

Comparative Analysis of Various Techniques of VM Live Migration in Cloud Computing

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DOI: <https://doi.org/10.26438/ijcse/v7i5.355359> | Available online at: www.ijcseonline.org

Accepted: 07/May/2019, Published: 31/May/2019

Abstract- Cloud computing is a potent field with an on-demand resource provisioning and “Pay Per Use” facility to the customers. Virtualization is the most centered technology used in cloud computing. The virtual machine live migration is an important feature of virtualization which provides virtual machine migration from one host to another host when the services are still running. It provides fault tolerance, load balancing, power saving in data centers. The most efficient technique will have least total migration time and downtime. With an increasing data, we need data centers to store and process it, which leads to huge environmental destruction. Introduction of Virtual machines steps towards Green Computing. Virtual machine migration is of high importance for the uninterrupted and high-quality services. This paper reviews various techniques for virtual machine migration with their merits and demerits.

Keywords- Virtualization, Virtual Machines, Live Migration, Downtime, Total Migration Time.

I. INTRODUCTION

Cloud computing is totally over internet without the requirement of the infrastructure at the user’s site. The users access the services from data centers from any location at much less cost which are jointly referred to as the term “cloud”. On demand resources as Infrastructure, platform, software and other resources are delivered. Essential characteristics involve elasticity, On demand services, huge network access, resource pooling. Here the resources are shared and users access these resources simultaneously with the concept of virtualization. Cloud computing provides different services to the end users like Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Widely used in the government sector, education, business, research etc. Most business uses some sort of cloud computing which can be models and services to access various shared resources also services which reduces capital expenditure (CAPEX) and operating expenditure (OPEX). Cloud provides Quality as a Service which includes reliability, performance and availability. Services which are delivered, are in the form of software, hardware, storage, platform, database, Infrastructure etc. using Amazon’s EC2, Microsoft Azure, IBM Smart Cloud. The Deployment Model of cloud computing are Private cloud, Public cloud, Community cloud and Hybrid cloud. The main technology used in cloud computing is Virtualization. Cloud providers offers services to users by using virtualization technology and

uses huge data centers which have large bandwidth, storage, computing resources.

VIRTUALIZATION

Virtualization is an important technology in cloud by creating virtual environment on a host by extracting hardware details, due to which users handle multiple virtual machines on it. The virtual machine provides reliability and flexibility by resource sharing. It involves migrating virtual machine from one physical host to another. [23], [24] When the SLA is not satisfied or violated the hosted VM is migrated to another server which do have enough resources.

Hypervisor or VMM is a program, which handles more than one virtual OS on a single host. The hypervisor is responsible for providing the resources to the virtual machines which are hosted over the host operating system. These are of two types.

- 1) BARE METAL HYPERVISOR- It is installed on the hardware and no intermediary is required. complete Have a complete control over its resources (storage, memory, network etc.) Example – Hyper-V, VMware.
- 2) HOSTED HYPERVISOR – Hypervisor which is installed in the OS of the server and the OS is the controller of it. Example – Virtual Box, XEN etc.

VIRTUAL MACHINE MIGRATION

Goals like fault tolerance, reliability, availability, load balancing, energy consumption, green computing etc. can

be achieved [1], [23], [24]. Various VM migration algorithms turned out to be a great improvement in the utilization of resources in data centers. Virtualization migrates virtual machines from one physical host to another. When the SLA is compromised by the serves because of the lack of resources hence the VMs hosted are migrated to another server with enough resources.

The rest of the paper is organized as follows. Section II contains related work done in live migration of VMs in cloud computing followed by a comparison table, Section III contains discussion of various VM migration techniques and Section IV concludes the paper.

II. RELATED WORK

Wen-tao Wen [2015] [1] proposed Ant Colony Optimization Algorithm using the concept of live migration. The algorithm described the local agents continuously monitors the utilization of the resources and then initiates the migration of virtual machines.

Babu, KR Remesh, Amaya Anna [2015] [2] proposed Bee Colony Algorithm that considers the priorities of the tasks of the VMs waiting in the queues. The algorithm lead to the improvement in the Quality of Services (QOS).

Hu, Jinhua, Jianhua Gu, Guofei Sun [2010] [3] proposed Genetic Algorithm which took historical and the current state of the system. The algorithm have an influence on the host after when the VM resources are deployed on to it. Least affected solution is chosen.

Wentian Cui, Meina Song [2010] [4] proposed Matrix Bitmap Algorithm which collected the dirty page information for number of times before deciding which and when pages are to be transfered. If sufficient information regarding the dirty page is collected, the total migration

time will be decreased without increasing the burden on the system.

Hai Jin, Li Deng, Song Wu [2009] [5] proposed migration with adaptive memory compression which first uses memory compression for fast virtual machine migration, also introduced adaptive zero-aware compression algorithm where the pages are compressed in the batches on the source and are recovered the same on the target.

Y Liu, Bo Gong, Yanbing Liu [2014] [6] proposed a migration strategy which is based on the time series workload prediction algorithm. Here the upper and lower workload bounds for host machines are set, foreseeing the workload to appear by introducing workload time series with cloud model.

Umesh Deshpande [2016] [7] proposed Agile migration technique which eliminated the resource pressure faster as compared to the traditional techniques. Leads to the reduction in the pressure of memory on both the source and the destination.

Kate Keahey, Umesh Deshpande [2016] [8] considered the migration of the multiple virtual machines from multiple source host to multiple destination host taking network contention into consideration.

Salem A.W Ba Hmaid, Sulsimsn A.M Ghaleb, Akram S.A Alhammadi [2017] [9] discussed and compared various virtual machine migration techniques.

Rajwinder Singh, Dr. K.S Kahlon, Sarabjit Singh [2013] [10] compared various migration techniques and proper understanding of post copy VM migration technique and challenges by comparing existing work. [9]

Table 1

TECHNIQUES	BACKGROUND	DESCRIPTION	FINDINGS	LIMITATIONS
ACO- (Ant Colony Optimization) [2]	Ant colony optimization using live migration. Pre-copy.	Examination of the resource utilization and launch migration.	1.Reduces the migration. 2.SLA Violation is improved. 3.Load balancing improved.	Theoretical analysis is difficult.
Bee colony Algorithm using VM Migration. [22]	Used for balancing of load in cloud computing.	Prioritizing the tasks. Low priority tasks are selected for removal.	1.Minimum waiting time. 2.Maximize throughput.	No consideration of energy consumption.
Genetic Algorithm [10]	Strategical approach on load balancing of VM	Computing the after effect of the deployment	Load imbalance Is resolved.	Time consuming.

	resources.	of the needed VM resources.		
Non-Live Migration [1]	Non-live migration	VM is stopped at the source and then transferred.	Reduces number of VM migrations.	More downtime.
Pre-Copy [1], [23], [24]	Pre-copy	First the memory is transferred than the execution is transferred.	Downtime < 1 sec.	Overhead of duplicate page transmission.
Post-Copy [1], [23], [24]	Post -copy	Firstly, the execution is transferred then the memory is transferred.	Memory is transferred in a single go.	More downtime as compared to pre-copy.

Table2

MATRIX Bitmap [3]	Weight calculation.	Weight of the pages more than the threshold value will not be forwarded on to the destination host.	1.Reduced migration time. 2.Minimize the total data transfer rate.	Strength of the algorithm is only based on the threshold value.
Memory Compression Technique. (MECOM) [4]	Compression.	Memory pages are compressed.	Increased rate of migration.	Compression requires huge disk space for holding memory data.
Time Series Prediction Technique. [15], [7]	Prediction	Identification of the frequently updated dirty pages (high dirty pages) and then transmit them in the last iteration round.	1. Lower number of iterations. 2. Low down time and migration time. 3. Few pages are transferred.	Useful when the dirty page's iteration is high.
Agile Technique [21]	Hybrid	Uses HOT pages and places the cold pages in the per VM swap devices.	Reduces resource pressure.	Scalability, regular feedback and change is needed.
Stop-and-Copy Approach [6]	Non-Live Migration	Halting the targeted VM, copy all the pages to the destination, and then resume execution.	Simple	More service downtime.

III VM MIGRATION TECHNIQUES

NON-LIVE MIGRATION pauses the working of the virtual machine and migrates it.

LIVE MIGRATION continues the migration without pausing the running state of the machine.

Various performance parameters are-

- 1) Preparation Time- It is the time between the initiation of the migration and the processor state send to the destination host while the VM is still running.
- 2) Resume Time- It is the time between the stopping of the virtual machine and the migration's end.
- 3) Pages Transferred- The number of pages transferred along with their copies.

- 4) Down Time- Time during which the working of the virtual machine is stopped.
- 5) Total Migration Time- The complete total time of the migration from starting of the initiation phase to the end of the migration.
- 6) Overhead- Additional working which is not a part of the migration process. This leads to the application performance degradation.

Algorithms used in live migration are pre-copy, post copy, hybrid migration.

1) **Pre-copy migration [1]-**

(Warm Up Phase) It is the initial stage where the copies of the required memory pages are created by the hypervisor

and are sent from source node to the destination node but VM is not halted during the process by the hypervisor. (Stop and Copy phase) Here the source node is halted, data is moved to the destination node and VM starts the process in the destination node.

2) **Post copy migration** [1]- VM is suspended from source host for some time and sent to the destination host. It immediately starts executing in the destination node even if most of the memory state is residing on the source node. If the required pages are not found in the destination node, it will send the page fault to the source node and it will act accordingly by sending the faulty pages to the destination. Performance degradation occurs due to data transfer overhead.

If migration fails, the VM is stopped at the source host and switches the execution states at destination host to resume the VM and the memory pages are copied from source to the destination.

3) **Hybrid Migration**- Combination of pre-copy and post copy migration techniques. Contains four phases-

1) **PREPARATION PHASE**- The required system resources in the target host are reserved.

2) **BOUNDED Pre-Copy ROUND PHASE**- It includes identification of the pre-copy rounds and the working VM's are transferred from sender to the destination node.

3) **VIRTUAL MACHINE RESUME PHASE**- Here the transfer state is introduced at the destination server.

Results: The number of migrations were reduced by using ACO-VMM. Improved SLA violations.

Bee-Colony VM Migration:

Bee colony migration algorithm is a type of swarm optimization category which is dependent on the priority of tasks [22]. The honeybee is considered as a task assigned to the virtual machine for execution and the virtual machines are treated as a food source. When the seeker bee finds the new source, then the removed tasks are scheduled to under-loaded virtual machines from the overloaded virtual machine. The lowest priority tasks are selected for removal.

Results: Minimum waiting time, minimize the degree of imbalance, low overhead, maximize throughput, reduced response time.

Genetic Algorithm:

Jinhua, introduced a scheduling strategy based on load balancing of virtual machine on resources based on Genetic Algorithm [10]. The genetic algorithm is a random searching method with better optimization ability. When there are VM resources, the algorithm chooses the scheduling according to the probability. Genetic algorithm uses the concept of natural computing.

Results: Best load balancing achieved.

4) **ON DEMAND PAGING PHASE**- According to the requirement of the application, read and write is requested.

Pre-copy provides low service downtime for migration of VMs whereas post copy is known for its low network overhead and even allows quick consolidation of the VMs. Live migration is network intensive activity which requires transfer of huge VM memory state from source to destination host over the network. When the migrating VMs are running network bound applications, the application traffic competes with the migration traffic for the network interface cards at the source and the destination hosts.

Ant colony optimization VM migration (ACO-VMM):

ACO-VMM is ant colony optimization algorithm where the resource utilization is examined by local migration agent independently and then initiates the migration. The main goal of ACO is to search minimum cost graph [2]. Wen Tao Wei, proposed ACO optimization algorithm which was based on Ant's behavior who are searching for food for the real optimal solution. In this algorithm like the ants, the virtual machine will leave more Pheromones (Markers) when the bandwidth between the original physical machine and destination physical machine is less or when the destination physical machine has a high load condition.

Matrix Bitmap:

Wentian Cui introduced matrix bitmap algorithm which collects the dirty page information for few times before deciding whether to transfer the page [3].

Results: 50% reduction in the total migration time i.e fast migration.

Memory Compression:

Hai Jin presented novel memory compression based VM migration (MECOM) [4] which first uses memory compression for faster VM migration. Introduction of the adaptive zero-aware compression algorithm for the cost factor and the performance. Here the pages are compressed in batches on the source and are recovered the same on the destination.

Results: Downtime and total migration time are reduced.

Agile Migration:

It eliminates the resource pressure faster than the traditional approaches [21]. This approach tracks the working set of the VM and offloading the non-working set (cold pages) to the portable per-VM swap device.

Results: Reduction in the memory pressure on both the source and the destination hosts.

Time Series Workload Prediction:

This includes the setting up of the upper and the lower workload bounds for the host machines, also foreseeing the workload occurrence by the creation of the workload time series using cloud model [15].

Results: Resource and workload balance for virtual machines is maintained and the improved utilization of the resources.

IV. CONCLUSION

Cloud computing is achieved by Virtualization. Load Balancing becomes complex in data centers so Virtual machine migration overcomes the problem of load balancing. Here the overloaded virtual machines are migrated from one physical host to another. This paper reviewed various techniques for virtual machine migration. The algorithms have their own parameters which measures the performance of the virtual machines. Main aim of the algorithms is the minimized violations of the SLA (Service Level Agreement). Agile Technique showed better results as compared to the existing migration techniques due to its high migration speed and the reduction of the memory pressure on source and the destination hosts. It quickly recovers the performance of all VMs under resource pressure by eliminating resource pressure faster than traditional live migration. It is a hybrid pre/post-copy techniques that reduces the performance impact on the workload by transferring only the working set. Hence much better as compared to the rest of the techniques.

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