A Review Study of Cloud Computing for Resource Optimization Based On Virtual Machines

Ms. Rachna Pandey[1] Prof.(Dr.) R.K.Bathla[2]

Ph.D Research Scholar, Department of CSA, Desh Bhagat University,Mandi Gobindgarh, Punjab, India[1]
Professor, Department of CSA, Desh Bhagat University,Mandi Gobindgarh,, Punjab, India[2]

Abstract

Cloud computing has brought a revolution in the domain of computing, enhancing every aspect of computation. In general, cloud computing is defined as the platform used for providing services to the users through the internet. In the present scenario, cloud computing developers mainly focus on to the reduction of computation complexity, computation overload, energy consumption etc., this is done via the concept of virtualization. In cloud computing, Virtualization plays a significant role and entire performance of cloud depends on Virtual Machine (VM) allocation and Virtual Machine Migration (VMM). A cloud provider creates multiple VM instances on a single Physical Machine (PM), with the main motive of improving resource utilization and decreasing Service Level Agreement (SLA) violations. The VM allocation includes concerns like determining the load of host and also deciding the approach for selection of VMs for migration and placement of VMs to suitable hosts with minimum SLA violation. The term VM allocation is the process of allocating the cloud resources such as CPU, memory, storage, network etc. to a VM. Every PM in cloud comprises a number of VMs. Every task is required to utilize a number of VMs during a given period. A number of researchers proposed efficient algorithms for minimizing energy consumption and SLA violation with the Quality of Service (QoS) at a satisfaction level. Virtual machine consolidation is considered as a technique that guarantees energy-QoS balance. This research proposed an architecture where the main server along with sub-servers handles the requests coming from the users. In case, the load is increased on the sub-server, the VM migration is done on the basis of the coverage area. A distance aware allocation process is used, which allocates the VM from an ad-hoc sub-server which contains the VM. Thus the load is distributed to the sub servers and energy is saved.

Keywords: Cloud Computing, resource optimization, virtual machine

1. Introduction

Cloud computing is a construct that allows you to access applications that actually resides at a location other than your computer or other internet-connected device. It has become one of the most talked about technologies in recent times and has got lots of attention from media as well as analysts because of the opportunities, it is offering. The beauty of cloud computing is that Cloud computing is combination of two terms: Cloud & Computing. Cloud is the Network. A network is a bulk of thousands of users. These users may or may not be connected. If they are connected, there will be one of model formed (IaaS, PaaS, SaaS), discussed further. The cloud also consists of Server & a Database. Server is also known as Cloud-Provider; while Database is a collection of user-details and applications to be worked upon by users. Computing is the term used for services of cloud. another company hosts your application (or the suite of applications, for that matter). This means that they handle the costs of servers, they manage the software updates, and—depending on how you craft your contract—you pay less for the service. It's also convenient for telecommuters and traveling remote workers, who can simply log in and use their applications wherever they are

1.2 CLOUD COMPUTING SERVICES

The cloud computing mainly focuses into three categories named

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

They are sometimes referred to as cloud computing stacks because they are built on top ofeach other. The detail description of these services is provided in Figure 1.

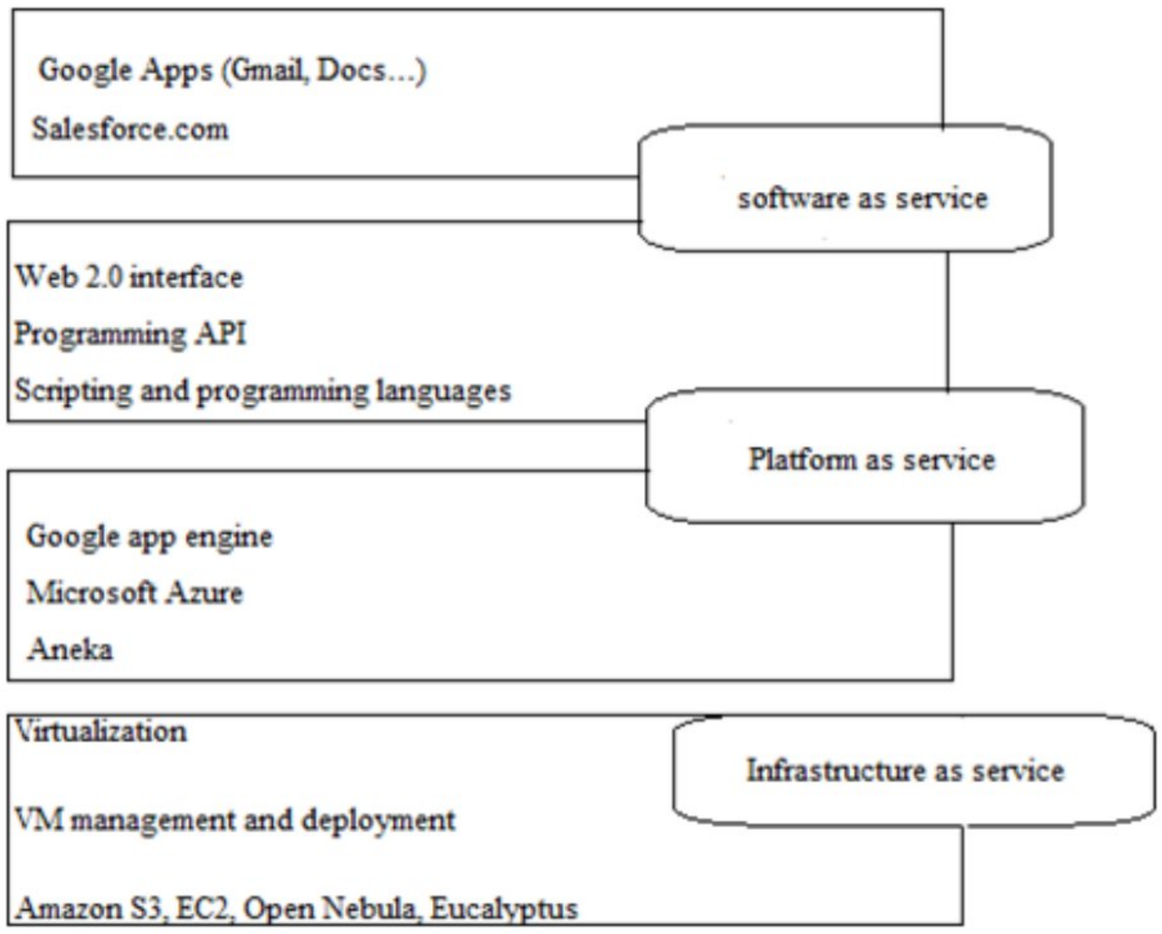

Figure 1: Cloud Computing Services

1.2.1 Infrastructure as a Service (IaaS)

This is a way to provide cloud infrastructures such as storage, servers, networks and operating systems. Customers can access the service as a pay-per-use model instead of purchasing servers, software and network devices, Rackspace Hosting and Go- daddy Hosting are considered examples of IaaS (Goudarzi, 2011)

1.2.2 Platform as a Service (PaaS)

Tools required for application development are provided by third party service providers in a platform as a service cloud computing model. PaaS users get hassle free services without the need of installation and configuration because the required infrastructure is made available by the service provider from its own resources. Most of the objectives of PaaS providers are channelized towards development of software. Some of the services offered are computation and storage facility, version control, text editing capabilities, compilation and test tools to aid developers for fast and efficient software development.

1.2.3 Software as a Service (SaaS)

SaaS utilizes the web to convey applications that are overseen by an outsider merchant and whose interface is accessed on the customers' end. A large number of SaaS applications are run directly with the help of internet browser without any setup or download requirements in some exceptional cases add-ins are used. SaaS wipes out the need to install and run applications on standalone PCs due to the web delivery models‟ composition. SaaS makes it simple for undertakings to streamline their upkeep and support in light of the fact thateverything can be overseen by service providers like information, middleware, applications, runtime, servers, virtualization, stockpiling and systems network administration. Salesforce application is a very good example of SaaS.

1.3 VIRTUALIZATION IN CLOUD COMPUTING

Virtualization essentially creates a virtual image/version, for example, server, Operating System (OS), saving media or network sources for utilizing them on various machines at the corresponding time. The principal goal of virtualization is to handle the workload by modifying traditional computing to work in a more scalable, effective and economical way. Virtualization can be implemented in a wide variety of OS virtualization, hardware level and server. virtualization (Peng, 2014). Virtualization scheme is hardware decreasing cost maintenance and energy efficient technology which is quickly transforming the principle way of computing. By using virtualization, one can improve the utilization of resources accessible to the user to perceive more gains. The virtualization is done for the following reasons:

a. Separation among users: An individual user must be isolated from another user so that he/she might not obtain knowledge about the others user‟s data and usage and cannot even obtain other‟s data.

b. Resource sharing: Virtualization also helps to share resources by dividing a large resource into small virtual resources.

c. Active resources: Resources reallocations like saving and computational resources are very hard but if we are using virtualization then they can be simply re-allocated.

d. Gathering of resources: The little resources available in the system can be expanded to a great extent with the help of virtualization (Zhang, 2011).

The most effective solution for the problems like hardware cost and IT cost is Virtualization. It is also important in power consumption minimization and also maintains a level of utilization of hardware and energy efficiency. Xen, Oracle VirtualBox, Kernel-dependent Virtual Machine (KVM), VMware ESX are with normal features but these are the highly established virtualization methods (Farokhi, 2014).

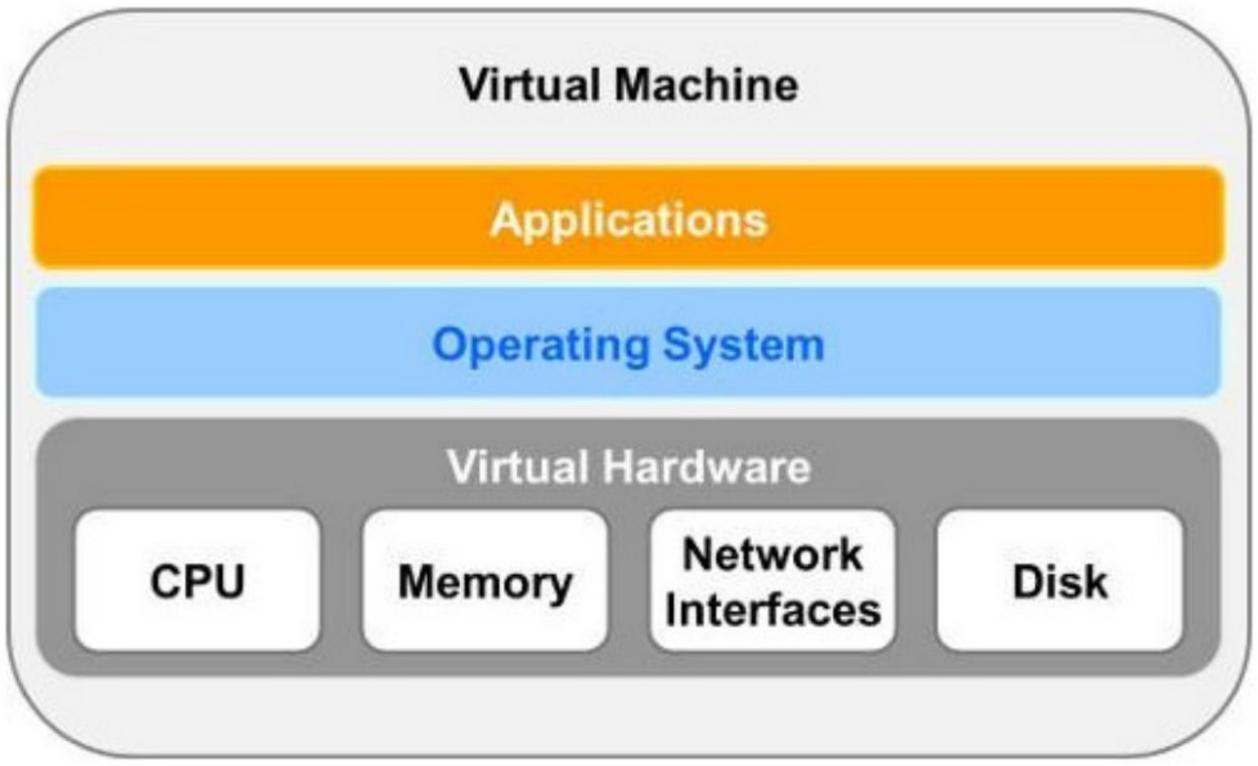

Figure 2. Concept of Virtualization

1.4 ADVANTAGE OF VIRTUALIZATION

1) Virtualization helps in creating a more eco-friendly environment for cloud computing.Virtualization is important for these three aspects:
   a) Cost saving
   b) Energy Saving
   c) Hardware reducing
2) The all users will be working separately because they will be inaccessible for others to contact and will also not be able to access for anyone‟s data.
3) Virtualization also provides security for cloud computing by saving the data of the client on a virtual machine with cloud components. VMs can be increased or decreased according to the need and thus provides reliability.
4) The resources available can be increased with the help of Virtualization to the point

needed; this is called Aggregation of Resources (AOR).

5) Virtualization provides the user with a choice of sharing. These resources are dynamic or highly utilized pooled (Linlin, 2011).

2. Literature Review

Resource allocation in a cloud environment is a challenging task. Different computational models and methods are available to solve this problem. This chapter presents a study of various techniques and benchmarks available for resource allocation and machine migration in view of resource utilization, energy minimization, SLA violations, speed of computation, accuracy, etc.

A considerable amount of work has been done in this domain. A comprehensive study reveals the need of energy minimization for decreasing cost of implementation as well as helps fighting global warming. Another aspect of SLA violation helps in minimizing energy consumption in such a way that SLAs are not violated thus business balances the act of energy saving with quality of service.

This chapter presents key findings of the literature survey, with breif description of work undertaken that inspired this research.

2.1 Sultanpure et al. [2018] proposed an ABC algorithm to observe the working of server as well as host performance in order to make sure the condition of overload. The author considered n number of tasks and the requests has been posted on the central server. The main server checks the requirement of the client into the cache memory. The sub-server unit takes the tasks allotted by the main server and executed the tasks on time.

2.2 Selim et al. [2016] proposed an „IaaS model", with a huge data center which consists of n number of heterogeneous PM (physical machine).In this work, network attached storage has been taken into consideration for data sharing, which require live migration of VMs. Whenever the remote user wants to complete the task a new VM has been required and SLA has been established between the service provider and end user. After every 5 minutes, host overloading has been checked to identify the host violation.

2.3 Qiang et al. [2009], utilizing the feedback techniques for virtualized machines management. In this paper, „VM machines" have been grouped collectively into the shared pool, after that according to „SLO" (Service Level Objective) conformity, the „VM" allocation has taken place. VMs can be animatedly allocated and relocated to the resources as per the requirement and ease of use, and the opportunity of consolidating numerous VMs into the similar physical _server. Although, it may take place that the offered resources have not sufficient for the present demand at a given interval of time, particularly in „private clouds".

2.4 Walsh et al. [2004], proposed a „two-layer framework" that employs utility functions along with the context of active and independent resource allocation, that includes „local and global" arbiter. In this paper, authors have been utilized „cloud bursting" method in order to obtained VMs from the public cloud on the basis of on demand, which increase the computing capacityin a transparent manner to the client.

2.5 Jiayang et al. [2011], presented an flexible resource allocation method for the cloud system with computing tasks in which techniques modify the resource allocation flexibility on the basis of the updates of the real job executions. Resource allocation encompasses scheduling of activities as well as allocating the accessible resources in a quite cost-efficient way and also, it has implemented optimal processes to proficiently assign physical and/or virtual resources to various applications of developers", therefore, by reducing the operational price of the cloud-environment

2.6 Shi et al. [2011], proposed a „quantitative request dependent instrumentation technique which examined different significant dimensions of a VM list scalability. The energy consumption associated with the resource allocation has been taken into account. Resource allocation is the primary techniques of the „cloud-computing domain" that used the examined resources like as „bandwidth", „energy", and „delay" and so on in the computer network to make possible the execution of immense jobs that need large-scale computation time.

2.7 Hadi et al. [2010] solved resource allocation problem using SLA violations. For solving this problem, the upper limit of total revenue has been offered with the help of „Force-Directed Resource Assignment" FRA as a heuristic algorithm, in which original way out is depends on providing a resolution for upper limit profit issue. The main technique of server agglomeration is VM. Conventional methods usually find out a exclusive VMs placement before

providing services in the manufacturing environment. Though, such methods are not appropriate to cloud scheme due to the uniqueness and the time-variation of the workload through which hosted services are presented, which is the reason of changes in the operative circumstances of the services and if the services have not taken into account this may enhance the likelihood of an SLA violation.

2.8 Dhiman et al. [2009] focused on Green developed framework Predictive Control (MPC) balance algorithm that concentrates on the reduction of CPU and memory utilization, sum of power saved up to 15% to 20% of total power is required. Power is directly proportional to energy, so, amount of energy is also saved.

2.9 Farahnakian et al. [2015] proposed a distributed architecture for performing dynamic virtual machine consolidation for lessening the consumption of energy of the data centers of cloud with the maintenance of required QoS. As the VM consolidation issue is probably the NP- hard problem, to solve this problem an online optimization Meta heuristic algorithm has been used known as Ant colony system (ACS). The presented ACS is dependent on VM consolidation method with an enhanced solution having an accurate objective function. The results have depicted that the real workload traces that ACS-VMS has reduced the energy consumption when the maintenance of the required performance in cloud data centers is taken place. The proposed work has performed better as compared to the existing VM approach by means of a number of VM migration and energy consumption.

2.10 Masdari et al. [2016] reviewed VM placement method for data centers and cloud computing. The approach discussed has been categorized as the VM placement method on the basis of the placement algorithm and have assessed the objectives and the capabilities. Furthermore, the advantages and properties of VM placement with the schemes have been compared.

2.11 Steinder et al. [2008] proposed a method of how to manage heterogeneous workloads in a data center consists of virtualization. They convey a method of placement of workload dynamically, on the same hardware, in order to increase utilization of resources. The

performance function in the method used to check out the performance of di_erent workloads and analyse them.

2.12 Yatendra et al. [2013], proposed a dynamic compare and balanced algorithm that works on dynamic threshold values. The method is an algorithm uses load balancing and consolidation of server techniques. In the technique, the resource consumption is noted and whenever needed process are migrated so that the load get balanced and thus minimizing the power consumption.

2.13 Ahuja et al. [2008] have explores the dynamic placement of applications in a system comprised of VMs , while optimizing the consumption of power and within the SLA constrained. They have proposed the pMapper application placement framework, which comprises of 3 managers and an arbitrator, and they coordinates their respective actions and then make the allocation decisions.

2.14 Srikantaiah et al. [2008] have studied the multi-tiered web-applications problem in virtualized heterogeneous systems in order to minimize energy consumption. To optimization energy consumption, the authors have proposed a heuristic for the multidimensional bin packing problem as an algorithm for workload consolidation.

2.15 Kang et al. [2010] have discussed in maximizing reliability of distributed computing systems with genetic algorithm based task allocation and the task have represented in task graph. This comparison of different heuristic through simulations proves the effectiveness of genetic algorithms on HDCS. Several researchers have used GA for load balancing on cloud computing systems; however the majority of the papers has no specifc representation of the genetic algorithm.

2.16 Braun et al. [2001] compare eleven heuristic and meta-heuristic scheduling methods including of a simple GA-based scheduler, Min-Min, Min-Max, Minimum Completion Time algorithms. The experimental study was performed for task scheduler for independent task in distributed heterogeneous computing environment. The task execution time instances have defined using the ETC matrix.

2.17 Jung et al. [2008] proposed an approach that combines a queuing model with an optimization model is given. The optimization model is a bin packing-like model with the objective to maximize a utility function, which is based on the performance of the multi-tier services running in the data center of an infrastructure provider. The proposed algorithm selects the replication level at each tier, and places the resulting components by the first fit heuristic. In the search for the best replication levels, according to the utility function, the algorithm starts with the maximum replication levels (i.e., maximum performance and utility) and gradually reduces them until the algorithm stops when finding a feasible packing of the components.

2.18 Mirobi et al. (2015) proposed a state of art of SLA, benefits of c1oud computing, the need of c1oud computing, the significance of SLA, c1assification of SLA and SLA-based c1oud structure of c1oud computing. Cloud computing is defined an internet-based computing, offering the on-demand facilities through the internet like as servers, storage_disk, dissimilar platforms and apps to some business organization. SLA is an agreement, contracted among service provider and the third party such as service purchaser, trader and monitor, where service is officially defined. In fact, the term SLA is used to refer to the delivery period of a contracted service and is used to assess the performance of the service. Cloud computing is a state-of-the-art technology that provides a large number of services for critical business applications, a reliable and flexible management. Therefore, SLA is very important for the smooth development of cloud business. The SLA is a legal, formal and negotiated document that defines services based on quantitative and qualitative indicators. The metrics involved in the SLA should be able to measure on a consistent basis and the SLA should be evaluated through this metric. SLAs play a role in the lifecycle of a service. SLA cannot an assurance that clients can access the service as illustrated in the SLA documentation.

2.19 Eman et al. (2015) presented a technique used to solve resource utilization problem in cloud computing. A private cloud is assumed to serve a large number of users. For a given resource, hundreds or thousands of requests are accumulated over time to be used by different users around the world over the Internet. A previous knowledge of the request to employ the resource has also been considered. The main aim of this research is to determine the most excellent utilization schedule for a known resource based on the profit earned from the resource and the number of time periods in which the resource is utilized. This problem demonstrates an

NP-complete problem and to solve this problem a greedy algorithm has been proposed and examined based on its runtime complexity. The analyzed results show good performance implemented in JAVA software with runtime complexity.

2.20 Khoshdel et al. (2011) proposed a heuristic scheme to enhance the resource management and then utilized fuzzy logic to solve the issues of resource management. These algorithms are implemented as practical clouds on Eucalyptus. The results obtained by the fuzzy and heuristic algorithm have been compared with those obtained by the original algorithm of resource request scheduling in Eucalyptus. Experimental results illustrated that using these algorithms results in resource utilization by to 65% more than the original request scheduler in the Eucalyptus have been obtained. Increased cloud resource utilization by at least 20% across all types of incoming requests. Computed results demonstrated that using fuzzy algorithms enhance the resource utilization in the cloud, but comparing the balance request with other requests shows that this incoming request can obtain a better knot using the fuzzy algorithm, and hence improving the performance of the proposed algorithm. One of the resolutions is to balance arriving cloud requests from senior levels. This means that requests can be balanced between associated cloud computing resource ratios.

3. Research Gap

There are an increasing number of Cloud Services available in the Internet. Cloud services can be a component of a system and different Cloud Servers that would provide different services. In this present work we have defined a multiple cloud environment. Each cloud server is defined with certain limits in terms of memory and the cpu specifications. Now as the users enter to the system, the user request is performed in terms of processes. To represent the parallel user requests, n number of requests are been generated by the users. All these requests are to be handled by the cloud servers in parallel by using the multiple cloud concept. A middle layer is defined between the cloud servers and the client requests that will perform the allocation of the processes to different clouds in under load and over load conditions. As user requests are performed, some parameters are also defined with each request. These parameters are the process time, deadline, input output specifications etc. In the general case, the allocation of the processes are performed in a sequential order. Each process must be executed within the deadline limit. But

if more than one processes occur at same time and not get executed before the deadline, in such case the processes is switched from one cloud server to other called the process migration. In this present work, a parametric analysis is performed to identify the requirement of process migration and based on this analysis the migration will be performed on these processes. The effectiveness of the work is identified in terms of successful execution of the processes within the time limits.

4. Problem Formulation

The modern era of computation including the cloud platform, faces a lot of issues like reduction of the computation complexity, minimization of computation overload, resource utilization etc. To resolve these issues, concept of virtualization came in to picture. It not only shares the load of physically available computation machine known as Physical Machine (PM) but also speedup the processing. Introduction of Virtual Machines (VMs) solves the issues related to PMs but it has its own challenges as well. As per conventional concepts, a VM is created and turned on when a PM is overloaded. When a VM is turned on it takes sometime to settle down and hence the futuristic job models like zooming in and out of a 3D mapin a zoom will not allow any wastage of time for its turning ON and OFF. Solution to this problem led to development of MBFD and MM algorithms. The allocation policy may have certain shortcomings like false allocations and unwanted energy consumption which not only increase the cost of computation but also affects the global warming.

The prime focus of this research work is to optimize the allocation policy and to cross validate the migration system in order to optimize Quality of Service (QoS) parameters.

The parameters used are as follows:

Energy consumption

i. Total number of migrations
ii. SLA violation
iii. Time consumption
iv. Accuracy
v. Number of jobs completed

5. Research Objectives

This research encompasses a set of objectives that are associated with the resource allocationprocess. The objectives are mentioned as follows.

1. To study the previous implemented algorithms and architecture of VM allocation andmigration.
2. To evaluate, compare and validate the proposed algorithm with previous architecturesusing QoS parameters.
3. Create an Intermediate Architecture that will accept the user request and monitor the cloud servers for their capabilities.
4. Scheduling of the users requests is performed to identify the order of allocation of the processes.
5. Performing the effective resource allocation under defined parameters and the cloud server capabilities.
6. Define a dynamic approach to perform the process migration from one cloud to other.

6. Proposed Research Methodology

These phases can be described as follows:

The proposed system is a middle layer architecture to perform the cloud allocation in case of underload and overload conditions. The over load conditions will be handled by using the concepts of process migration. The middle layer will exist between the clouds and the clients. As the request will be performed by the user this request will be accepted by the middle layer and the analysis of the cloud servers is performed by this middle layer. The middle layer is responsible for three main tasks

1. Scheduling the user requests
2. Monitor the cloud servers for its capabilities and to perform the process allocation

3. Process Migration in overload conditions

A discussion towards the Resource Management of Virtual Machines in CLOUD and how to make resources more efficiently available to clients, is provided. The notion of Job Scheduling is addressed.

Phase 1

A novel approach to optimize job deadlines when run in virtual machines by developing a deadline-aware algorithm that responds to job execution delays in real time, and dynamically optimizes jobs to meet their deadline obligations.

Phase 2

Cloud computing system is featured by its workload, deadline and corresponding utility obtained by its completion before deadline, which also are factors considered in devising an effective scheduling algorithm.

Utility is attained from completed jobs. So amount of utility that cloud system obtained is defined in terms of completion of jobs.

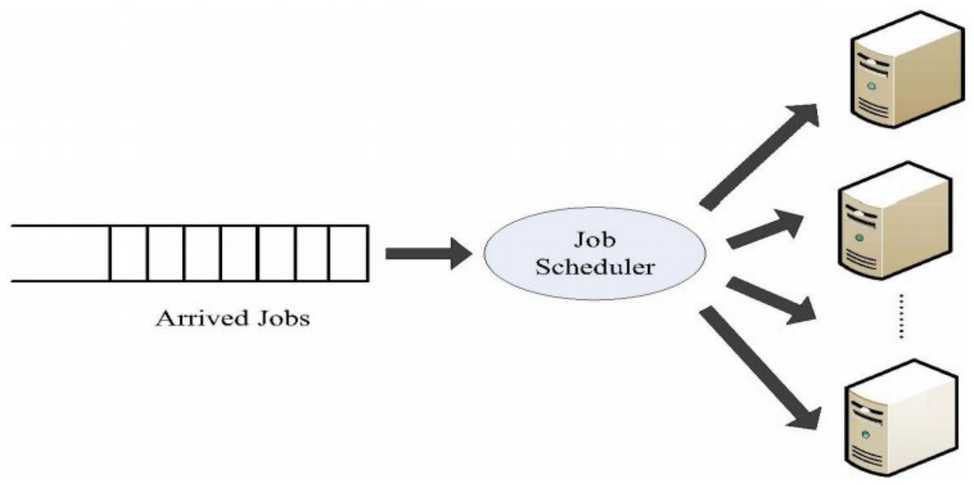

Figure 3 : Job Scheduler

Phase 3

To serve to diverse user communities with often competing Quality of Service (QoS) requirements for their jobs/virtual machines, some jobs being more CPU or memory intensive than the others and vice versa, requires a dynamic and intelligent resource scheduling which is

adaptive as the nature of workloads at any given moment changes. QoS varies from different utility context such as its different for EC2 user community.

Phase 4

In this paper, we propose a new set of metrics, called potential capacity (PC) and equilibrium capacity (EC), of resources that incorporate these dynamic, elastic, and sharing aspects of co-located virtual machines. We then show that we mesh this set of metrics smoothly into traditional scheduling algorithms.

7. Conclusion

This paper presented the findings of a thorough examination of studies on consolidation approaches for the years 2015 through 2023. The fundamental concepts underlying VM consolidation have also been explored as a means of developing green data centers by reducing their power and energy usage. 119 appropriate research articles were selected for the review based on inclusion and exclusion criteria as well as quality criteria. Consolidating virtual machines for cloud computing can be difficult since it's difficult to achieve the right balance between energy usage, resource usage, and service quality demands. The challenge arises due to the dynamic nature of cloud workloads and the varying resource demands of different applications. While VM consolidation tries to reduce energy consumption, the energy usage of cloud data centers cannot be reduced without compromising service quality. To address these challenges, researchers need to explore more advanced algorithms to make an energy-efficient cloud system without violating service-level agreements with the cloud user. Future research is aimed at developing a multi-objective system that emphasizes minimizing cloud energy usage without sacrificing service quality, preventing service level agreements from being compromised. Moreover, the cloud system needs to be empirically tested on a variety of real-world cloud platforms, e.g. open stack, Amazon EC2, etc. In addition, more research is needed on the open issues that were brought up in this review, like the need for a common framework for VM consolidation as well as methods to lessen the burden of VM migration.

References:

[1].Adeeb, P, A., "Cloud deployment model", Retrieved from: https://www.researchgate.net/figure/Cloud-deployment model_fig2_260192916, 2014.

[2]. Ahmad, R, W., Gani, A., Ab.Hamid, S, H., Shiraz, M., Xia, F., "Virtual Machine Migration in Cloud Data Centers: a review, taxonomy and open research issues", The Journal of Supercomputing, Springer Science & Business Media, New York, ISSN: 1573- 0484, Vol. 71, Issue 7, pp. 2473-2515, 2015.

[3].Bamini, A and Enoch, S. "Dynamic Scheduling and Resource Allocation in Cloud". International Journal of Control Theory and Applications, Vol. 10, Issue 3, pp. 63-72, 2017.

[4].Beasley, J, E. and Chu, P, C., "A Genetic Algorithm for the Set Covering Problem." European Journal of Operational Research, Vol. 94, Issue 2, 1996, pp. 392–404., doi:10.1016/0377-2217(95)00159-x.

[5].Beloglazov, A., Abawajy, J., Buyya, R., "Energy-Aware Resource Allocation [6].Heuristics for Efficient Management of Data Centers for Cloud Computing." Future Generation Computer Systems, Vol. 28, issue 5, pp. 755–768, 2012, doi:10.1016/j.future.2011.04.017. Elsevier

[6].Beloglazov, A., Buyya, R., "Energy Efficient Allocation of Virtual Machines in Cloud Data Centers." 2010 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing, ISBN: 978-0-7695-4039-9, pp. 577–578, 2010 doi:10.1109/ccgrid.2010.45.

[7].Beloglazov, A., Buyya, R., "Managing Overloaded Hosts for Dynamic Consolidation of Virtual Machines in Cloud Data Centers under Quality of Service Constraints." IEEE Transactions on Parallel and Distributed Systems, ISSN: 1558-2183 Vol. 24, Issue. 7, pp. 1366–1379, 2013, doi:10.1109/tpds.2012.240.

[8].Beloglazov, A., Buyya, R., Lee, C, Y., Zomaya, A., "A Taxonomy and Survey of Energy-Efficient Data Centers and Cloud Computing Systems", Advances in Computers, Elsevier, ISSN: 00652458, Vol. 82, pp. 47-111, 2011.

[9].Michael Menzel," CloudGenius: Decision Support for Web Server Cloud Migration", WWW 2012, April 16–20, 2012, Lyon, France. ACM 978-1-4503-1229-5/12/04.

[10].Kento Sato," A Model-Based Algorithm for Optimizing I/O Intensive Applications in Clouds using VM-Based Migration", 9th IEEE/ACM International Symposium on Cluster Computing and the Grid 978-0-7695-3622-4/09© 2009 IEEE

[11].Takahiro Hirofuchi," Enabling Instantaneous Relocation of Virtual Machines with a Lightweight VMM Extension", 2010 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing 978-0-7695-4039-9/10© 2010 IEEE

[12] Anton Beloglazov," Energy Efficient Allocation of Virtual Machines in Cloud Data Centers", 2010 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing 978-0-7695-4039-9/10 © 2010 IEEE

[13] J. Brandt," Using Cloud Constructs and Predictive Analysis to Enable Pre-Failure Process Migration in HPC Systems", 2010 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing 978-0-7695-4039-9/10© 2010 IEEE

[14].Anton Beloglazov," Energy Efficient Resource Management in Virtualized Cloud Data Centers", 2010 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing 978-0-7695-4039-9/10© 2010 IEEE