A Review On Green Cloud Computing

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Abstract—The objective of green computing is to reap monetary growth and enhance the way the computing devices are used.
In large data centers computational offloading is main problem due to increased demand for timely and response for real time application which lead to high energy consumption by data centers, so the aim of green computing is to find energy efficient solution which monopolize optimal utilization of the available resources. Green IT methods comprises of environmentally viable management, energy efficient computers and enhanced recycling procedures.
By using different algorithm and energy efficient scheduling power consumption of virtual machine can be minimize, this paper provide an overview of different algorithms and techniques which are used to move towards the green computing

Keywords-*Cloud Computing, Green computing,Data centers,Energy efficiency, Energy Consumption, Virtualization, , Virtul migration,correlated-virtual migration,Task consolidation,Resource utilization,*

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I. INTRODUCTION

Cloud is distributed system which consist of the group of interconnected, virtualized computer that dynamically presented as unified based on the service level agreement between service providers and customers. To provide efficient services that can enhance the overall performance of organizations and business, an effective management of cloud resources is very important in order to serve as many user requests as possible. There are resources scheduling techniques for managing these resources. Resources in the form of virtual machines are allocated to the user requests and de-allocated after completion of the task. The huge datacenters of cloud providers consume large amount of power which affects the environment. It has been noticed that among several enterprises that have implemented server virtualization, the main focus and concern was the power consumption to minimize it we have different algorithm and scheduling by applying this we can move towards Green computing.

II. GREEEN CLOUD COMPUTING

With the advancement in the technology the next step is to make it environmental friendly, by improving the utilization of resources the energy efficiency can be increased which a step to move towards Green Cloud is computing.
1. Energy impact in cloud computing-Transfer of the data in the cloud can be done by using Gateway, Router and Local area network.
According to the Cisco Global Index (GCI) there is phenomenal chances of amplification in Data Center.
By 2021 It has been gauge that more than 85 percent of workloads will be moved to the cloud.
With the reference to this Natural Resource Defense Council (NRDC) has come up with survey of Energy usage in DC.
It has been evaluated that the usage of power will be more than 45 billion Kwh, cost of it will be $4.7 billion and emission of carbon dioxide will be 50 million.
Considering all this estimated data optimistic solution is needed.

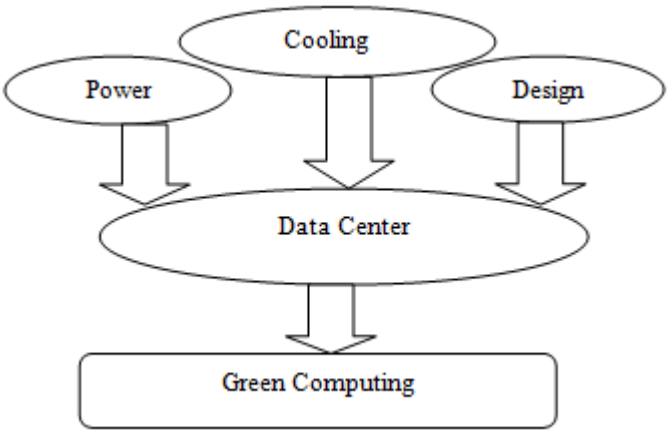

Fig.1 Green Cloud Computing Model

2. Green Cloud Computing techniques-Virtualization plays a vital role in green cloud computing, it increases the energy efficiency by improving utilization of resources.
Energy can be saved by using Power Gating, Reducing the requirement of cooling, advance clock gating.
The outcome can be upgraded by applying scheduling algorithm.

III. RELATED WORK

Rubgya.G,Dr.Ponsy R.K SathiaBhama2016[1] in their paper *"A Survey of Computing Strategies forGreen Cloud"*provide an overview of cloud system**,** Metrics and various algorithm

which are mandatory for green flavor in cloud computing are also discussed in this paper.

In this paper there are various Research which are discussed are:-

Federico Larumbe and Brunilde Sanso(2013)[2] in their paper *"A Tabu Search Algorithm for the Location of Data Centers and Software Components in Green Cloud Computing Network"* the strategy is provided to improve network design better Quality of Service while minimizing cost and energy consumption using penalty term until a feasible solution is found.

The request that is provided in real time can vary treadmously and hence the procedure can consider this and the current technologies used in data centers and host to improve method further.

*FeiXu,FangmingLiu,LinghuiLiu,HaiJin,Bo Li and Baochun Li(2014)[3]*in their paper *"I Aware: making live migration of Virtual Machine Interference-Aware in the Cloud"* in this paper they have proposed interface aware Live Migration.

In this strategy Decision proceeds is provided to select candidate VM that has to be migrated to the appropriate PM.This strategy can reduce VM migration interface and Co-location interference.

This approach is developed by using the interface-aware VM Live Migration Strategy and ,multi resource demand supply model, this advantage canbe applied to heterogeneous PM as only data centers with PM is considered.

*Bei Guan, Jing Zheng Wu, Yongji Wang and Samee U.Khan (2014)[4]*in their paper *"Livsched: A Communication-Aware Inter-VM Scheduling Technique for Decreased Network Latency between co-located inter VM latency communication* aware scheduling to reduce the co-located inter VM latency are discussed by this scheduling the communication between the inter VM running on same virtualization is considered, in this method the performance with more Virtualization platform should be Evaluated.

Due to the rapid growth of cloud the advantage of cloud are increasing which leads the organization divert towards the cloud.

As organization are diverting towards the cloud power dissipation is also increasing, to minimize it we need a solution, many algorithm, scheduling and allocation are developed for it.

The core techniques which are used are virtualization, consolidation and migration are used to move virtual machine into the physical machine so that number of host can be reduce and underutilized and over-utilized machines can be manage.

Haikun Liu and Bingsheng He (2015)[5] in their paper *"VM buddies: coordinate Live Migration of Multi-tier Application in Cloud Environment"* **in** this paper they discussed live migration technique of multi-tier applications across geographically distributed data centers. This live migration is technique is important for load management, Power saving, Routine server manage ment and quality of service.

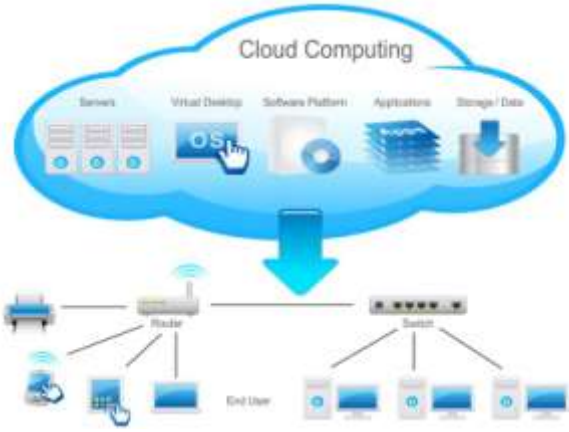

Fig2. Virtual-migration

A. Single-VM migration

Now a days in virtualization platform effective approach for manage workloads is live migration in disruptive manner. The most widely used algorithm is pre-copying which is used in today's virtualization this paper comprises of several pre-copying rounds.

Virtual machine's physical memory is first transferred from host A to host B source VM is running in host for memory consistency the page is dirtied in each round must be re-sent. This data is known as dirty pages which are generated in previous round, When several rounds are done stop and copy phase is performed, after this phase remaining dirty pages are transmit, while the source VM temporarily stop the execution. When final data transferring is complete, the VM on host B resumes and takes over the VM on host A.The number of factors which are affecting the migration cost are down time, migration completion time and total traffic in the network, other major factor size of VM memory dirtying rate, network transmission rate and configuration of migration algorithm.

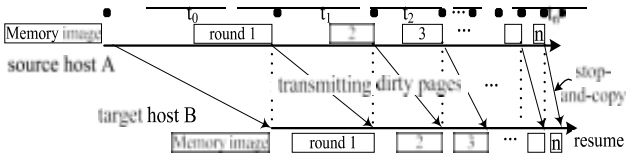

Fig3. Single Virtual migration

B.*Correlated VM migration*

A multitier web application is migrated from Data Center 1 to Data Center 2.In multitier each tier is running on multiple VM's,and thus VM across the tiers are correlated with data dependency.Network bandwidth is critical resource across distributed data center and this network bandwidth is smaller than the network bandwidth within a data center.

Erstwhile the NW bandwidth in two datacenter was 465Mbps with no loss of generality, the peak network bandwidth between DC1 and DC2 are reserved for migration process in B.In multitier web application the application traffic and migration traffic have common link between two data centers.

The bandwidth strife between datacenters may out turn in remarkable performance degradation in both application and VM migration which impel to develop, VM buddies to coordinate the VM migration of multitier application and allow the inter-cloud network bandwidth to be exclusively used by the migration traffic.

The main objective of this paper is to solve the correlated VM migration problem raised in multi-tier application.

Single VM migration, VMs in a multi-tier application is closely correlated VM migration problem. Current live migration algorithm for single VM cause performance degradation, for the reason that intermediate data exchange between different VMs suffers relatively low bandwidth and high latency across distributed data centers.

Single VM migration, VMs in a multi-tier application is closely correlated VM migration problem. Current live migration algorithm for single VM cause performance degradation, for the reason that intermediate data exchange between different VMs suffers relatively low bandwidth and high latency across distributed data centers. In this paper, they design and implement a coordination system called VMBuddies for correlated VM migration in the cloud.They proposed an adaptive network bandwidth allocation algorithm to minimize the cost of migration completion time, and network Traffic and migration downtime experiments using public benchmark experiments to show that VM Buddies significantly reduce the performance degradation and migration cost of multi-tier application.

Design and implementation of VM buddies based on Xen4.1 platform.

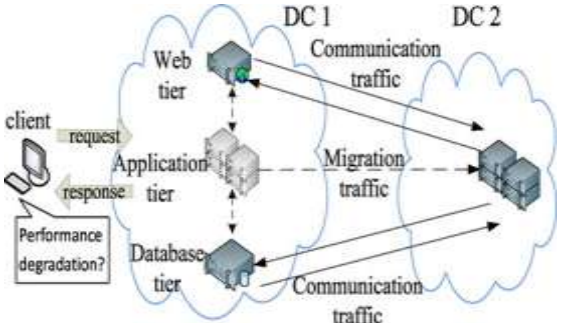

Fig4. Performance penalty due to live migration of a multi-tier web application across distributed data centers

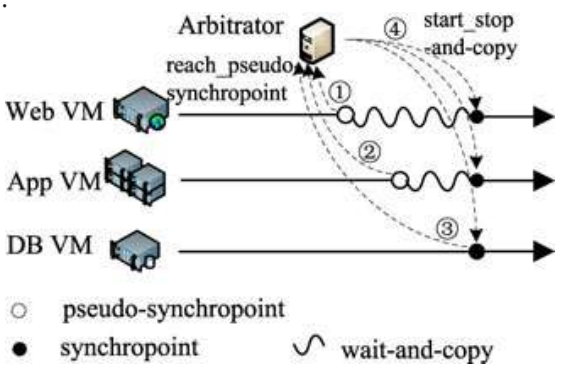

Fig5. Synchronization of live migration of multi-tier applications.

SusheelThakur,ArvindKalia,JawaharThakur (2014)[6] in their Paper *"Performance Analysis of Server Consolidation Algorithms in virtualized Cloud Environment with Idle VMs"* in this paper they discussed that we can transfer virtual machine between the physical machine by using technique of live migration, the idea of Live Migration is introduced for improving efficiency and it is an efficient technique towards the Green Computing.

In 1969, Leonard Kleinrock one of the chief scientist of the original Advanced Research Project Agency Network (ARPANET) which implanted the internet said "As of new, computer network are still in their infancy, but as they grow up and become sophisticate, we will probably see the spread of computer utilities "which is same as the today era where telephone utilities are services individually across the homes and offices across the country.

This inventiveness of computing utilities based on a service provisioning model intercept the prodigious amendment of entire computing services readily available on demand access to the network to shared pool of configurable computing resources, which can be readily provisioned and released with minimum effort in management, and for service provider interaction, with instantons enlargement in the processing and storage technique and the success of the internet, computing resources have become globally avail than ever before.

In business the personnel are trying to cut the cost without affecting the performance standard thisaspiration to grow and enabled a new model called cloud computing.

Virtualization play a vital role in cloud computing, that enable configuration of new feature of the cloud computing, it provide us noteworthy benefit in cloud computing by VM migration across the data centers.

C. *Live Migration*

it is amplification of virtualization in which VM are server to be active and give response all time during the process of migration to optimize efficient resources live migration is effective process.

D.Server Consolidation

By using this technique total number of server can be reduced, which can solve the problem of server sprawl.

In server utilized multiple underutilized server accommodate more space which led to increase in power consumption.

E. *Server Consolidation algorithm*

To reduce total number of server, location of server should be organized server sprawl is major problem for solution of this server consolidation algorithm are implemented.

In this algorithm VM packing is done in which VM's are packaged on PM to improve the resource usage.

1) Sandpiper This is a new system in which task monitoring and detecting is done for eliminating the hotspot and new mapping can be done for physical machine resources to virtual machine resources**.**

In view of this algorithm the PM are collocated in descending order with respect to their volume metrics, V_{Sr} metric here volume metric and V_{Sr} are computed as,

$$vol=\left(\frac{1}{1-Cpu}\right)*\left(\frac{1}{1-Mem}\right)*\left(\frac{1}{1-Net}\right) \quad (1)$$

$$V_{Sr}=\frac{volume}{size} \quad (2)$$

Here CPU and memory and network refers to the CPU, memory and network usage of PM and VM respectively and size refers to the memory footprint of VM.

To alleviate hotspot on an overloaded PM, the highest V_{Sr} it migrated to a least loaded PM,if least loaded PM's can house the PM and next PM in sorted order is checked, similarly if the VM cannot housed in any of the under loaded PM's,next VM in sorted order is checked.

This way sandpiper may mitigate hotspot by remapping VM on PM through migration.

The experimental result shows that there is an improvement compare to other algorithm, despite that swapping increase the chances of alleviating hotspot in cluster with high average utilization.

2) Khanna's Algorithm Dynamic management algorithm(DMA) this is based on polynomial time approximation scheme(PTA) heuristic algorithm .There are two type of list which are migration cost list and residual capacity list.

The PM are sorted according to their residual capacity in increasing order across any resource dimension like CPU.

In case of VM each PM are sorted in increasing order of their resource utilization and CPU.

Migration cost of VM on each PM are based to their resource utilization like CPU usage high usage implies high migration cost.\

When in CPU there is violation of upper threshold hotspot is detected, VM which have least resource usage is chosen for migration to target host which has least residual capacities to house.

If PM cannot accommodate the VM next order is checked, this process is continues until the VM is found.

Whenever cold spot is detected, the least usage across all the under loaded PM is chosen and migrated to targeted PM, when addition of new VM increases the variance of residual capacities across all the PM,else we chose next VM in order. If there is no residual space left for chosen VM, then the heuristic mitigationstops, variance is defined as follows-

$$\textbf{\textit{Variance,R(t)}}=\frac{(mean-rescpu)^2+(mean-resmem)^2+(mean-resnet)^2}{(m-1)} \quad (3)$$

$$\textbf{\textit{Mean}}=\frac{rescpu+resmem+resnet+\cdots}{m} \quad (4)$$

$$r_n=\sqrt{var_{p1}{}^2+var_{p2}{}^2+..+var_{pn}{}^2} \quad (5)$$

Here mean is the average normalized residual capacities across "m" different resources like CPU, network, resmem, resnet, and stands for residual capacity.

Khanna's algorithm packs the VM as tightly as possible and trying to minimize power consumption by detecting underutilization in the managed by using Max-min threshold selection model, when the resources usage of running VM as close as possible and trying to minimize the running PM.

Table 1.Migration Heuristics

Algorithm	Goal	Metric Used	Virtualization	Resource considered	platform
Sandpiper	Hotspot mitigation	Volume Volume/size	Yes	Cpu, memory, network	Xen 4.1
Khanna's algorithm	Server consolidation	Residual, Capacity Variance	yes	Cpu, memory	Xen 4.1
Entropy	Server consolidation	No.of migration	yes	Cpu, memory	Xen 4.1

In this paper structured analysis of server consolidation including their urgency in the direction of resource management in virtualized cloud computing environment in this paper they try to scrutinize the impacts of different server consolidation heuristic depends upon the performance of both source and target machine.

After performance evolution of these heuristics and fundamental insight the next point of convergence is to diminishing server sprawl compressing power consumption and balancing across the physical machine for moving towards green computing.

A.Verma, Ahuja, A.Neogi(2008)[7] in their paper *"PMapper: Power and Migration Cost Aware Application Placement in Virtualized System"* In this paper investigation of power application placement problem and present P-Mapper are discussed, by using application placement controller which can dynamically places applications to minimizing power while meeting performance guarantee.

Virtualization is solution which can provide the desideratum isolation layer to consolidate application on a large number of low utilization server to a smaller number of highly utilized server.

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Virtualization is a solution which can provide the desideratum isolation layer to consolidate application on a large number of low utilization server to a smaller number of highly utilized server.

By the use of virtualization layer flexible runtime mechanism for translucent resource allocation in this paper architecture and implementation of power aware application placement framework called PMapper,which can as similar numerous scenarios implicate power and performance management by the use of virtualization mechanism.

PMapper administer the solution to the most practical possibility power minimization under performance restraint.

*S.Jayanthi, SrinivasaBabu (2015)[8]*in their paper *"Green Cloud Computing –Resource Utilization with Respect to SLA and Power Consumption"*in

this paper they discussed the way of Reducing carbon footprint and power consumption. Server virtualization is used to decrease the power by consolidating multiple server onto few Physical Machine, Virtualization also provide Flexibility by dynamically move one Physical Machine to another.

By using resource utilization as a proxy for power, power models along with consumption of power for individual server type. We can use this power model information along with business value and SLA information and by using this we can efficiently allocate virtual machine to physical machine.

*Amlan Deep Borah,DeborajMuchahary,Sandeep Kumar Singh and Janmani(2015[9])*in their paper *"PowerSaving Strategies in Green Cloud Computing System"*in this paper various Efficient Energy Saving Green IT method are discussed. In IT sector most of energy is consumed by Data centers.

Use of Cloud computing is effective only if energy consumed in server issaved. By the use of virtual machine migration and Task Consolidation especially in cloud computing is an effective approach to improve energy efficiency and cut down the cloud footprint and saves a sufficient amount of power. In this paper they have analyzed various energy saving strategies in data centers and cloud computing environment.

Gagan Prakash Negi,Hemant Kapoor ,Amit Kapoor(2015)[10] in their paper *"Green Computing : A Demand of Time"* in this paper they have analyzed that the main motive of Green Computing is the low amount of power consumption to save time and money. There are some It Industries those are working on these concept.

In this paper we have also focused on some techniques which are making Green Computing an Emerging Technology this techniques are Carbon Free computing, SolarComputing, EnergyEfficient Computing this are the techniques which making Green Computing successful .

*BoominathanPerumal,AramudhanMurgaiyan(2016)[11]*in their paper *"A Firefly Colony and its Fuzzy Approach for server consolidation andvirtual Machine Placement"*In this paper there are two key issue which are server consolidation and multiobjective virtual machine placement problem, they proposed firefly colony optimization algorithm, to manage cloud datacenter is the most predominant challenging task ahead for IT industries.

The data centers are treated to be major source for resource provisioning to the cloud user.

To manage their resources to stem large number of virtual machine urgency heuristic optimization algorithm to equip the optimal placement strategies gratifying the objective and constraints develop.

This firefly technique illustrate better performance compare to heuristic and metaheuristic approaches studied in terms of server consolidation, and discover optimal placement strategy.

IV. OVERVIEW OF SCHEDULING ALGORITHM APPROACHES

In table 2 various papers are discussed and compared. Different Columns are used to describe papers ,Algorithms and their future scopes. First column specifies the name of the author, second Column specify about the paper name, third column specify concept and theoretical model while making the algorithm, forth Column tells about the energy saved by the proposed algorithm/techniques.

Table.2 Overview Of Scheduling Algorithm Approaches

Author Name	Paper Name	Concept /Theoretical model	Algorithm/Techniques used	Conclusion
Rubgya.G, Dr.Ponsy R.KSathiaBhama (2016)	A survey of computing strategies for green cloud	This paperprovide an overview of cloud system**,** Metrics and various algorithm which are mandatory for green flavor in cloud computing are also discussed in this paper.	This paperprovide an overview of cloud system**,** Metrics and various algorithm which are mandatory for green flavor in cloud computing are also discussed in this paper.	All this algorithm are used for load balancing and virtual machine migration among server with in cluster so that energy can be reduced
Susheel Thakur, Arvind Kalia, JawaharThakur (2014)	Performance Analysis of Server Consolidation Algorithms in virtualized Cloud Environment with Idle VMs.	In this paper they we have studied that virtual machine can be transferred between the physical machines by using techniques of live migration. By the use of this kind of technique the efficiency is increasing which is leads to move towards the green computing.	1)sandpiper 2)Khanna's algorithm 3)Entropy	A comparative study of this algorithm for optimization which result to give efficient distribution of work load over Physical Machine.
A.Verma ,Ahuja A.Neogi (2008)	PMapper: Power and Migration Cost Aware Application Placement in Virtualized System	In this paper probe of power application& placement problem and present P-Mapper are discussed, by using application placement controller which can dynamically places applications to minimizing power while meeting performance guarantee.	1)Power minimizing placement algorithm 2)History aware packing algorithm 3)Migration cost aware locally optimal placement algorithm 4) P-Mapper algorithm	P-Mapper is different from all existing literature because it address the problem of power & migration cost aware application placement in heterogeneous source cluster
S.Jayanthi, SrinivasaBabu (2015)	Green Cloud Computing –Resource Utilization with Respect to SLA and Power Consumption	Numerous Organizations are approaching in the field of carbon footprint of their data centers for reducing their power consumption. By using virtualization along with resource utilization as a intermediating for power models of power consumption by each server types and use this information onward with business value & SLA information to conveniently allocate VM to PM.	1)Data center scenario 2)Inability to trace the use of power 3)Inability to certain rapid growth in power demand 4)Inability to quantify the tradeoffs when using new green technology 5)Inability to Match Applications to Hardware 6)Benefits of Traceability 7)Power consumption of a transaction 8)Carbon footprint of a transaction	To reduce power consumption virtualization provide us new possibility by using this flexibility can be increased for complex system good management is needed which takes the power consumption and cooling power into account in addition with server level for allocating virtual machine to the server by doing this we can predict the power consumption effect of changes in Dc.
AmlanDeep	Power Saving	In this paper various	1) By using advance clock	energy efficient

Borah, Deboraj Muchahary Sandeep Kumar Singh and Janmani(2015)	Strategies in Green Cloud Computing System	Efficient Energy Saving Green IT method are discussed. In IT sector most of energy is consumed by Data centers	gating 2)Server consolidation 3)Live VM	strategies can save the energy which big step to move towards green is computing,
BoominathanPerumal,AramudhanMurgaiyan (2016)	A Firefly Colony and its Fuzzy Approach for server consolidation and virtual Machine Placement	In this paper to solve the key issue of data centers, server consolidation and multiobjective virtual machine they proposed firefly colony and fuzzy firefly colony optimization algorithm	1)Firefly colony and Fuzzy firefly colony optimization algorithm	By using this proposed algorithm the performance is convalescent compare to heuristic and meta heuristic approaches.

V. CONCLUSION

The main objective of this paper is to supporting Green Cloud Computing to make cloud computing environmental friendly In modern era Green Computing becomes a demand of time too many organization are working to minimize their energy consumption,. Seeing that modern data centers are heterogeneous this paper comprises of algorithms and techniques which can escapade the heterogeneity of server to filter the resource utilization and thus energy consumption can be minimized. Many algorithm and techniques are used to get optimum solution for reducing the power consumption without affecting the services which are provided to the user.Virtualization is one of the very importanttechniques, by using this consolidation can be done of multiple servers onto a few physical servers which increases their utilization along with energy efficiency by minimizing their power consumption. Nonetheless, virtualization also grants new anticipation to increase flexibility by increasing the number of virtual machine in one physical machine, virtual machine can be moved dynamically according to the requirement.

VI. ACKNOWLEDGEMENT

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REFERENCES

[1] Rubyga, G., and Ponsy RK SathiaBhama. "A survey of computing strategies for green cloud." Science Technology Engineering and Management (ICONSTEM), Second International Conference on. IEEE, 2016.

[2] .Larumbe, Federico, and Brunilde Sanso. "A tabu search algorithm for the location of data centers and software components in green cloud computing networks." IEEE Transactions on cloud computing 1.1 (2013): 22-35.

[3] Xu, Fei, et al. "iaware: Making live migration of virtual machines interference-aware in the cloud." IEEE Transactions on Computers 63.12 (2014): 3012-3025.

[4] Jayanthi, S., and Srinivasa Babu. "Green Cloud Computing-Resource Utilization with Respect to SLA and Power Consumption." (2015).11-21

[5] Liu H, Haikun, and Bingsheng He. "Vmbuddies: Coordinating live migration of multi-tier applications in cloud environments." IEEE Transactions on Parallel and Distributed Systems 26.4 (2015): 1192-1205.

[6] Thakur, Susheel, Arvind Kalia, and Jawahar Thakur. "Performance Analysis of Server Consolidation Algorithms in Virtualized Cloud Environment with Idle VMs." International Journal 2.3 (2014)

[7] Verma, Akshat, Puneet Ahuja, and Anindya Neogi. "pMapper: power and migration cost aware application placement in virtualized systems." ACM/IFIP/USENIX International Conference on Distributed Systems Platforms and Open Distributed Processing. Springer Berlin Heidelberg, 2008.

[8] Jayanthi, S., and Srinivasa Babu. "Green Cloud Computing-Resource Utilization with Respect to SLA and Power Consumption." (2015)."vol.3 No2,19. Borah, Amlan Deep, et al. "Power Saving Strategies in Green Cloud Computing Systems." International Journal of Grid Distribution Computing 8.1 (2015): 299-306.

[9] Borah, Amlan Deep, et al. "Power Saving Strategies in Green Cloud Computing Systems." International Journal of Grid Distribution Computing 8.1 (2015): 299-306.

[10] Prakash Gagan Negi,Kapoor Hemant , Kapoor Amit (2015)"Green Computing : A Demand of Time,34-36, 1-21

[11] Perumal, Boominathan, and Aramudhan Murugaiyan. "A Firefly Colony and Its Fuzzy Approach for Server Consolidation and Virtual Machine Placement in Cloud Datacenters." Advances in Fuzzy Systems (2016):5