Qualitative Perspective of live VM migration techniques in Cloud Computing

Garima Verma[1], Sandhya Adhikari[2*]

[1] Assistant Professor, School of Computing (IT), DIT University, Dehradun, INDIA
[2] Research Scholar, School of Computing (CSE), DIT University, Dehradun. INDIA

* Corresponding author's email id: sanadhi2594@gmail.com

doi: https://doi.org/10.21467/proceedings.100.6

ABSTRACT

Cloud Computing becomes the most reckless developing computing platform which is known as the future of distributed computing. Virtual Machine (VM) is one of the important part of the cloud computing concept. For various type of goals the VMs needs to be migrated from one place to another with in data centre or out of data centre, such as – load balancing, fault tolerance or energy consumption, etc. Live migration is a technique of migrating VM from source to destination in running stage, in result it gives high availability of services. The main objective of this paper is to provide the exhaustive review of literature to analyse the proposed methods of VM migration, purpose and their findings.

1. Introduction

The cloud computing has become a buzz world in the field of Information Technology today. This is because of the services and facilities offered by the cloud computing which can meet the lively demands of industry and academics with less required investment on infrastructure and maintenance in compared to old IT infrastructure [1]. The shared pool of resources provided by cloud computing includes CPU, storage, applications, platforms, software, and services. The most attractive payment scheme offered by the cloud computing is pay-per-use model, which offers user to pay only for services that they availed [2]. If we see the situation now a days for all over world every organization whether academic institutes, schools or corporates are suffering due to pandemic COVID-19. The only solution left for companies are to work in online mode. The services in the market used by companies are cloud based such as: Microsoft Teams, Zoom, Blackboard, etc.

The virtualization is the core of any cloud computing environment. Which allows the creation of virtual computer and services for dealing with various demands and full utilization of physical resources [3]. It offers the optimized utilization of computing infrastructures, power, and cost etc. by merging cloud servers. The most important activity is the process of virtualization in creation of Virtual Machines (VMs). Creation of VMs offers the collaborative multiple un-utilized or under-utilized resources into a shared resource pool. The performance of cloud depends on the various background activities. VM migration is one of them [2], [3]. The VM migration is an essential background activity is required to provide various benefits such as- utilization of under-utilized hosts i.e. load balancing, fault tolerance (in case one host is not working or in a risk situation), for saving of energy consumed by physical machines, etc. [4].

The VM migration can be done in two ways generally- Live VM migration and offline VM migration. In this paper we will discuss about only state-of-arts discusses the live VM migration. The rest of the paper is organized as follows- section 2 illustrates the review of literature, major parameters affect the performance

Proceedings DOI: 10.21467/proceedings.100; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-942709-6-6 (eBook)

of VM migration and also presents the qualitative comparative study about the different state-of-arts present in different literatures, section 3 describes the conclusion.

2. Review of Literature

VM migration is a process of migrating VM from one host to another host. Live VM migration is a type of VM migration in which VM migrates from source to destination without getting disturbed its services from cloud providers. But as the popularity of cloud computing has increased day by day the requirements and expectations of customers are also increasing day by day. Live VM migration results in cloud-wide load balancing and operational consolidation while the migrating VMs remain accessible to users. Motivated with Green cloud data centre xu et al. (2013), presented a heuristic approach PS-ABC providing the VM placement selection of live migration to reduce power consumption. They included a combination of artificial bee colony (ABC), uniform random initialization idea, binary search, and Boltzmann selection policy resulting better global exploration's ability and local exploitation's ability. Authors also included Bayes theorem to increase the optimization level for faster solution and achieved a longer-term efficient optimization to reduce power consumption [5]. Zhao and Xu et al. (2014), proposed another VM placement selection heuristic approach for energy conservation (Green Cloud Computing). The proposed technique was a combination of Particle Swarm Optimisation (PSO) with simulated annealing (SA) and then applying statistics and probability to reach to the final solution, naming this procedure as PS-ES. Again, obtaining a long-term optimization for energy conservation considering the future scenario. Resulting in live VM migration procedure as more high-effective and valuable [6]. Raju et al. (2014), proposed an Energy-Aware Multi objective Chiropteran Algorithm (EAMOCA) which was a combination of echo-localization and hibernation properties for resource scheduling and energy conservation. Promotion of energy salvation in cloud environment is achieved in a well delineated manner. Authors had set up a private cloud with VMware for real time implementation and evaluated different parameters like total energy consumption by physical resources, SLA violation (CPU performance) and VM migration [7]. Focusing on network based optimisation, how to control traffic forwarding and network update by running programs on the controller, design and implement a Software-Defined Network (SDN) based system for live VM migration across datacentres which proves to be efficient [8]. Farahnakian et al. (2015), proposed and implemented a dynamic VM consolidation using a architecture based on distributed system while considering required QoS for energy conservation of cloud data centres. Authors have applied the Ant Colony System (ACS) which is a meta-heuristic algorithm naming it as ACS based VM Consolidation (ACS-VMC) [9]. In 2016, Kansal et al. implemented energy aware Firefly algorithm for VM migration. The proposed system migrates the high load VM to a low load active node and succeed in energy efficiency and performance maintenance of the data centres. In comparison with other techniques author claims an improvement of average energy consumption by 44.39% reducing from an average of 72.34% of migrations and 34.36% hosts saving [10]. For load balancing VM migration is done either by reducing dirty pages using CPU scheduling or compressing memory pages. Therefore, Patel et al. (2016), proposed development of time series-based prediction framework by analysing historical inputs. Authors applied two regression models for time series as it is created by memory pages transfer iteratively. One is based on statistical probability and autoregressive integrated moving average (ARIMA) model which predicted 91.74% accuracy for dirty pages. Other is based on statistical learning and Support Vector Regression (SVR) model resulting in

Proceedings DOI: 10.21467/proceedings.100 Series: AIJR Proceedings
ISBN: 978-81-942709-6-6 ISSN: 2582-3922

94.61% accuracy. Both results are output of Xen real time data set [11]. For energy conservation and reduction of resource wastage in data centres Sharma et al. (2017), proposed energy aware Virtual Machines (VMs) allocation and migration using Hybrid Genetic Cat Swarm Optimization (HGACSO) algorithm. Authors also implemented energy efficient VMs migration for consolidation of VMs into the lesser number of Physical Machines (PMs) and shut down of idle PMs for improving energy efficiency at a cloud data centre [12]. For prevention from highly loaded hours for resources IaaS cloud operators divide time into windows for VM migration. Tsakalozos et al. (2017), focused on real-time scheduling of VM migrations in IaaS clouds so, that migrations are done on time, without violating SLAs. They created a file system named MigrateFS capable of duplicating and keeping in sync all virtual disks when the hypervisor migrates live VMs and using it proposed a network of brokers to monitor all on-going migration operations which is scalable and distributed. They also implement two policies to reduce SLA violations by restricting the resources used during migration which were simulated in a share-nothing configuration. First is based on task prioritization and second considers the financial implications set by migration deadline requirements. Result of their approach was 24% improvement in comparison with unsupervised set up for a high saturated network [13]. In terms of reduction in cost and better fitness function for heuristic approaches task scheduling algorithm can be designed which will be efficient. Gobalakrishnan et al. (2018) proposed a multi-objective function including load utilization, energy consumption, migration cost and time and a hybrid algorithm Genetic Gray Wolf Optimization Algorithm (GGWO) by combining Gray Wolf Optimizer (GWO) and Genetic Algorithm (GA) is proposed. Comparison is done between proposed and combine ones and the proposed one is said to be improving task scheduling with minimum computation time, migration cost, energy consumption and maximum load utilization [14]. Another multi-objective technique using ant colony system algorithm for virtual machine (VM) consolidation in cloud data centres is proposed by Ashraf and Porres (2018). Minimisation of over-provisioning of physical machines (PMs) by consolidating VMs on under-utilised PMs is done by building VM migration plans with the help of proposed algorithm. Optimisation of maximum number of released PMs and minimum number of VM migrations is done and they eliminated the need for an aggregate objective function (AOF) and allows to combine the optimisation objectives in an appropriate manner [15]. For increasing computational power, large-scale data centres were created which gave rise to high energy consumption problem resulting in high operating costs and CO_2 emission. Also, there is a requirement to produce a high Quality of Service (QoS) to the clients in cloud computing environments by handling power shortages. Therefore, Soltanshahi et al. (2019), proposed a solution for the allocation of virtual machines to physical hosts in cloud data centres with the help of Krill Herd algorithm known as the fastest collective intelligence algorithm introduced at that time and successfully achieved 35% reduction in energy consumption [16]. In 2019, Sultanpure and Reddy proposed an architectural design to deal with placement of the job on the servers. The model also included the monitoring of the servers so that it can be prevented from overloading. Authors have used Cuckoo search Algorithm for job handling to monitor the overloading of servers [17]. The Naive Bayes classifier with hybrid optimization using Artificial Bee Colony–Bat Algorithm (ABC–BA) proposed by Karthikeyan et al. (2020) to reduce the energy consumption while VM migration. The model being implemented using CloudSim and comparing the performances for parameters like success &failure rate, and energy consumption, results shows the minimum energy consumption and failure rate i.e., 1000–1200 kWh, 0.2 with maximum success rate and accuracy of 1 and 97.77% [18]. Ibrahim et al. (2020), proposed a decimal encoded Particle Swarm Optimization (PAPSO) for Power-Aware technique to result in near-optimal placement for the migrated VMs. Reduction in power consumption, violation of SLA and overloaded hosts are achieved by minimising the fitness function consolidation of migrated VMs to minimum number of hosts. PAPSO was able to reduce consumed energy on average terms by 8.01%, number of VM migrations by 39.65%, and combined metric Energy SLA Violation (ESV) by 11.87% [19].

2.1 Performance parameters considered in studies

There are various performance metrics taken by researcher while improvising the performance of live VM migration.

1. Total energy consumption –
   Power or energy consumption is determined by generally the CPU, memory and secondary storage in the data centers. The main part of energy is consumed by the CPU of a host. The power consumption of a host can be represented as linear growing relationship, which grows from idle state to the state where CPU is fully utilized [20]. Therefore, the power or energy consumption is relational to the CPU utilization. This relation can be represented in eq.1. The μ is representing current CPU utilization.

$$E(\mu) = E_{idle} + (E_{busy} - E_{idle})\mu \quad (1)$$

2. Total Migration Time (T(m))-
   It is represented as the ratio of total amount of memory transferred (v_m) and allocated bandwidth (bw) [5], [21].

$$T(m) = V(m)/bw \quad (2)$$

3. Downtime (D_m) –
   It is a time elapsed in VM migration during the service is not available because of processor states migration. Downtime in migration depends on dirty page rate (d_p), page size (s) , time elapsed in last pre-copy of round n (t_n) and speed of link (bw) [5],[6].

$$D_m = \frac{d_p * s * t_n}{bw} \quad (3)$$

4. Migration Overhead – This is represented as need of extra machine resources and cycles.

5. Dirty page rate – It is major factor in the performance of VM Migration algorithm. This is a rate at which VM applications update VM memory pages [6].

Proceedings DOI: 10.21467/proceedings.100
Series: AIJR Proceedings
ISBN: 978-81-942709-6-6
ISSN: 2582-3922

2.2 Qualitative summary of VM migration algorithms proposed in existing state-of-arts-

The table-l shows the qualitative analysis of all the algorithms that we have studied and discussed. Total 25 papers have been downloaded and after removal of duplicate or similar type of concepts finally the 13 papers have been selected for the study and presented in summary. The oldest paper that is being considered for the study is from 2013 and the latest is taken from 2020. From the study it has been observed that the most critical parameter taken by all researcher is energy consumption and downtime. The reason specified by maximum researcher is the energy saving is required to save the environment and also to reduce the level of CO_2, the later parameter i.e. downtime is required to be less for the better service availability.

Table -1 Qualitative summary of live VM migration methods

S.No	Year	Problem Statement	Proposed Method	Performance Parameters	Tool	Findings
1	2013	VM placement selection of live migration for power saving [5].	ABC-based approach which employs the Boltzmann selection idea and Bayes theorem	power consumption per week, no. of failures in VM migration events, speed up ratio	Cloudsim	• Reduced power consumption • Better performance.
2	2014	The main objective of authors to focus on the load balancing, reduction the execution time and energy [6].	Chiropteran Algorithm	total energy consumed by physical resources, CPU performance	Vmware	• Reduced VM migration, • Service Level Agreement (SLA) violations • Energy dissipation
3	2014	The main objective was to reduce penalty costs in the compensation of SLA violation and reduction in energy expenditure [7].	PS-ES Algorithm that integrates two techniques (Particle Swarm Optimization-Simulated Annealing)	Reduced energy consumption	Cloudsim	• Reduction in energy consumption, • Less number of failures in VM migration.
4	2014	Network based optimization, e.g., selecting the best path for data copy or optimizing the net-work update process to reduce service downtime [8].	Software-Defined Network (SDN) to control traffic forwarding and net-work update by running programs on the controller	service downtime	Open stack	• Minimum Pre-copy time • Less service downtime

5	2015	The objective is to reduce energy consumption, number of VM migrations and improved QoS [9].	ACS-based VM Consolidation	Energy consumption, number of VM migration, QoS requirements	Cloudsim	• Increased performance • Reduced energy consumption
6	2016	The objective of authors was to save energy, and reduce the no. of migrations [10].	A Firefly Optimization Technique	Performance and energy efficiency of the data center	Cloudsim	• Reduces 44.39 % of energy consumption • Reduced 72.34 % of migrations • Saving 34.36 % of hosts power.
7	2016	The objective was to achieve reduce energy consumption and reduction in resource wastage [11].	Hybrid Genetic Cat Swarm Optimization(HGACSO) algorithm	Energy saving and reduction in resource wastage	Cloudsim	• Lower Energy Consumption • Reduced resource wastage.
8	2016	Real-time scheduling of live VM migrations [12].	1. A flexible, distributed network of brokers that manages the progress of all running migration operations. 2. A file system, termed as MigrateFS, which is capable of replicating and keeping in sync of all virtual disks	1. Quantify the overheads involved in hosting VMs in MigrateFS 2. Effectiveness of combining MigrateFS with resource management policies	1.Real cloud infrastructure setup using Xen 3.2- 1 and Open Nebula 2. own cloud simulator in Java using the proposed priority-based and cost-driven management policies	• Reduction in SLA violation • Improved I/O performance.
	2016	Prediction of dirty pages in advance using machine learning technique during Live VM	Two models are developed-1. Statistical probability based regression model, 2. statistical learning based	dirty pages prediction, total migration time, downtime	Xen 4.2	• Normal workloads and advanced workloads are evaluated based on Model-1 and

		migration in cloud [13].	regression model			Model-2 model and it has been found that Model-2 is able to predict dirty pages with 94.61% accuracy that is higher than Model-1
9	2017	The main objective taken by the authors is to increase the no. of host machines so that system can minimize the no. of VM migrations [14].	Ant colony System	Number of VM migrations and Load balancing	Cloudsim	• Packing efficiency, • No. of VM migrations • No. of released host machines.
10	2018	To reduce the no. of VMs, reduce the cost and to enhance fitness function [15].	Genetic Gray Wolf Optimization	Load balancing, Migration cost, Energy consumption, Processing time,	Cloudsim	• Minimum migration cost • Energy reduction.
12	2018	To diminish energy consumption in VM migration [16].	Naive Bayes classifier with hybrid optimization using Artificial Bee Colony–Bat Algorithm	Success and failure rate, energy consumption	Cloudsim	• Minimized energy consumption, • failure rate, • maximized success rate, • Accuracy.
11	2019	The objective was to achieve improved VM allocation and to reduce energy consumption [17].	krill herd algorithm	Service level agreement (SLA), energy consumption, SLA violation	Cloudsim	• Achieved 35% minimization in energy consumption
	2019	The main objective was to propose z model which covers placement of the job at servers, monitors the servers to prevent them from overloading [18].	Cuckoo search Algorithm	energy consumption, Service Level Agreement violation and total number of migrations	MatLab	• Reduction in SLA violation, • Energy consumption • Total number of migrations

13	2020	The objective of proposed model to provide dynamic association of VMs into the minimal number of hosts for solution to manage power consumption [19].	Power-Aware technique depending on Particle Swarm Optimization (PAPSO) to determine the near-optimal placement for the migrated VMs	Reduced power consumption, reduce number of VM migrations	CloudSim	• Reduce about 8.01% consumed energy, • 39.65 % no. of VM migration, • 66.33% no. of host shutdowns, • 11.87% combined metric Energy SLA Violation (ESV) on average

3. Conclusion and Future Scope

VM migration is the most important activity in cloud computing environment. Most of the time VM migration technique is used as Live VM migration. In live VM migration a running VM moves from one host to another host without interrupting its services from cloud providers. This paper outlines the different techniques proposed by various researchers and the parameters they have taken in consideration. The study also represents a qualitative summary of all the discussed algorithms in existing state-of-arts. This article can help new researchers to given an overview of algorithms proposed by various researchers and the parameters they have taken for optimization.

References

[1] G. Rastogi and R. Sushil, "Cloud computing implementation: Key issues and solutions," in *2015 International Conference on Computing for Sustainable Global Development, INDIACom 2015*, 2015.

[2] G. Rastogi and R. Sushil, "Performance Analysis of Live and Offline VM Migration Using KVM," *Int. J. Mod. Educ. Comput. Sci.*, vol. 8, no. 11, pp. 50–57, 2016, doi: 10.5815/ijmecs.2016.11.07.

[3] G. Rastogi, S. Narayan, G. Krishan, and R. Sushil, *Deployment of cloud using open-source virtualization: Study of VM migration methods and benefits*, vol. 654. 2018.

[4] J. B. Princess, G. Jeba, L. Paulraj, and I. J. Jebadurai, "Methods to Mitigate Attacks during Live Migration of Virtual Machines – A Survey," *Int. J. Pure Appl. Math.*, vol. 118, no. 20, pp. 3663–3670, 2018.

[5] G. Xu, Y. Ding, J. Zhao, L. Hu, and X. Fu, "A Novel Artificial Bee Colony Approach of Live Virtual Machine Migration Policy Using Bayes Theorem," vol. 2013, 2013.

[6] J. Zhao, L. Hu, Y. Ding, G. Xu, and M. Hu, "A Heuristic Placement Selection of Live Virtual Machine Migration for Energy-Saving in Cloud Computing Environment," vol. 9, no. 9, 2014, doi: 10.1371/journal.pone.0108275.

[7] R. Raju, "A Bio Inspired Energy-Aware Multi Objective Chiropteran Algorithm (EAMOCA) For Hybrid Cloud Computing Environment."

[8] C. A. Datacenters, "SDN-based Live VM Migration Across Datacenters 2 . KEY CHALLENGES AND SOLUTIONS," pp. 583–584.

[9] F. Farahnakian, A. Ashraf, T. Pahikkala, P. Liljeberg, and J. Plosila, "Using Ant Colony System to Consolidate VMs for Green Cloud Computing," vol. 1374, no. c, pp. 1–13, 2014, doi: 10.1109/TSC.2014.2382555.

[10] N. J. Kansal and I. Chana, “Energy-aware Virtual Machine Migration for Cloud Computing - A Firefly Optimization Approach,” *J. Grid Comput.*, vol. 14, no. 2, pp. 327–345, 2016, doi: 10.1007/s10723-016-9364-0.

[11] M. Patel, S. Chaudhary, and S. Garg, “Machine Learning Based Statistical Prediction Model for Improving Performance of Live Virtual Machine Migration,” *J. Eng. (United Kingdom)*, vol. 2016, 2016, doi: 10.1155/2016/3061674.

[12] N. K. Sharma and R. M. R. Guddeti, “On demand Virtual Machine allocation and migration at cloud data center using Hybrid of Cat Swarm Optimization and Genetic Algorithm,” *Proc. 5th Int. Conf. Eco-Friendly Comput. Commun. Syst. ICECCS 2016*, pp. 27–32, 2017, doi: 10.1109/Eco-friendly.2016.7893236.

[13] S. Iaas, K. Tsakalozos, V. Verroios, M. Roussopoulos, and A. Delis, “Live VM Migration under Time-Constraints in,” vol. 9219, no. c, pp. 1–14, 2017, doi: 10.1109/TPDS.2017.2658572.

[14] N. Gobalakrishnan and C. Arun, “A new multi-objective optimal programming model for task scheduling using genetic gray Wolf optimization in cloud computing,” *Comput. J.*, vol. 61, no. 10, pp. 1–14, 2018, doi: 10.1093/comjnl/bxy009.

[15] A. Ashraf and I. Porres, “Multi-objective dynamic virtual machine consolidation in the cloud using ant colony system,” *Int. J. Parallel, Emergent Distrib. Syst.*, vol. 33, no. 1, pp. 103–120, 2018, doi: 10.1080/17445760.2017.1278601.

[16] M. Soltanshahi, R. Asemi, and N. Shafiei, “Energy-aware virtual machines allocation by krill herd algorithm in cloud data centers,” *Heliyon*, vol. 5, no. 7, pp. 3–8, 2019, doi: 10.1016/j.heliyon.2019.e02066.

[17] K. A. Sultanpure and L. S. S. Reddy, “Virtual Machine Migration in Cloud Computing using Artificial Intelligence,” *Int. J. Recent Technol. Eng.*, vol. 8, no. 4, pp. 2079–2088, 2019, doi: 10.35940/ijrte.d7657.118419.

[18] K. Karthikeyan *et al.*, “Energy consumption analysis of Virtual Machine migration in cloud using hybrid swarm optimization (ABC–BA),” *J. Supercomput.*, vol. 76, no. 5, pp. 3374–3390, 2020, doi: 10.1007/s11227-018-2583-3.

[19] A. Ibrahim, M. Noshy, and H. A. Ali, “PAPSO : A Power-Aware VM Placement Technique Based on Particle Swarm Optimization,” vol. 8, pp. 81747–81764, 2020, doi: 10.1109/ACCESS.2020.2990828.

[20] N. Uppalapati, “Optimizing Energy Consumption Using Live Migration,” 2016.

[21] A. Choudhary, M. C. Govil, G. Singh, L. K. Awasthi, E. S. Pilli, and D. Kapil, “A critical survey of live virtual machine migration techniques,” *J. Cloud Comput.*, vol. 6, no. 1, pp. 1–41, 2017, doi: 10.1186/s13677-017-0092-1.