cloud data centers.
The random estimate shows the main costs involved in the setup of cloud data center which is between $15 million to $25 million. The cloud data centers are highly scalable, elastic and easy to organize, so the switch from traditional data centers to cloud data centers is growing rapidly. This further leads to high power consumption, demanding cooling infrastructure. The cost of data centers is also on the rise due to energy management. The environmental impact and energy consumption has now become a matter of concern for present and future diversity.[20][21]

In the current work we propose the architecture for virtualization of cloud data centers and green algorithm for green computing.

III. METHODS

Virtualization

Virtualization helps to customize the software patching and portability. Virtual machines can shift the data from one cloud to another in case of any compatibility issues. Thus it provides a way to manage resources efficiently. This is because mapping tables are used to map between virtual resources and physical resources, hence reducing the redundancy. Therefore Virtualization helps to gain energy efficiency.
There exist various virtualization models such as XEN, KVM, CPU, I/O, and networking resource management model. The global and local loads can be managed using any or all models. Data is collected from physical and cyber systems in data centers is correlated and analyzed to provide models and tools for data center management and performance optimization.

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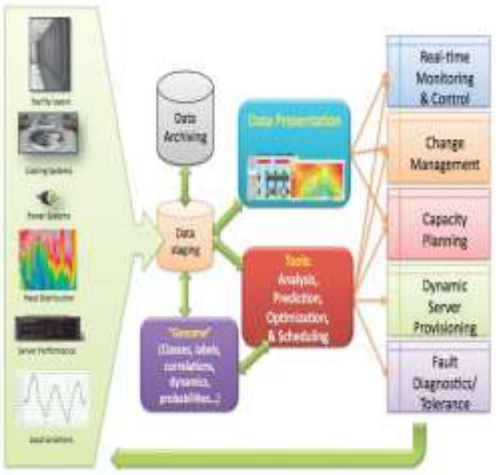

Figure 3

Fig. 3 Overall architecture for the Data Center[4]

Till now we have discussed about virtualization, technique. Now it's time to develop the green algorithm which falls under algorithmic approach of green computing.

Green Computing Algorithm

In this section, now we present the algorithm which sounds beneficial in managing clouds overload. The name given to it is MAX_UTIL algorithm. The first and obvious advantage is energy consumption is reduced. The other benefit is that it's cost function implicitly decreases the number of active resources since it tends to intensify the utilization of a small number of resources. The value f_{ij} of a task t_j on a resource r_i using the cost function of MaxUtil is defined as: [17]

$$F_{ij} = \frac{\sum_{r=1}^{€_o} Ui}{€_o}$$

F_{ij} =Cost Function U_i=Max util function

ALGORITHM

Input: A task Ij and a set R of r cloud resources

Output: A task-resource match

I. Let r* =α
2. for ∀r € R do
3. Compute the cost function value f_{ij} of t_j on r_i
4. if f_{ij}>f*J **then**
5. Let r*=r_i
6 Let f*j = f_{ij}
7. **end if**
8. **end for**
9. Assign t_j to r*

IV. RESULT

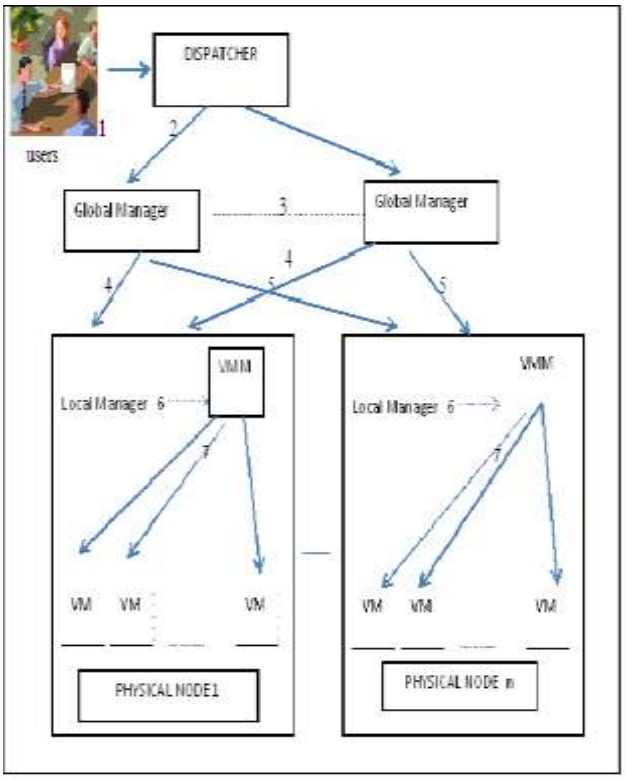

Fig 4.System Architecture

The software system architecture consists of dispatcher, global and local managers. The local managers reside on each physical node, as a part of virtual machine monitor (VMM). They are responsible for observing current utilization of the node's resources and the thermal state. The local managers send the information about the utilization of resources and virtual machines chosen to migrate, to the global managers. This decentralization removes the single point of failure risk and improves scalability[12]. The system operates in following steps:

- New Requests arrive &Dispatcher distributes requests to global manager
- Communication between global mangers
- Propagation of information about resource utilization
- VM's chosen to migrate to global managers & issues commands to optimize allocation
- According to the command local managers monitor host nodes and issue commands for VM resizing.

- VMM performs actual resizing operation of VMs
- Resource Scheduling is done finally.

V. EVALUATION: By using the Virtualization technique in collaboration with Green Algorithm, we are able to develop optimum solution for energy efficient cloud systems.

The performance of MAX_UTIL was evaluated thoroughly with a large number of experiments using a diverse set of tasks. The entire results obtained are summarized as:

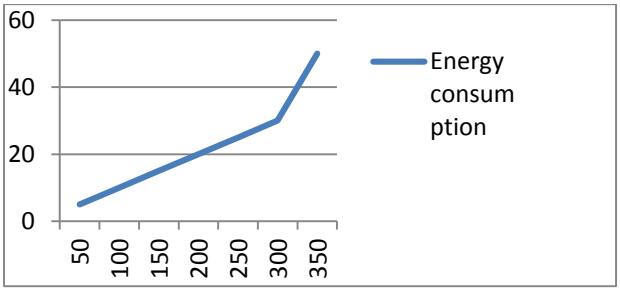

Fig.5 Energy consumption graph

Task	In[25]	Arrival time	In[25]	Processing time	In[25]%	Utilization
0	0	0	20	20	40	40%
1	3	4	8	8	50	45%
2	7	8	25	24	20	22%
3	14	15	19	12	40	41%
4	20	21	15	16	70	60%

Table I

The energy savings were found to be appealing .The MAX_UTIL algorithm outperformed by 12%. Thus it effectively captures energy saving possibilities and their capability has been verified by our study.

VI. CONCLUSION

The results of our study should possibly impact electricity bills of cloud infrastructure providers and other related costs. The decentralized architecture of virtualization for cloud data centers also lead to significant reduction of energy consumption to approximately 67%. So now we can develop the green approach for computing methods using virtualization and Green Algorithm simultaneously; utilizing the processor for lesser consumption and optimum computation. Although both the techniques have been used but never run simultaneously, which can increase the efficiency of green cloud computing. We hope to implement it in a cost effective manner.

FUTURE WORKS

Based on our study we propose a plan for future research work as-

- Development of other resource managing algorithms for network and temperature optimization
- Real implementation of the system using Virtualization and further experimental evaluation.

Once the algorithms are developed and the combined effort of virtualization can be a real Green implementation of cloud platform. This further can be projected as socially valuable in reducing the overall energy consumption and overhead by modern IT infrastructure

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