Design and Implementation of Virtual Machine Migration Method in Cloud Computing

[1]Shubhashish Goswami, [2]Digvijay Singh, [3]Sachin Sharma
[1]Associate Professor, Computer Science & Engineering, School of Computer Science & Engineering, DevBhoomiUttarakhand University, Chakrata Road, Manduwala, Naugaon, Uttarakhand 248017
[2,3]Assistant Professor, Computer Science & Engineering, School of Computer Science & Engineering, DevBhoomiUttarakhand University, Chakrata Road, Manduwala, Naugaon, Uttarakhand 248018
[1]coe@dbuu.ac.in, [2]socse.digvijaysingh@dbuu.ac.in, [3]socse.sachin@dbuu.ac.in

Article Info
Page Number: 138 – 148
Publication Issue:
Vol. 71 No. 3s (2022)

Article History
Article Received: *22 April 2022*
Revised: *10 May 2022*
Accepted: *15 June 2022*
Publication: *19 July 2022*

Abstract
The cloud is a communication architecture that includes virtual machines, data centers, hosts, and brokers. For cloudlet execution, the broker looks for the most reliable virtual machine. Uncertainty may arise in the network as to which system is overloaded. A work technique is proposed in this study to improve the system's fault tolerance. The proposed enhancement is based on the ACO algorithm, which can determine the best virtual machine to migrate a cloudlet to. The proposed algorithm's performance is being evaluated on Cloudsim in terms of execution time and energy consumption. When compared to TESA, the simulation results showed that ACO (Ant Colony Optimization) takes the least amount of time and energy to run (Three Step Encryption Algorithm). The proposed algorithm can be used in cloud computing for load balancing.
Keywords: Cloudlet, ACO, Migration, virtualmachine.

1. Introduction

This paper provides an introduction to green cloud computing, which is a new type of cloud computing service. In the following section of this chapter, the basic architecture of green cloud computing is also presented. In addition, the major issues that this technology faces are briefly discussed. Within the green cloud computing scenario, the Virtual Machine (VM) Migration is discussed in the final section.

1.1 Cloud Computing

Cloud computing is a type of computing. The number of systems connected in public and private networks is large in this case. The goal of cloud computing is to provide a dynamically scalable infrastructure for applications that have previously been used to store data and files. The invention of cloud computing has drastically reduced the cost of application hosting, content storage, and delivery, as well as the time it takes to do so.

a) Figure 1.1 depicts the cloud computing diagram. It demonstrates the use of cloud computing in a variety of devices, including computers, televisions, phones, codes, app servers, and databases. CSPs and ISPs both provide these services (Internet Service Providers). Clouds provide metered services, which are used by consumers. With the help of this mechanism, pricing plans and models can be created. This accounting model can be used to manage and optimize resource utilization.
b) • Autonomous: Clouds use autonomous behavior to manage their own systems in the event of failures or performance degradation due to the presence of highly reliable services.
c) 1.1 Cloud computing that is green
d) Cloud computing is a scalable and cost-effective infrastructure for a variety of applications, including HPC, enterprise, and Web applications. However, there is one major critical issue with cloud computing that has emerged as a result of its increasing demand, which has resulted in a significant increase in energy consumption in data centers. High energy consumption not only raises operating costs, reducing cloud providers' profits, but it also has an environmental impact, as high energy consumption results in high carbon emissions. As a result, energy-efficient solutions are required to reduce the environmental impact of Cloud computing [2]. Green cloud computing can help achieve the goal of making the cloud more environmentally friendly.
e) Green computing is the environmentally friendly use of computers and related resources. To achieve this goal, energy-efficient central processing units, as well as servers and peripherals, have been implemented, as well as resource reduction and proper disposal of electronic waste [3]. The computer, servers, and other subsystems that are associated with it, such as monitors, printers, networking and storage devices, or communication systems, are used to dispose, design, and manufacture by green computing. It has met all of the requirements while having no negative impact on the environment in terms of achieving effective and efficient results. The key or important area of research in the field of computing is computer technologies related to efficiency that have been used to make it efficient.
f) 1.1.1 A green cloud computing platform's architecture
g) A high level of architecture has been shown in Figure. 1.2 in the Green cloud computing environment, which is capable of supporting energy efficient allocation services. The following are the four main elements involved in this:
h) Consumers: Cloud consumers can submit services from anywhere in the world. There is a distinction to be made between users of deployed services and cloud computing. A web application deployed company can be a consumer, and the workload has been presented in terms of varying workload based on the number of users accessing it [4].
i) Green Resource Allocator: It has provided the infrastructure between consumers and cloud infrastructure. Interactions between the following components are required to support energy efficient resource management:
j) Green Negotiator: The consumer's QoS requirements and various energy sharing schemes are factors that aid in the finalization of prices between the consumer and the cloud provider. Negotiations with consumers/brokers resulted in the finalization of the SLA with specified prices. The QoS metric can be 95 percent of requests that need to be served in Web applications

in less than 3 seconds.

k) Consumer Profiler: Because there are a large number of consumers who use computing services, special privileges consumers are given priority by gathering consumer characteristics.

l) Pricing: Charges for service requests must be decided in order to prioritize an allocation of services in an effective manner for managing computing demands and supply.

m) Energy Monitor: By observing [5], the physical device that needs to be powered off/on has been determined.

n) VM Manager: It has been used to track the availability of the assigned resources and virtual machines. It also has control over how virtual machines are moved between physical machines.

o) Accounting: In order to maintain an actual use of resources, usage costs have been computed by request, and service allocation decisions have also been improved using historical data.

p) Virtual machines: To meet the demands of accepted requests, a single physical machine was used to dynamically start and stop multiple virtual machines. Different specific service request requirements were met by using the same physical machine, which allowed for the most flexibility in configuring different portions. A single physical machine can be used to run multiple applications in different virtual machines at the same time [6]. By dynamically migrating VMs across physical machines that help manage a workload, a resource that is not in use can be put into a low-power state. When a system is not in use, it is turned off or set to a low power level, which saves a significant amount of energy.

q) Physical Machines: The hardware infrastructure provided by physical computing servers that create virtualized resources has met the service demands.

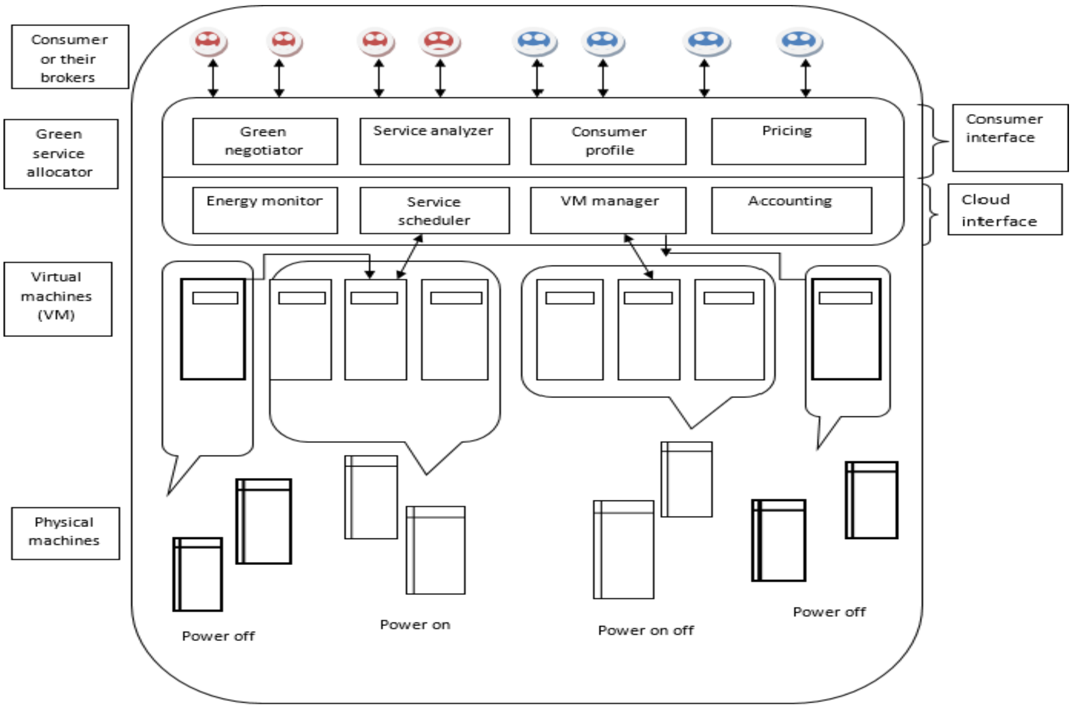


Figure.1.2: Architecture of green cloud computing environment

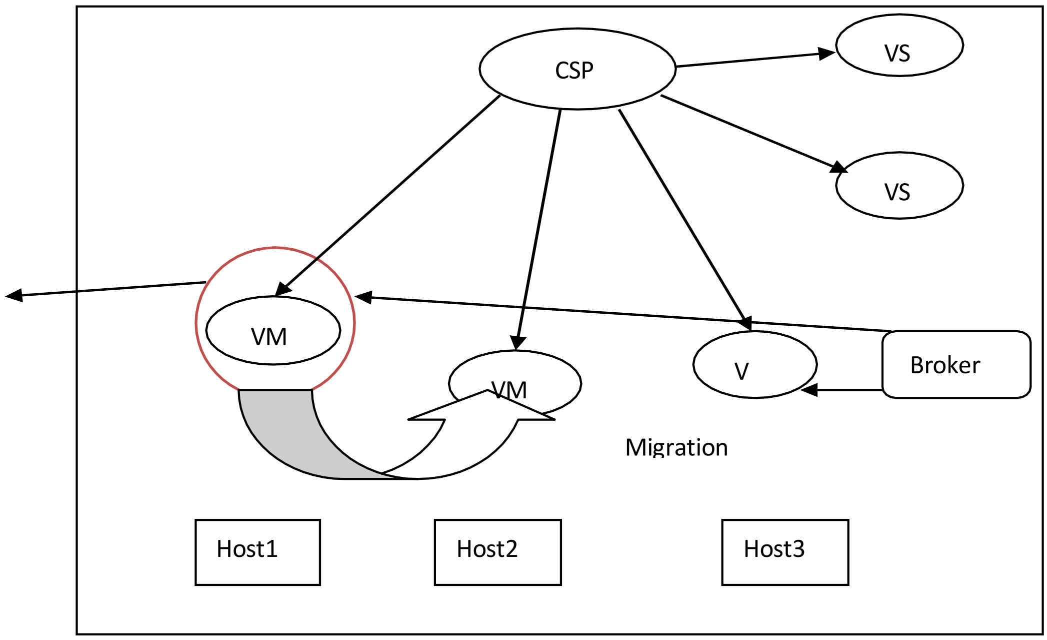
1.1 Challenges of Green cloud computing [4]:

- Requirement for a New Optimization Technique: A tradeoff between temperature and energy is required in order to achieve the high-performance goal.

- Reduce Architecture Complexity: In order to reduce the amount of power required to start a system, the dependencies between different components must be reduced.
- Demand for Efficient Data Centers: In order to save a significant amount of energy, very limited IT equipment is required, further reducing the need for large data centers.
- Creating Green Maturity Indexes: IT equipment requires a maturity index that aids in the improvement of greenness.
- Performance deprivation: By lowering server performance, power consumption and energy throughput have increased [9].
- Platform management: In order to deploy and maintain applications in a scalable environment, server density must be managed. The operating cost is higher in terms of energy because it necessitates a large amount of server density to run cloud applications.

1.2 Migration of Virtual Machines (VMs)

- Green cloud computing has a number of drawbacks. The Virtual Machine (VM) is the most important of all the issues to consider. The VM allocation problem has been divided into two parts, as shown below [10]:
- The first part of the job entails placing virtual machines on hosts in response to new requests for VM provisioning.
- The second part of the current VM allocation needs to be optimized.



Overloaded

Fig.1.3:Virtual mitigation Migration

Additionally, there are two steps to optimizing the current VM allocation:

• In the first step, the migrated VMs were chosen.

The MBFD algorithm was used to place selected VMs in the second part's functioning.Cloud operation costs are reduced to a large extent by increasing the level of cloud resource utilization through the use of virtualization technology. However, if virtualization is not properly implemented in cloud data centers, cloud performance can suffer significantly. Virtual machine (VM) migration is a technique that helps cloud service providers manage cloud resources more efficiently while removing the need for human supervision. The live or non-live migration pattern is used to migrate current-hosted workload from one server to another in VM migration methodology. Live migration does not suspend application services prior to the VM migration process, unlike non-live migration. Green computing, load balancing, fault management, and real-time server maintenance are just a few of the resource management goals that VM migration enables cloud operators to achieve [11].The VM is moved from one host to another based on some parameters, as shown in the diagram below. The VM migration process is the name for this procedure.

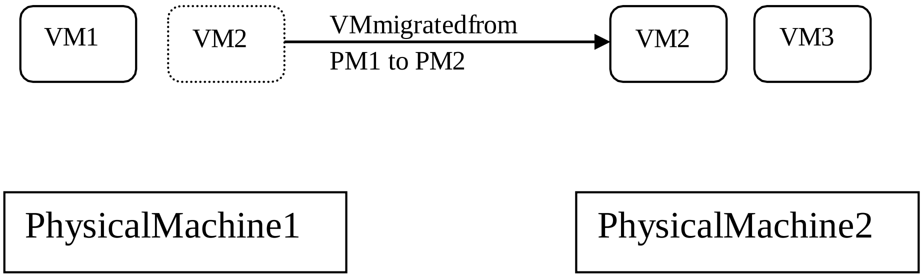


Fig1.4:VMmigration process

1.2 GeneticAlgorithm

Genetic Algorithms are heuristic search methods that can be used to solve a variety of optimization and learning problems. It is based on biological evolution principles, is simple to construct, and does not require a large amount of storage, making it a viable option for solving an optimization problem. The following are the basic steps involved in using Genetic Algorithm:

a. Population selection: The fitness of objective function values has been used to select the population of an individual for reproduction [12].

b. Crossover: The genetic information of the two individuals has been merged, and only proper coding will result in the production of good children.

c. Mutation: In the case of true evolution, improper reproduction or deformation of other genes results in changes in genetic materials. A string is randomly de-formulated in the process of mutation by genetic algorithms with a certain probability.

d. Sampling: It is based on a spring that computes a new generation based on a previous one.

1. Review of the Literature 2.1 [14] Mohammed Amoon et al., (2019) Because of their inherently unstable nature, cloud computing systems have a higher risk of failure. Furthermore, the size of a cloud computing system changes over time, making failures a common occurrence. Failures have a significant impact on cloud performance and the benefits that customers and providers expect. Fault tolerance is a critical challenge for cloud providers to overcome in order to mitigate the effects of failures while keeping the Service Level Agreement (SLA) in place. One of the most well-known reactive fault tolerance techniques in distributed computing is checkpointing. However, depending on the interval of the checkpoint used, it can result in significant overheads, which can degrade cloud performance.

2.2SeyedehSolmazMadani et al., (2018) [15] Cloud computing has grown in popularity as a widely used computing technology. For users, there must be dependability and availability. This necessitates the use of tried and true tolerance methods that can handle any type of fault in any way. Fault tolerance is required when a fault crosses the system's boundary. As a result, fault tolerance techniques are used to predict failures and take the necessary actions before damage occurs. In cloud computing, two important parameters are reliability and availability. As a result, we require a fault tolerance method that will prepare cloud computing services for the resulting faults and failures.

2.3MeysamMasoudi et al. (2017) investigated [16] the problem of power minimization for user terminals in multi-cell multi-user OFDMA mobile cloud computing networks with some practical constraints such as backhaul capacity limitation, interference level on each channel, and maximum tolerable delay as user's quality of service. The mixed integer nonlinear problem is also converted to a convex form using the D.C. approximation. The authors then proposed a joint power allocation and decision making (J-PAD) algorithm to solve the optimization problem, which can make an offloading decision and allocate power at the same time. The simulation results of this new proposed algorithm show that when compared to baselines, the J-PAD algorithm saves a significant amount of power, e.g. about 30% for delays greater than 100ms. Still, there is a need to improve power efficiency and reduce the delay even further.

2.4According to JagadeeswaraRao et al. (2017), cloud computing is a great platform for corporate world to reduce their expenditure on resources such as software, platform tools, and infrastructure. Cloud computing provides a low-cost, high-scalability, and high-performance infrastructure. The services are provided by the [17] cloud service providers through a large data center. These data centers are organized into clusters, with each cluster consisting of several physical machines. Virtual machines will be created from these physical machines, and clients will access the services through these virtual machines. Increased demand on the data center will result in increased power consumption and carbon emissions.

2.5 For efficient green cloud computing using virtualization techniques, Mr. Nitin S. More, et al., (2017) recommend studying various techniques, models, and algorithms. There are a variety of power-saving techniques that can assist in improving the efficiency of systems depending on the server and network involved. All of these strategies will be examined in order to present a study of the current methods [18].. They didn't work on the computation-to-power ratio, which aids in better resource utilization while consuming the least amount of energy.

2.6EhsanArianyan (2016) proposed consolidation as a novel energy-saving technique for Cloud data centers. One of the major flaws of current consolidation studies is that they concentrate solely on one criterion while ignoring others. This study proposed a novel multi-objective consolidation solution based on the modified analytic hierarchy process (AHP) technique.

2.7In this paper, Federico Larumbe, et al., (2016) present [20] that the response time of the systems is lower for users who are close to the VMs. As a result of the distribution of VMs near the users, the QoS for those users is improved. The impact of increasing cloud energy consumption is extremely negative. It may also have an impact on the planet's global warming. The solution to this problem is to place virtual machines (VMs) in data centers that use green energy sources in their systems. For managing applications with such dynamic demand, a comprehensive optimization modeling system is provided. In order to resolve the issues, an effective search heuristic is developed.

2.8Virtual machine consolidation, according to ChonglinGu et al. (2015), is the best solution for research utilization. More power can be saved here once the power consumption of each VM is known. Because power consumption is difficult to calculate directly, a variety of modeling methods are proposed here to calculate it. The performance of current models is not very accurate when multi-VMs compete for resources on the same server. Individual VM accuracy, on the other hand, is not computed in this paper.

2.9 Ke HAN, et al. (2015) conducted research on the cooperative behavior of multiple cloud servers and presented a hierarchical cooperative game model for improving energy efficiency in Green Clouds. This paper proposes an evolutionary mechanism that allows for a change in the multiplexed methods that are required for initial optimal solutions for various users. As a result, the efficiency loss in these systems is reduced. This algorithm has taken into account both optimization and fairness. In a public cloud environment, game theory is used to improve the efficiency of virtual machine deployment. The [22] disadvantage of this scheme is that only Nash equilibrium exists when the resource allocation game has feasible solutions.

2.10 Antonio Marotta, et al., (2015) argue in this paper [23] that big data centers must reduce their consumption while utilizing virtualization technology. This is primarily due to the pollution they cause to the environment, as well as other economic issues that arise within these systems. The virtual machine consolidation method is one of many that can assist in lowering energy consumption in these systems. The main goal of this paper is to maximize cost efficiency while reducing the number of active nodes in use in a system. To consolidate the problem, a novel technique is proposed. On the basis of a simulated annealing-based algorithm, the attractiveness of possible VM migrations can be assessed. Other issues concerning the VM's topology and traffic are not discussed in this paper.

2.11In this paper, Bharti Wadhwa et al. (2014) propose a novel approach for reducing carbon emissions and energy consumption in distributed cloud datacenters. Within the cloud's distributed architecture, the proposed architecture made use of datacenter carbon footprint rates. The authors of [24] have also included a method for virtual machine allocation and migration in order to reduce carbon emissions and energy consumption in federal cloud systems. The proposed work's simulation results show that this novel technique aids in reducing CO_2 emissions as well as the amount of energy consumed in cloud datacenters. The findings are also compared to the previously proposed scheduling method, which includes round robin VM scheduling within their cloud datacenters.

2.12 Two new dynamic VM migration algorithms have been proposed by Jing Huang et al. (2014). A method of local regression was used to predict the potential overutilized servers, and then 0-1 knapsack dynamic programming was used to find the best fit VMs combination. The [25] results of this algorithm were examined in terms of time complexity and found to be highly scalable when compared to existing algorithms in terms of various performance parameters. The energy consumption, as well as the number of VM migrations that necessitate server reboots, have been significantly reduced thanks to two new heuristics schemes.

2.13 SupriyaKinger, et al. (2013) concluded that the goal of energy savings can be achieved through continuous VM consolidation. The current utilization of cloud computing thermal states has been used to move towards green computing consolidation [26]. Consolidation and resource management are linked in some way. Virtual machine migration has saved a significant amount of energy in the cloud. Workload management has been used in this paper for migration, which aids in keeping the temperature power consumption under control.

2.14 According to N. Rasouli et al. (2013), the use of large data centers causes issues such as greenhouse gas emissions and increased energy costs. As a result, providing an efficient method for reducing data center energy consumption has become a key topic for researchers. The authors of this paper [27] propose a learning automaton-based new approach to reduce power consumption and the need for virtual machine dynamic replacement in data centers.

2. Statement of the Issue: Green cloud computing is a cost-effective method of reducing energy consumption when storing data in the cloud. Virtual servers, brokers, and cloud service providers are all involved in data communication in the network architecture. Cloudlets are assigned to the most capable virtual machines by brokers, who are a third party. The broker is used in the base paper to select the most capable virtual machine for cloudlet execution using a meta-heuristic algorithm.

3. Model and Methodology Proposed

3.1 Model Proposed

Green cloud computing is a low-energy approach to cloud computing that stores and processes data in the cloud. The occurrence of faults is a major issue in green cloud computing, lowering its efficiency. The meta-heuristic approach is used in the base paper for cloud assignment and execution. The ACO (Ant Colony Optimization) algorithm will be used for task execution and assignment in this study. In the event of machine overload, the ACO algorithm is used to migrate the task from one virtual machine to another. The ACO algorithm operates in three phases, as detailed below: -

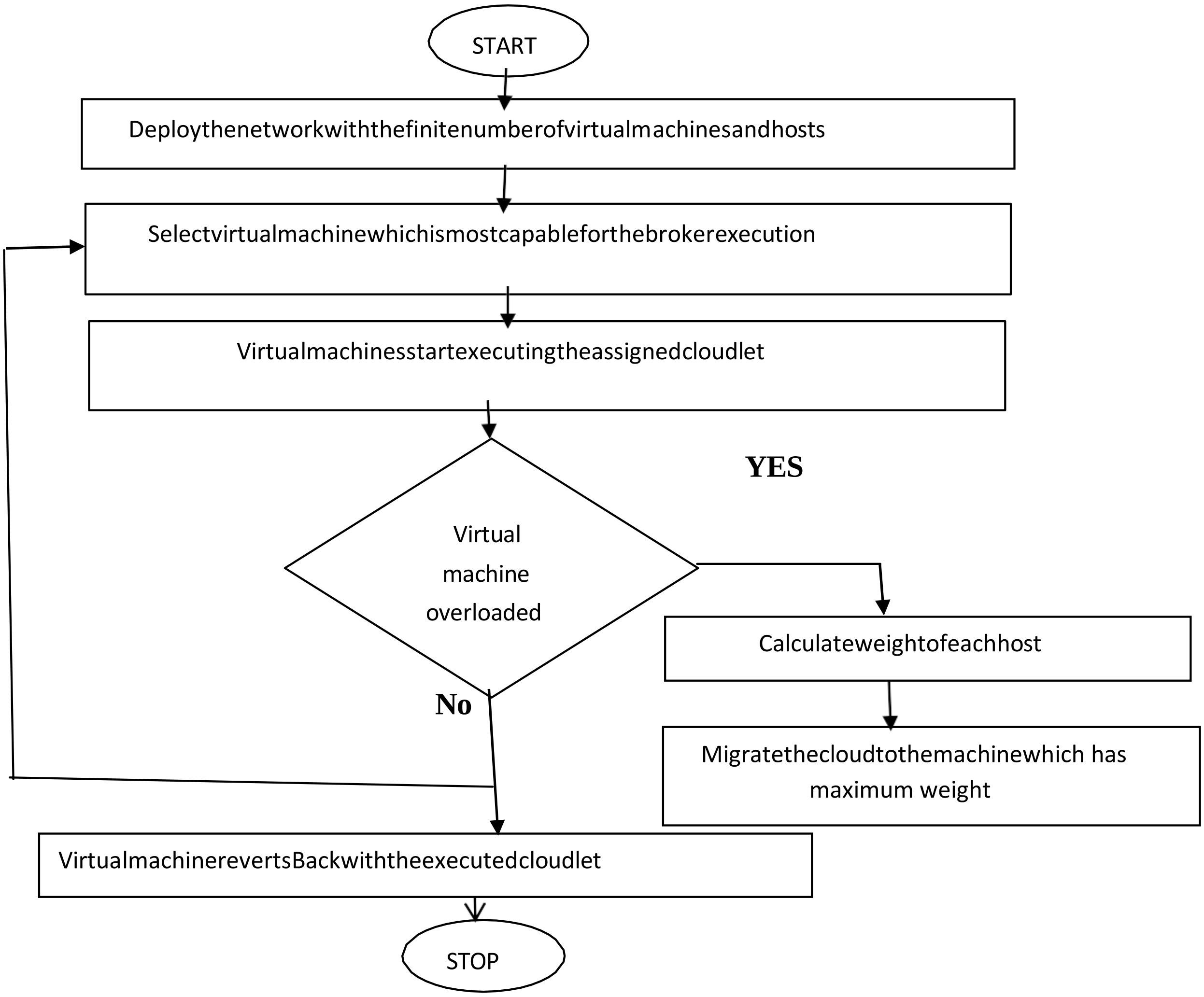


Fig5.1:SystemModelflowdiagram

The network is set up with a limited number of virtual machines, a cloud service provider, brokers, and a host, as shown in figure 5.1. The broker is a third party that assigns tasks to the most capable machine, and the broker uses the ACO algorithm to select virtual machines. When one or more virtual machines become overloaded, the genetic algorithm will be used to migrate them. In terms of certain parameters, the performance of proposed and existing algorithms will be compared.

References:

[1] Abdallah Ali Z. A. IBRAHIM, Dzmitry KLIAZOVICH, Ariel OLEKSIAK, “Virtual Desktop Infrastructures: architecture, survey and green aspects proof of concept”, IEEE, vol. 35, 130-138, 2016.

[2] S. Agarwal, R. Biswas, and A. Nath, “Virtual Desktop Infrastructure in Higher Education Institution Energy Efficiency as an application of Green Computing”, IEEE Fourth International Conference on Communication Systems and Network Technologies, vol. 27, 110-121, 2014.

[3] A. Kochut, "Power and Performance Modeling of Virtualized Desktop Systems”, IEEE

International Symposium on Modeling,Analysis and Simulation of Computer and Telecommunication Systems, vol.30, pp.354-362, 2009.
[4] GaganjotKaur,SugandhiMidha,“Apreemptive priority-basedjob schedulingalgorithmingreen cloud computing”, IEEE, vol. 27, pp. 152- 156, 2016.
[5] ShreenathAcharya, DemianAntony D'Mello, “Ataxonomyof LiveVirtualMachine(VM) Migrationmechanismsincloudcomputingenvironment”,IEEEConferencepublication,vol.37, 809-815, 2013.
[6] Pushpendra Kumar Yadav, Dr.N.L.Prajapati, “An Overview of Genetic Algorithm and Modeling”,IEEEInternationalJournalofScientificandResearchPublications,vol.2,pp.1-4,2014.
[7] J.Gubbi,R.Buyya,S.Marusic,M.Palaniswami,“Internetofthings(IoT):Avision,architectural elements,andfuture directions,” ElsevierFuture Generation ComputerSystem, Vol. 29, pp. 1645– 1660, 2013.
[8] A.Sgora andD.D.Vergados,“Handoffprioritizationanddecision schemesinwirelesscellular networks: a survey,” IEEE Communications Surveys Tutorials, Vol. 11, No. 4, pp. 57-77, April 2009.
[9] I.Mashal,O.Alsaryrah,T.-Y.Chung,C.-Z.Yang,W.-H. Kuo,andD.P.Agrawal,“Choicesfor interaction with things on Internet and underlying issues,” Ad Hoc Networks, vol. 28, pp. 68–90, 2015.
[10] O. Said and M. Masud, “Towards internet of things: survey and future vision,” International Journal of Computer Networks, vol. 5, no. 1, pp. 1–17, 2013.
[11] M.Wu,T.-J.Lu,F.-Y.Ling,J.Sun,andH.-Y.Du,“Researchonthearchitectureofinternetof thing”, 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE '10), vol. 5, pp. V5-484–V5-487, 2010.
[12] Zeinab Kamal AldeinMohammeda, ElmustafaSayed Ali Ahmed, “Internet of Things Applications, Challenges and Related Future Technologies”, World Scientific News, 2017.
[13] Daiwat A. Vyas1, Dvijesh Bhatt2, DhavalJha, “IoT: Trends, Challenges and Future Scope”, IJCSC, 2015.
[14] MohammedAmoon, Nirmeen El-Bahnasawy, SamySadi and Manar Wagdi- On the design of reactive approach with flexible checkpoint interval to tolerate faults in cloud computing systems- JournalofAmbientIntelligenceandHumanizedComputing, November2019, Volume10, Issue 11, pp 4567–4577.
[15] SeyedehSolmazMadani and Shahram Jamali- A Comparative Study Of Fault Tolerance TechniquesInCloudComputing,InternationalJournalOfResearchInComputerApplicationsAnd Robotics- ISSN 2320-7345.
[16] MeysamMasoudi, BehzadKhamidehi, and CicekCavdar. Green Cloud Computing for Multi Cell Networks. IEEE, 35 (2017), 150-157.
[17] JagadeeswaraRao.G,G.StalinBabu.EnergyAnalysisofTaskSchedulingAlgorithmsinGreen Cloud. IEEE International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2017), vol. 65, pp.302-305, 2017.
[18] Mr. Nitin S. More, Dr. Rajesh B. Ingle, “Challenges in Green Computing for Energy Saving Techniques”,IEEE2017InternationalConferenceonEmergingTrends&InnovationinICT(ICEI), vol. 20, pp. 73-76, 2017.
[19] EhsanArianyan,“MultiObjectiveConsolidationofVirtualMachinesforGreenComputingin

CloudDataCenters",IEEE20168thInternationalSymposiumonTelecommunications(IST'2016), vol. 27, 654-659, 2016.

[20] Federico Larumbe, Brunilde Sanso, "Green Cloud Broker: On-line Dynamic Virtual Machine Placement Across Multiple Cloud Providers", 5th IEEE International Conference on Cloud Networking, vol. 34, pp.119-125, 2016.

[21] ChonglinGu, Pengzhou Shi, Shuai Shi, Hejiao Huang and Xiaohua Jia, "A Tree Regression Based Approach for VM Power Metering", IEEE ACCESS, vol.70, pp. 610-621, 2015.

[22] Ke HAN, Xiaobo CAI, "An Evolutionary Game Theoretic Approach for Efficient Virtual Machine Deployment in Green Cloud", IEEE 2015 International Conference on Computer Science and Mechanical Automation, vol. 6, pp. 1-4, 2015.

[23] Antonio Marotta, Stefano Avallone, "A Simulated Annealing based Approach for Power Efficient Virtual Machines Consolidation", IEEE, 8th International Conference on Cloud Computing. vol. 26, 445-452, 2015.

[24] BhartiWadhwa,AmandeepVerma,"CarbonEfficientVMPlacementandMigrationTechnique for Green Federated Cloud Datacenter ", IEEE, vol. 22, 2297-2302, 2014.

[25] JingHuang, Kai Wu,andMelodyMohynamic,"VirtualMachineMigrationAlgorithmsUsing Enhanced Energy Consumption Model for Green Cloud Data Centers", IEEE, vol. 23, 902-910, 2014.

[26] SupriyaKinger and KeffyGoyal, "Energy-Efficient Cpu Utilization Based Virtual Machine Scheduling In Green Clouds", IEEE, vol. 18, pp. 28-34, 2013.

[27] N. Rasouli, M. R. Meybodi, H. Morshedlou, "Virtual Machine Placement in Cloud systems using Learning Automata", IEEE2013 13th Iranian Conference on FuzzySystems(IFSC),vol.15,pp.110-115, 2013.

[28] R. Khan, S. U. Khan, R. Zaheer, and S. Khan, "Future internet: the internet of things architecture, possible applications and key challenges," in Proceedings of the 10th International Conference on Frontiers of Information Technology (FIT '12), vol. 34, pp. 257–260, 2012

[29] S. Tekinay and B. Jabbari, "Handover and channel assignment in mobile cellular networks," IEEE Communication Magzine, Vol. 29, No. 11, pp. 42-46, 1991.

[30] DeepakMishraandSwadesDe,"EnergyHarvestingandSustainableM2MCommunicationin 5GMobileTechnologies",BookseriesonModelingandOptimizationinScienceandTechnologies, Springer, vol. 8,pp. 99-125, 2016.

[31] Keyur K Patel1 , Sunil M Patel2, "Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges", IJESC, 2016.

[32] Marina ruggier,homayounnikookar,"Internet ofThings:ConvergingTechnologiesforSmart Environments and Integrated Ecosystems", IEEE, 2013.