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AN EFFECTIVE IMPLEMENTATION OF LOAD INDICES ANALYSIS AND DYNAMIC LOAD BALANCING IN CLOUD COMPUTING

Shivani Dudeja
M.Tech. Research Scholar
SUSCET Tangori, Mohali, India

Dr. Dheerendra Singh
Professor and Head
Computer Science and Engineering
SUSCET Tangori, Mohali, India

ABSTRACT

Cloud Load Balancing algorithms are used and implemented to manage the cloud based traffic by distributing workloads across multiple servers and resources—automatically or on demand. They maximize your workload performance and help prevent overload to help give your users a seamless experience. Load Balancing is another important aspect of cloud computing to balance the load among various servers. It is a mechanism that distributes the excess workload dynamically and evenly across all the servers. It is used to achieve high user satisfaction and resource utilization ratio and hence improving the overall performance of the system. Proper load balancing can help in utilizing the available resources optimally, thereby reducing response time, cost and energy consumption. When entrusting data to the cloud the data creators i.e. service users need assurances over access to their data. In essence data creators need to regain control over this access i.e. data creators need to become empowered. For implementation purpose this work integrates and makes use of a simulation scenario for platform-as-a-service facility provided by cloud. The implementation of three-tier privacy aware cloud computing model is done in real-time cloud simulated environment which is created using a website hosting platform. In the proposed algorithmic approach, this work makes use of metaheuristic technique simulated annealing in which there is a specific function by which the better and optimal results can be extracted after leaving the less efficient results. The results evaluated in the form of Query Execution Time for the existing and proposed approach. But these results are not enough and there are several directions in which this investigation can go in. The load balancing techniques are essential, but not the only one, method to protect and load the data against partially trustworthy cloud server. Therefore, future work of this research might include the metaheuristics techniques including Genetic Algorithms, Ant Colony Optimization, Neural Networks or HoneyBee Algorithm. The proposed work as compared with the base paper is having better and efficient results in terms of less execution time and secured load balancing for multiple cloud services. In the proposed work, we have implemented a probabilistic or stochastic metaheuristic technique simulated annealing for the load balancing in cloud environment.

Keywords - Cloud Computing, Resource Management, Cloud Resource Optimization, Load Balancing

INTRODUCTION

Cloud Computing is a latest technology in which all computing resources like hardware, software and platforms for developing applications are provided as services to the customers through internet. Customers do not have to invest capital to purchase, manage, maintain and

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scale the physical infrastructure. The customers can take required resources on demand from the cloud providers and pay for it as they use. The services that are provided by the cloud providers are broadly classified into three categories:

Infrastructure-as-a-Service (IaaS): In Infrastructure as a Service model, the service provider owns the equipments including storage, hardware, servers and networking components and is provided as services to the clients. The client typically pays on per-use basis. Amazon elastic Compute (EC2) and Simple Storage Service (S3) are typical examples for IaaS.

Platform-as-a-Service (PaaS): In Platform as a Service model, the service provider provides virtualized server, operating system and development tools as service. Using these services, users can develop, test, deploy and manage new applications in a cloud environment or run existing applications. These applications are delivered to users via the internet. Google App Engine is a typical example for PaaS.

Software-as-a-Service (SaaS): In Software as a Service model, the service provider provides software as a service over the Internet, eliminating the need to buy, install, maintain, update and run the application on the customer's own computers. Google Docs is a typical example for SaaS.

DATA MODEL OF CLOUD COMPUTING

In data models of cloud computing, it is of three types which are mentioned below : -

A. PUBLIC CLOUD

This type of cloud computing is the traditional model that everyone thinks of when they envision cloud computing. In this model, vendors dynamically allocate resources (hard drive space, RAM, and processor power) on a per-user basis through web applications. Salesforce.com and ADP are two well-known vendors that offer public cloud computing services.

Unlimited access- As long as you have internet access and a compatible device such as a smart phone or laptop computer, you can access your data anywhere.

Unlimited data capacity- Public cloud computing is flexible to meet your business' growing data storage and processing needs.

B. PRIVATE CLOUD

Also known as "internal cloud computing," private cloud computing is the next generation of virtualization. While similar to virtualization at the server, workstation and application levels, private cloud computing has enhanced features that appeal to many businesses. Two examples of private cloud solutions are VMware vCloud and Citrix VDI.

Increased data security- You and your business are in control of security since data never leaves your network.

Simple compliance enforcement- Depending upon your vertical market, government regulations may prohibit your business from using traditional or hybrid cloud computing. Private cloud computing lets you take advantage of cloud computing features while keeping all regulated data onsite and secure.

Customized IT network control- By keeping your cloud private, you are free to customize your network to meet your specific business needs.

C. HYBRID CLOUD

This model combines your business' hardware with cloud computing. Generally, one of your business applications such as Exchange Server 2007 or Microsoft Dynamics will interact with a vendor-hosted service. For example, Cisco, traditionally recognized for networking hardware, offers IronPort Email Security as their hybrid solution and Google, known for hosted solution, offers Postini email archiving.

- **Hardware required-** Hybrid cloud computing requires that you have or purchase hardware to interact with the hosted solution.
- **Software required-** In addition to hardware requirements, your business will need to have or purchase the software to manipulate and store data.

CLOUD COMPUTING ENTITIES

Cloud providers and consumers are the two main entities in the business market. But, service brokers and resellers are the two more emerging service level entities in the Cloud world. These are discussed as follows : -

Cloud Providers : Includes Internet service providers, telecommunications companies, and large business process outsourcers that provide either the media (Internet connections) or infrastructure (hosted data centers) that enable consumers to access cloud services. Service providers may also include systems integrators that build and support data centers hosting private clouds and they offer different services (e.g., SaaS, PaaS, IaaS, and etc.) to the consumers, the service brokers or resellers.

Cloud Service Brokers : Includes technology consultants, business professional service organizations, registered brokers and agents, and influencers that help guide consumers in the selection of cloud computing solutions. Service brokers concentrate on the negotiation of the relationships between consumers and providers without owning or managing the whole Cloud infrastructure. Moreover, they add extra services on top of a Cloud provider's infrastructure to make up the user's Cloud environment.

Cloud Resellers : Resellers can become an important factor of the Cloud market when the Cloud providers will expand their business across continents. Cloud providers may choose local IT consultancy firms or resellers of their existing products to act as "resellers" for their Cloud-based products in a particular region. Cloud Consumers : End users belong to the category of Cloud consumers. However, also Cloud service brokers and resellers can belong to this category as soon as they are customers of another Cloud provider, broker or reseller. In the next section, key benefits of and possible threats and risks for Cloud Computing are listed.

REVIEW OF LITERATURE

Randles, Martin, David Lamb, and A. Taleb-Bendiab. "A comparative study into distributed load balancing algorithms for cloud computing." In *Advanced Information Networking and Applications Workshops (WAINA), 2010 IEEE 24th International Conference on*, pp. 551-556. IEEE, 2010 - The anticipated uptake of Cloud computing, built on well-established research in Web Services, networks, utility computing, distributed computing and virtualisation, will bring many advantages in cost, flexibility and availability for service users. These benefits are expected to further drive the demand for Cloud services, increasing both the Cloud's customer base and the scale of Cloud installations. This has implications for many technical issues in Service Oriented Architectures and Internet of Services (IoS)-type applications; including fault tolerance, high availability and scalability. Central to these issues is the establishment of effective load balancing techniques. It is clear the scale and complexity of these systems makes centralized assignment of jobs to specific servers infeasible; requiring an effective distributed solution. This paper investigates three possible distributed solutions proposed for load balancing;

approaches inspired by Honeybee Foraging Behaviour, Biased Random Sampling and Active Clustering.

Kansal, Nidhi Jain, and Inderveer Chana. "Cloud load balancing techniques: A step towards green computing." *IJCSI International Journal of Computer Science Issues* 9, no. 1 (2012): 1694-0814 - Cloud computing is emerging as a new paradigm of large-scale distributed computing. It is a framework for enabling convenient, on-demand network access to a shared pool of computing resources. Load balancing is one of the main challenges in cloud computing which is required to distribute the dynamic workload across multiple nodes to ensure that no single node is overwhelmed. It helps in optimal utilization of resources and hence in enhancing the performance of the system. The goal of load balancing is to minimize the resource consumption which will further reduce energy consumption and carbon emission rate that is the dire need of cloud computing. This determines the need of new metrics, energy consumption and carbon emission for energy-ef fi cient load balancing in cloud computing. This paper discusses the existing load balancing techniques in cloud computing and further compares them based on various parameters like performance, scalability, associated overhead etc. that are considered in different techniques. It fu rther discusses these techniques from energy consumption and carbon emission perspective.

Fang, Yiqiu, Fei Wang, and Junwei Ge. "A task scheduling algorithm based on load balancing in cloud computing." In *Web Information Systems and Mining*, pp. 271-277. Springer Berlin Heidelberg, 2010 - Efficient task scheduling mechanism can meet users' requirements, and improve the resource utilization, thereby enhancing the overall performance of the cloud computing environment. But the task scheduling in grid computing is often about the static task requirements, and the resources utilization rate is also low. According to the new features of cloud computing, such as flexibility, virtualization and etc, this paper discusses a two levels task scheduling mechanism based on load balancing in cloud computing. This task scheduling mechanism can not only meet user's requirements, but also get high resource utilization, which was proved by the simulation results in the CloudSim toolkit.

Wang, Shu-Ching, Kuo-Qin Yan, Wen-Pin Liao, and Shun-Sheng Wang. "Towards a load balancing in a three-level cloud computing network." In *Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on*, vol. 1, pp. 108-113. IEEE, 2010 - Network bandwidth and hardware technology are developing rapidly, resulting in the vigorous development of the Internet. A new concept, cloud computing, uses low-power hosts to achieve high reliability. The cloud computing, an Internet-based development in which dynamically scalable and often virtualized resources are provided as a service over the Internet has become a significant issue. The cloud computing refers to a class of systems and applications that employ distributed resources to perform a function in a decentralized manner. Cloud computing is to utilize the computing resources (service nodes) on the network to facilitate the execution of complicated tasks that require large-scale computation. Thus, the selecting nodes for executing a task in the cloud computing must be considered, and to exploit the effectiveness of the resources, they have to be properly selected according to the properties of the task. However, in this study, a two-phase scheduling algorithm under a three-level cloud computing network is advanced. The proposed scheduling algorithm combines OLB (Opportunistic Load Balancing) and LBMM (Load Balance Min-Min) scheduling algorithms that can utilize more better executing efficiency and maintain the load balancing of system.

PROPOSED AND IMLPEMENTED RESEARCH OBJECTIVES

1. To investigate various load balancing algorithms and paradigms in cloud infrastructure
2. To propose a novel algorithmic approach for effective load balancing in cloud environment
3. To simulate and analyze the results of load and resource balancing in cloud computing infrastructure

4. To perform a pragmatic comparative analysis between classical and proposed approach in terms of execution time and overall performance.

SIMULATED ANNEALING - A METAHEURISTIC SOLUTION

Metaheuristics are used to solve Combinatorial Optimization Problems, like Bin Packing, Network Routing, Network Design, Assignment Problem, Scheduling, or Time-Tabling Problems, Continuous Parameter Optimization Problems, or Optimization of Non-Linear Structures like Neural Networks or Tree Structures as they often appear in Computational Intelligence. Metaheuristics are generally applied to problems for which there is no satisfactory problem-specific algorithm or heuristic; or when it is not practical to implement such a method. Most commonly used Metaheuristics are focused to combinatorial optimization problems, but obviously can handle any problem that can be recast in that form, such as solving Boolean equations.

COMMONLY USED METAHEURISTICS

- Tabu search [Glover, 89 et 90]
- Simulated Annealing [Kirckpatrick, 83]
- Threshold accepting [Deuck, Scheuer, 90]
- Variable neighborhood [Hansen, Mladenovi´c, 98]
- Iterated local search [Loren¸co et al, 2000]
- Genetic Algorithm, Holland 1975 – Goldberg 1989
- Memetic Algorithm, Moscatto 1989
- Ant Colony Optimization, Dorigo 1991
- Scatter search, Laguna, Glover, Marty 2000

The name Simulated Annealing (SA) is taken from annealing in metallurgy, a well known technique involving heating and controlled cooling of a material to increase the size of its crystals and reduce their defects. The heat makes the atoms become unstuck from their initial positions (a local minimum of the internal energy) and stroll randomly through states of elevated energy; the slow cooling gives more chances of finding configurations with lower internal energy than the initial one. Each step in the SA algorithm replaces the current solution by an arbitrary "nearby" solution, chosen with a probability which depends on the difference between the corresponding function values and on a global parameter T (called the temperature), that is gradually decreased during the process. The dependency is such that the current solution changes almost randomly when T is large, but increasingly "downhill" as T goes to zero.

The table below shows the mapping of physical annealing to Simulated Annealing.

Thermodynamic Simulation	**Combinatorial Optimization**
System States	Feasible Solutions
Energy	Cost
Change of State	Neighboring Solutions
Temperature	Control Parameter
Frozen State	Heuristic Solution

Table 1 - Relationship between physical annealing and Simulated Annealing

Using these mappings, any combinatorial optimization problem can be converted into an annealing algorithm.

The major advantage of SA over other methods is an ability to evade becoming trapped at local minima. This algorithm employs a random search, which not only accepts changes that decrease objective function, f, but also some changes that increase it. The latter are accepted with a probability

$$p = \exp(-\delta f/T)$$

where δf is the increase in f and T is a control parameter.

The algorithm starts by generating an initial solution and by initializing the temperature parameter T. Then the following is repeated until the termination condition is satisfied: A solution s' from the neighborhood N(s) of the solution s is randomly sampled and it is accepted as new current solution depending on f(s), f(s') and T. s' replaces s if f(s') < f(s) or, in case f(s') >= f(s), with a probability which is a function of T and f(s') - f(s). The probability is generally computed following the Boltzmann distribution exp(-(f(s') - f(s))/T).

SIMULATION RESULTS AND DISCUSSION

In the proposed work and implementation, an effective algorithmic approach is devised and deployed for the dynamic secured environment.

CLASSICAL / EXISTING ALGORITHM – ALLOCATION OF CLOUDLETS / VIRTUAL MACHINES TO CLOUD SERVERS

- Representation of VM hosted on Servers using Vector
- Initialization of 'Allocation Policy in Random Way
- Virtual Machine Allocation Policy Implementation
- Allocation of VMs to the Servers in the Initial Manner
- Design and Activation of Allocation Vector
- Measurement of VMs Capacity
- Allocation of VMs as per VM Capacity
- Measurement of the Servers Capacity
- Maximum power consumption of each server in watts
- Calculation of Cumulative Capacity of the Servers
- Allocation of VMs as per the Servers Capacity

- Initial Server Capacity Allocated
- Capacity Consumption by the Virtual Machines
- Capacity Remaining with the Servers
- Measurement of free space after consumption by the VM
- Analysis of Below showing utilisation of each server
- Investigate reqdcpu and consumed energy parameters
- Analyze free space and vmcapacity in iterative manner
- Display Total Load of VMs in Queue
- Free maximum power consumed server')
- Compare the powers of servers
- Analyze Capacity Consumption in case of new allocation
- Calculate uft and pft with different parameters

PROPOSED ALGORITHM – ALLOCATION OF CLOUDLETS / VIRTUAL MACHINES TO CLOUD SERVERS

- Representation of VM hosted on Servers using Vector
- Initialization of 'Allocation Policy in Random Way
- Virtual Machine Allocation Policy Implementation
- Allocation of VMs to the Servers in the Initial Manner
- Design and Activation of Allocation Vector
- Measurement of VMs Capacity
- Implementation of Parallel Approach
    - Allocation of VMs as per VM Capacity
    - Measurement of the Servers Capacity
    - Maximum power consumption of each server in watts
        - Fragmentation of the input tasks for clustering

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        - Calculation of Cumulative Capacity of the Servers
        - Allocation of VMs as per the Servers Capacity
        - Initial Server Capacity Allocated
        - Capacity Consumption by the Virtual Machines
        - Capacity Remaining with the Servers
        - Measurement of free space after consumption by the VM
    - Machine Learning Implementation for Outlier Analysis
    - Analysis of Below showing utilisation of each server
    - Investigate reqdcpu and consumed energy parameters
    - Analyze free space and vmcapacity in iterative manner
- Detailed Analysis of Parallel Approach
- Display Total Load of VMs in Queue
- Free maximum power consumed server
- Compare the powers of servers
- Analyze Capacity Consumption in case of new allocation
  Calculate uft and pft with different parameters

PROPOSED WORK WITH IMPROVED SERVER ALLOCATION AND LOAD BALANCING

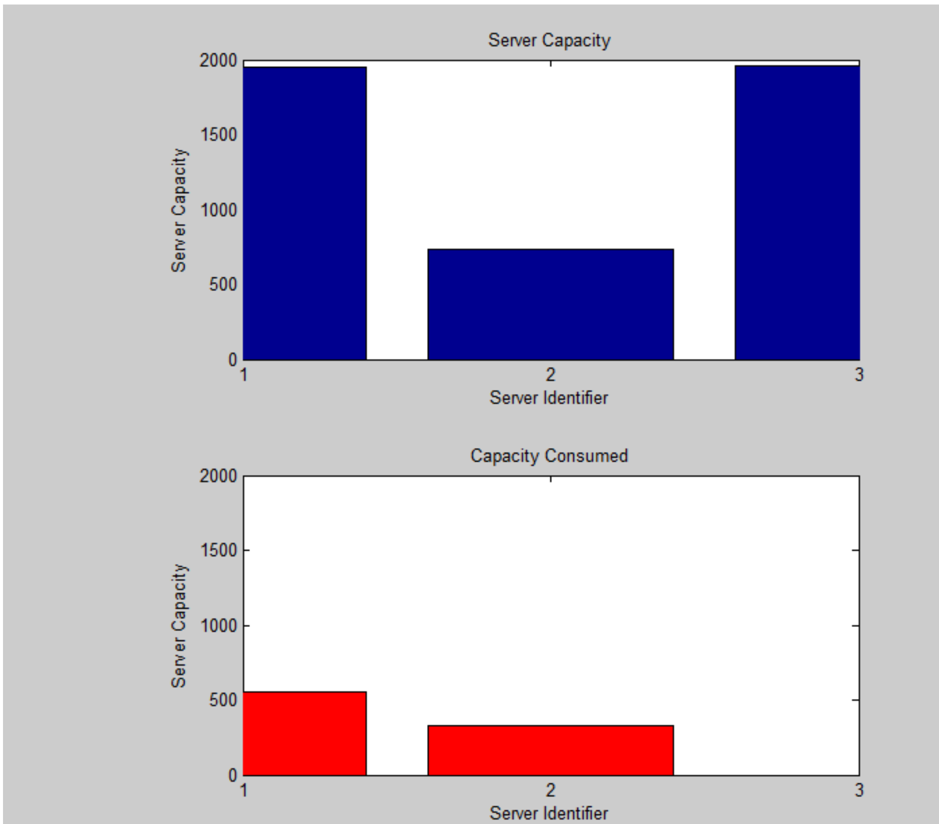
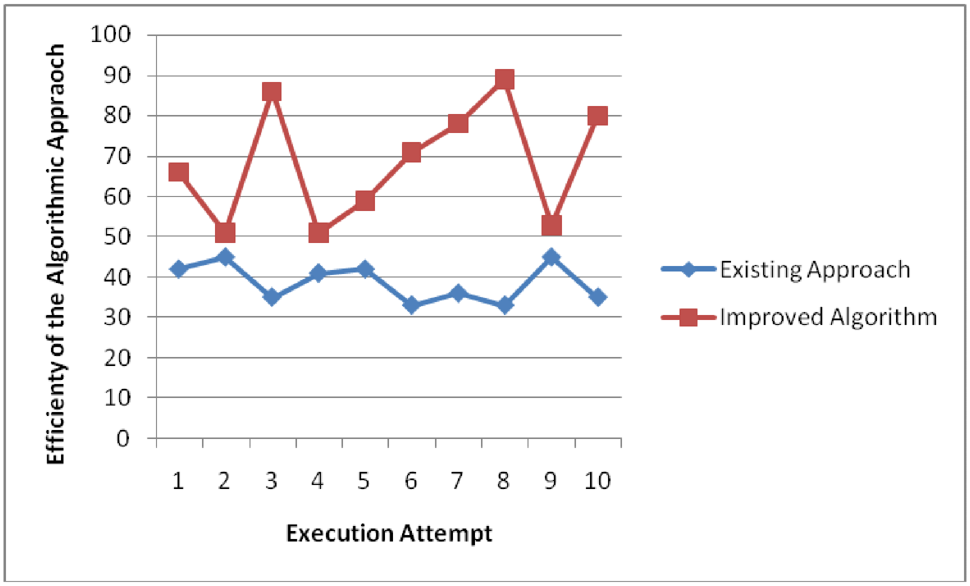


Figure 1 – Simulation Results for Server Allocation

SIMULATION AND COMPARATIVE RESULTS - 1

Existing Approach	Improved Algorithm
42	66
45	51
35	86
41	51
42	59
33	71
36	78

33	89
45	53
35	80



The figure shows the comparative analysis between classical and proposed approach. It is clear from the results that the proposed approach is giving better results as compared to the classical in terms of efficiency and integrity

SIMULATION AND COMPARATIVE RESULTS - 2

Existing Approach	Improved Algorithm
2.2	1.5232
3.2	2.1212
3.43	2.112
3.245	2.6
4.2323	3.3111

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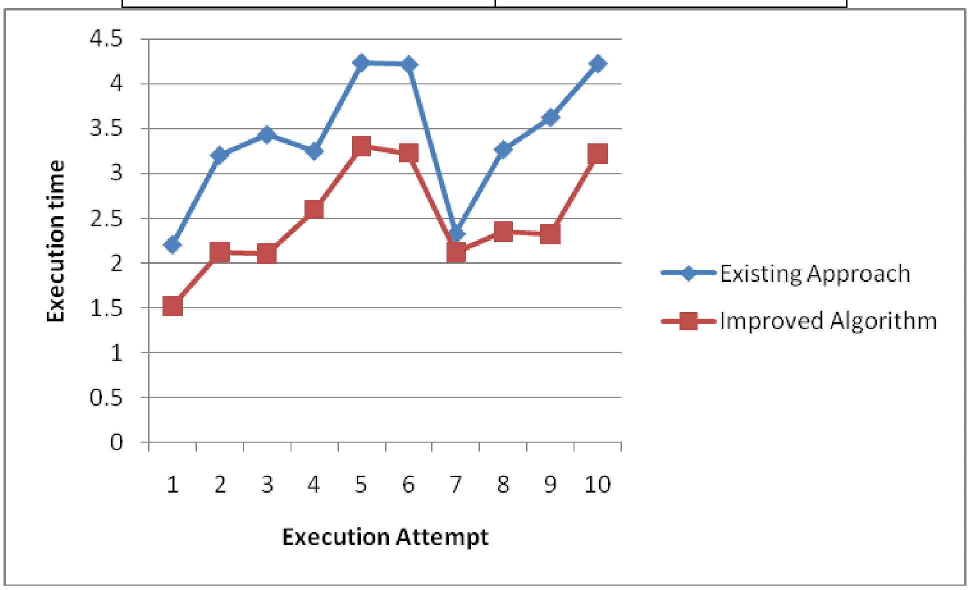
4.2112	3.2323
2.3232	2.1212
3.2637	2.35235
3.6211	2.32323
4.2222	3.221



COMPARISON OF EXECUTION TIME IN EXISTING AND PROPOSED APPROACH

The results represent the major differences in the classical and proposed approach in terms of execution time. It is evident from the results specified in the results that the execution time of proposed approach is very less as compared to the classical approach because the proposed approach is making use of parallel execution as compared to the sequential implementation in the existing approach. The proposed algorithmic approach is simulated in number of iterations which is mentioned here as Simulation Attempt.

Table 2 - Comparison Table of Classical and Proposed Approach in terms of Overall Efficiency

Simulation	Proposed	Existing

Attempt	Approach	Approach
1	90	53
2	94	59
3	97	78
4	89	49
5	90	47
6	86	30

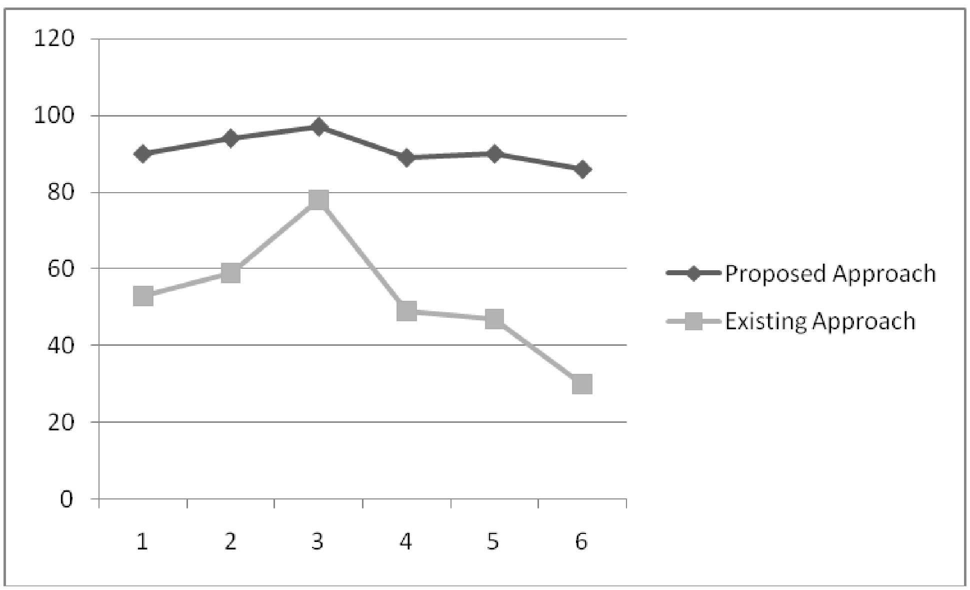


Figure 2 - Comparison between Existing and Proposed Approach

Table 3 - Comparison Table between Classical and Proposed Approach in terms of Overall Cost based on Simulated Annealing

Cost	
Existing	**Proposed**

Approach	Approach
90	60
79	42
58	53
78	64
87	69

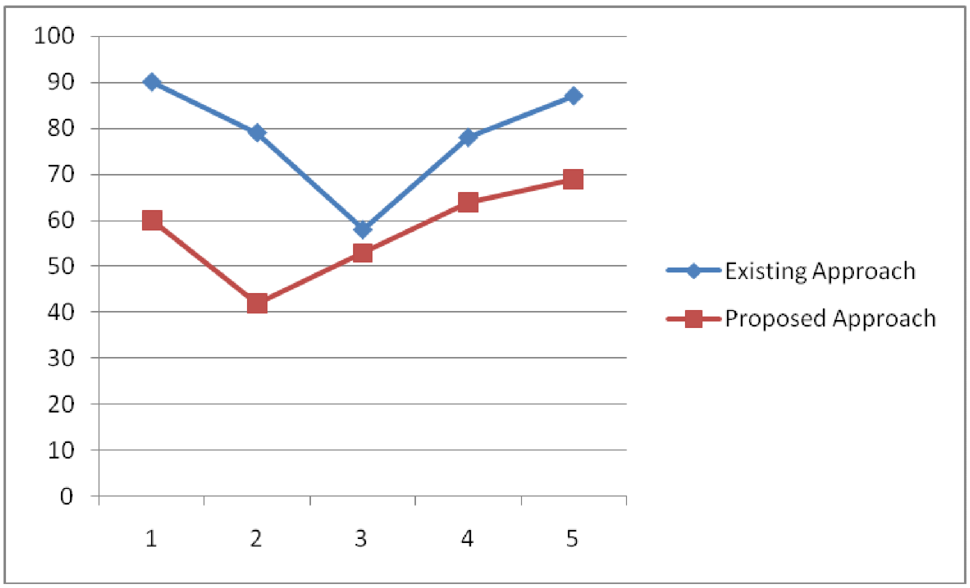


Figure 3 - Comparison of Cost between Existing and Proposed Approach

CONCLUSION AND SCOPE OF FUTURE WORK

The existing virtual machine(VM) resources scheduling techniques in cloud computing environment mainly considers the current state of the system but seldom considers system variation and current state of the servers, which always leads to load imbalance of the system. In view of the load balancing problem in VM resources scheduling, this work presents a scheduling strategy on load balancing of VM resources based on genetic algorithm. The uptake of Cloud computing is built on well-established research in Web Services, networks, distributed computing, utility computing and virtualisation and it bring many advantages in cost, flexibility and availability for service users. These benefits are expected to further drive the demand for Cloud services, increasing both the Cloud's customer base and the scale of Cloud installations. This has implications for many technical issues in Service Oriented Architectures and Internet of Services (IoS)-type applications; including fault tolerance, high availability and scalability. Central to these issues is the establishment of effective load balancing techniques. It is clear the scale and complexity of these systems makes centralized assignment of jobs to specific servers infeasible; requiring an effective distributed solution. This work propose a novel algorithmic approach for dynamic load balancing using simulated annealing that is one of the major metaheuristic approach and is used for many combinatorial optimization problems. The tolerance power of proposed model may be checked by implementing and penetrating various cloudlets and virtual machine behaviours. After the tolerance test we may come to a conclusion about its robustness in terms of confidentiality, integrity and authenticity. The work can be enhanced using metaheuristics techniques including Genetic Algorithms, Ant Colony Optimization, Neural Networks, HoneyBee Algorithm or other hybrid approaches.

REFERENCES

[1] G. Ritchie, J. Levine, "A Fast, Effective Local Search for Scheduling Independent Jobs in Heterogeneous Computing Environments", Technical report, Centre for Intelligent Systems and their Applications, School of Informatics, University of Edinburgh, Edinburgh, 2003.

[2] Shanti Swaroop Moharana, Rajadeepan D. Ramesh, Digamber Powar, "Analysis of Load Balancers in Cloud Computing ", International Journal of Computer Science and Engineering (IJCSE), Volume 2, Issue 2, ISSN 2278-9960, pp 101-108, May 2013.

[3] Shu-Ching Wang, Kuo-Qin Yan, Wen-Pin Liao, Shun-Sheng Wang, "Towards a Load Balancing in a Three-level Cloud Computing Network", 3rd IEEE Conference on Computer Science and Information Technology[ICCSIT], Taiwan, Volume 1, pp 108-113, 9-11 July 2010, DOI: 10.1109/ICCSIT. 2010.5563889.

[4] Che-Lun Hung, Hsiao-hsi Wang, Yu-Chen Hu, "Efficient Load Balancing Algorithm for Cloud Computing Network", International Conference on Information Science and Technology (IST 2012), pp 251-253, April 28-30, 2012.

[5] Po-Huei Liang, Jiann-Min Yang, "Evaluation of Cloud Hybrid Load Balancer (CHLB)", International Journal of E-Business Development, Volume 3, Issue 1, pp 38-42, Feb 2013.

[6] Meenakshi Sharma, Pankaj Sharma, “Performance Evaluation of Adaptive Virtual Machine Load Balancing Algorithm”, International Journal of Advanced Computer Science and Applications, pp 86-88, Volume 3, Issue2, ISSN: 2156-5570, 2012.

[7] Jasmin James, Bhupendra Verma, "Efficient VM Load Balancing Algorithm for a Cloud Computing Environment", International Journal on Computer Science & Engineering, pp 1658-1663, Volume. 4, ISSN: 0975-3397, September 2012.

[8] Mintu M. Ladani, Vinit Kumar Gupta, "A Framework for Performance Analysis of Computing Clouds", International Journal of Innovative Technology and Exploring Engineering (IJITEE), pp 245-247, Volume 2, Issue 6, ISSN: 2278-3075, May 2013.

[9] Mayank Mishra, Anwesha Das, Purushottam Kulkarni, Anirudha Sahoo, “Dynamic Resource Management using Virtual Machine Migration”, IEEE Communications Magazine, pp 34-40,Volume 50, Issue 9, September 2012 , DOI: 10.1109/MCOM.2012.6295709.

[10] Shu-Ching Wang, Kuo-Qin Yan, Shun-Sheng, Wang, Ching-Wei, Chen, “A Three-Phases Scheduling in a Hierarchical Cloud Computing Network”, Third International Conference on Communications and Mobile Computing [CMC], Taiwan, pp 114-117, 18-20 April 2011, DOI: 10.1109/CMC.2011.28.

[11] Kumar Nishant, Pratik Sharma, Vishal Krishna,Chhavi Gupta, Kunwar Pratap Singh, Nitin, Ravi Rastogi, "Load Balancing of Nodes in Cloud Using Ant Colony Optimization", 14th International Conference on Computer Modeling and Simulation, pp 3-8, 2012, DOI: 10.1109/UKSim.2012.11.

[12] Martin Randles, David Lamb, A. Taleb-Bendiab, "A Comparative Study into Distributed Load Balancing Algorithms for Cloud Computing", 24th International Conference on Advanced Information Networking and Applications Workshops (WAINA), pp 551-556, 2010 DOI:10.1109/WAINA.2010.85.

[13] Sunil Nakrani, Craig Tovey, "On Honey Bees and Dynamic Server Allocation in Internet Hosting Centers", International Society for Adaptive Behavior, pp 223-240, Volume 12, Issue 3-4, September-December 2004, DOI: 10.1177/1059-7123.

[14] Yi Lu, Qiaomin Xie, Gabriel Kliot, Alan Geller, James R Larus, Albert Greenberg, "Join-Idle-Queue: A Novel Load Balancing Algorithm for Dynamically Scalable Web Services", Elsevier, Journal on Performance Evaluation, pp 1056-1071, Vol 68, Issue 11, Nov 2011, DOI: 10.1016/j.peva.2011.07. 015.

[15] Geetha C. Megharaj, Mohan K G, "Two Level Hierarchical Model of Load Balancing in Cloud", International Journal of Emerging Technology and Advanced Engineering, pp 307-311, Volume 3, Issue 10, ISSN 2250-2459, October 2013.

[16] Rajkumar Buyya, Chee Shin Yeo, Srikumar Venugopal, James Broberg, Ivona Brandic, "Cloud Computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility", High Performance Computing and Communications, 10th IEEE International Conference, pp 5-13, September 2008, Digital Object Identifier: 10.1109/HPCC.2008.172.

[17] Meenakshi Sharma, Pankaj Sharma, Sandeep Sharma, "Efficient Load Balancing Algorithm in VM Cloud Environment", International Journal of Computer Science and Technology, pp 439-441, Vol 3, Issue 1, ISSN: 0976-8491[online], ISSN: 2229-433[print], Jan-March 2012.

[18] Ram Prasad Padhy, P Goutam Prasad Rao, "Load Balancing In Cloud Computing Systems", Thesis, Department of Computer Science and Engineering, National Institute of Technology, Rourkela-769 008, Orissa, India, May 2011.

[19] Sudha Sadhasivam, N Nagaveni, R. Jayarani, R. Vasanth Ram ,"Design and Implementation of an Efficient Two-Level Scheduler for Cloud Computing Environment", International Conference on Advances in Recent Technologies in Communication and Computing, pp 884-886, 2009, DOI: 10.1109/ARTCom.2009.148.

[20] Suresh M, Shafi Ullah Z, Santhosh Kumar B, "An Analysis of Load Balancing in Cloud Computing", International Journal of Engineering Research & Technology(IJERT), Vol 2, Issue 10, ISSN:2278-0181, October 2013.

[21] T. Kokilavani, D.I. George Amalarethinam, "Load Balanced Min-Min Algorithm for Static Meta-Task Scheduling in Grid Computing", International Journal of Computer Applications, pp 43-49, Vol 20, No 2, April 2011, DOI: 10.5120/2403-3197.

[22] W Kleiminger, E Kalyvianaki, P Pietzuch, "Balancing Load in Stream Processing with the Cloud", 27th IEEE International Conference on Data Engineering Workshops[ICDEW], Zurich, Switzerland, pp 16-21, 11-16 April 2011, DOI: 10.1109/ ICDEW.2011.5767653.