A modelling & Simulation via CloudSim for Live Migration in Virtual Machines

Ambika Gupta
GLA University, Mathura
Ambika.gupta@gla.ac.in

Abstract. In growing era of cloud computing, one major utility is better and improved performance. For which Cloud Computing is a model which provides various resources available in a pool from where the users can get available the same when required. In the overall process there can be an important issue that is Fault tolerance to provide the high availability for the process which is being required by the user. And simultaneously if any fault occurs then user might not found any server downtime and other kind of delay in getting the response. There are many compute nodes such as Virtual machines further controlled by the Hypervisor. For transferring the load among compute nodes can be done by Cold Migration earlier there was a technique Non-Live migration. But at the same time there were lot many issues and challenges with the same that user might get the server downtime for infinite delay. For overcoming that there is an on-going technique which is known as Hot Migration or Live migration. It allows system administrators to shuffle the load available on an operating system instance to other Guest Operating system instance without any intervention on hosted service. This approach benefits to provide and efficient online system where no downfall in server maintenance. It also cures the load balancing, reconfiguration of data centers. The simulation of above aforesaid concept has been done via Cloudsim a tool for modelling and simulation in Cloud computing environment for live migration of virtual machines without intervention of cloud services. This paper simulated the work and gives the efficient results in comparison to the existing techniques.

Keywords: Virtualization, Migration, Provision of resources, Virtualization Technology

1. Introduction
Provisioning of computing resources in an efficient manner which follows the enhanced usage of Virtualization via the internet is known as Cloud computing [1]. There is a feature that makes the frequent requirement of this technology is on demand availability which allows pure aggregation of resources such as Shared Memory, CPUs and I/O devices etc. With the help of Virtualization, we can improve the availability of computer systems in a virtualized manner to reduce the demand of keeping resources physically and further maintained them [2, 3].

For getting available the number of resources when required virtual machines are needed for proper functioning of virtualization technology which is further known as virtual Machine Monitor or Hypervisor. One thing arises when it comes to the concept of virtualization is whether it is different from Cloud Computing or a combination for the same? So we can say that it is interdependent to each other in every terminology which has been described such as:

A) If automation in management is required then effective server utilization can be only fulfilled by Virtualization.
B) Pay-per-Usage allows by the cloud then simultaneously it is required for cost effective solutions to establish the infrastructure.

![Hypervisor with multiple guest OS](image)

The process of moving the VM from one physical machine to another without switching off the VM is called live migration. There are various methods of Live Migration which are discussed as follows:

1.1 Pre-Copy Live Migration
There are two phases in this technique one is warm-up phase and the other is stop and copy phase.

The warm-up phase uses iterative push methodology as shown in the figure 3 in which dirty memory pages are regenerated on the host server this means the updated or modified memory pages in entire migration procedure have been regenerated.

And all the memory pages are transferred but still the Virtual Machine will be in the running state at the source node server.

In stop-and-copy phase, the Virtual Machine is suspended at the source node server. When the entire process of transferring memory pages is completed then Virtual Machine resumes its working on the target node server. Some of the virtual machine monitor or Hypervisors such as Kernel Based Virtual Machines and Xen Hypervisor use the Pre-Copy Live Migration Technique.

1.2 Post-Copy Live Migration
In this migration technique Virtual Machine is suspended from source node server for some time duration. After that the state of Virtual Machine is transferred to the target node server. And then it starts executing at the target node server, meanwhile any requests arise to fetch the memory page which is not available at the target server then there is a page fault.

This paper organized as follows: In the second part of the paper various related work has been given, after that in the next part of the paper the proposed architecture is there. The result analysis and conclusion has been discussed further.

2. Literature Review

In the present scenario where cloud computing environment has taken a significant aspect in the real world in which there should be no downtime while accessing any service from internet. For
providing the high time availability of cloud computing services it is required to apply live migration among virtual machines if any server node got faulty.

In this section, there is a discussion of various techniques on migration which has been given by valuable authors. At the initial stage Dawei Huang et al. [9] has surveyed various evaluation methods on live migration, after that proposed a benchmark for live migration of virtual machine and compares it to the existing techniques available and provided some results that performed better and gives the idea of performing scalability of the Virtual Machines to take up the heavily loaded node servers and also to manage the multiple migrating requests arise on a single node server. There are certain future directions also still remained to solve and give appropriate benchmark in the running environment of virtualization.

Felix Salfner et al. [10] proposed an approach for some factors that affect the migration process and result in more downtime. The approach is based on memory load and how to access the guest server node on that time. There is a usage of two hypervisors named as VMware ESX Citrix Xen Server. By using those virtualization products an experimental analysis has been done that gives the better results for live migration among virtual machine servers nodes and gives an aspect to manage the memory page load on source node server. Experiment design and load model follows two approaches one is carried on single variable experiments where VMSIZE set to 512MB, 1GB, 2GB, 4GB and 8GB RAM and the other one which is based on multiple variable experiments. And the final results have been used to identify the proactive faulty nodes so that they can be migrated onto the other node server.

An approach named as delta compression algorithm has been proposed by Wood et. al [11] for reducing the migration downtime. This algorithm uses the certain features of pre-copy live migration technique and enhances it by applying the data compression technique which includes data deduplication along with compression. Deduplication is used to reduce the bandwidth in accessing any requests arises so that it can give the effective results in terms of total migration time.

Ashima Agarwal et. al [12] improves reliability where any fault can arise in the case of disaster. And gives experimental results with the help of Redhat Cluster Suite which is used in Virtual Distributed Ethernet (VDE). It ensures the decrease in downtime for the entire migration process. VDE are virtual switches that are used for create the connection between virtual machines for creating better reliable solutions while migrating among virtual machines.

Divya Kapil et. al [13] investigates a critical survey available on live migration in cloud computing environment. It involves transferring the memory pages among distinct physical node servers. There are certain future directions discussed with respect to mitigate the downtime and consumption of low bandwidth. The investigations have been compared and analysed the research gaps for creating the strength for migrating the entire load from one node server to another node sever dynamically.

Wenjin Hu et. al [14] proposed an architecture for live migration in virtualization environment to control all the virtualization platform in an appropriate manner to ensure consistency to get reduce loss of data. A technique for profiling in live migration collected and manages basic data analysis from initial point up to end of the migration and calculates the exact downtime for service unavailability. Every analysis performed under profiling in migration procedure must be done upon benchmark server. And discussed on some of the active components of Infrastructure as a service. The analysis carried on to identify the various flaws in between actual service availability and assured quality of service.

Rakesh Kumar Mishra et. al [15] proposed an algorithm with sequence of instructions such as selection of data center on the basis of Round Robin algorithm as there were many issues while selecting data centre randomly. This algorithm works in such a way that equalizes the load evenly among various data centre. There is again an issue that might be the data centres have variation in processing speeds such as some are faster and some are slower. Therefore, we have to select the optimal data centre in terms of cost and overall processing time.

Christina Terese Joseph et. al [16] applied an approach for family Gene for random allocation of various data centres.
In the proposed algorithm the approach is all about reduction in total energy consumption and number of migrations. Zhou Lei, Exiong Sun et. al [17] has given an approach based on Hybrid-Copy for migration of various virtual machines. In this algorithm Markov Model has been used to predict the accessibility of memory structure. On the basis of forecasted results, the real situation can be identified.

Nagamani H Shahapurea, P Jayarekhab et. al [18] discussed about various parameters of traffic congestion and an additional energy consumption etc. For the same an algorithm has been developed for routing of distance among various virtual machines in the system of live virtual machine migration for applying checks in a fixed interval to maintain a track of various virtual machines. Naga Malleswari TYJ et. al [19] proposed deduplication approach for virtual machine migration in context of lesser energy consumption as well as reducing the overall cost of the system. The aforesaid algorithm can also be applied for bulky data transfer among various nodes in migration mechanism.

Amro Al-Said Ahmad et. al [20] has been given an approach on scalability analysis which describes about various cloud platforms for increasing the performance of the system if any fault arises. In this proposed algorithm they have discussed the scalability measures in cloud software’s when auto scaling policies has been applied.

Jyoti Prakash Mishra et. Al [21] has given an approach to reduce the overall energy consumption for efficient utilization of various resources such as Virtual Machine, CPU and Memory etc in cloud deployment model.

3. Proposed Methodology

There are few constraints and issues in the various above aforesaid techniques of live migration such as migration overhead to transferring the entire memory pages and Virtual Machine state etc. To get rid of this kind of overhead it is requiring further optimizing the transfer of memory pages and other information. There is a need of further optimize the transfer of memory and CPU state.

The proposed architecture has been shown in the Figure 2.
Figure 2: A framework for proposed approach on Live Migration in Virtual Machines between Compute Nodes
4. Result Analysis

The implementation has been done using Cloudsim (A modelling and simulation tool). After creating various cloudlets on Cloudsim the result of above proposed framework is as discussed as follows:

Number of VMs: 1052
Total simulation time: 86400.00 sec
Energy consumption: 184.88 kWh
Number of VM migrations: 26292
SLA: 0.00331%
SLA perf degradation due to migration: 0.07%
SLA time per active host: 5.03%
Overall SLA violation: 0.08%
Average SLA violation: 10.18%
Number of host shutdowns: 5759
Mean time before a host shutdown: 982.82 sec
StDev time before a host shutdown: 3508.23 sec
Mean time before a VM migration: 13.90 sec
StDev time before a VM migration: 6.38 sec
Execution time - VM selection mean: 0.00144 sec
Execution time - VM selection stDev: 0.00099 sec
Execution time - host selection mean: 0.01565 sec
Execution time - host selection stDev: 0.01804 sec
Execution time - VM reallocation mean: 0.10878 sec
Execution time - VM reallocation stDev: 0.04949 sec
Execution time - total mean: 0.29719 sec
Execution time - total stDev: 0.18154 sec

It has produced the summary after simulation that includes number of Virtual Machines are 1052 and used simulation time is 86400 seconds. In which simulation the number of virtual machine migrations are 26292 which is better results in terms of overall energy consumption and cost consumption.

5. Conclusion

From this above mentioned framework that is optimized approach from get rid of Page fault and other related issues that can be directly handled by tracker node that is a temporary node which takes care the entire load on the source and destination node server.

This proposed approach gives the better results on Cloudsim tool as discussed earlier.

References

[1] Armbrust M, Stoica I, Zaharia M, Fox A, Griffith R, Joseph AD, Katz R, Konwinski A, Lee G, Patterson D, Rabkin A (2010) A view of cloud computing. Communication ACM 53(4):50. https://doi.org/10.1145/1721654.1721672. 0521865715 9780521865715.

[2] Naga Malleswari TYJ, Rajeswari D, Senthil J (2012) A survey of cloud computing architecture and services provided by various cloud service providers. In: Proceedings of 2nd international conference on demand computing, the Oxford College of Engineering, November 15–16, Bangalore.

[3] Sangpetch A, Sangpetch O, Juangmarisakul N, Warodom S (2017) Thoth: Automatic resource management with machine learning for container based cloud platform. In: Proceedings of the 7th International Conference on Cloud Computing and Services Science - Volume 1: CLOSER. pp 103–111. SciTePress, https://doi.org/10.5220/0006254601030111
[4] Naga Malleswari TYJ1 and Vadivu G, “Adaptive deduplication of virtual machine images using AKKA stream to accelerate live migration process in cloud environment”, Journal of Cloud Computing: Advances, Systems and Applications, 06 February, 2019. https://doi.org/10.1186/s13677-019-0125-z.

[5] Obasuyi, G.C., Arif, S.: Security challenges of virtualization hypervisors in virtualized hardware environment. Int. J. Communication Network Syst. Sci. 08(07), 260–273 (2015).

[6] Bala A, Chana I (2012) Fault Tolerance - Challenges, Techniques and Implementation in Cloud Computing. Int J Comput Sci Issues 9(1):288–293

[7] Choudhary A, Govil MC, Singh G, Awasthi LK, Pilli ES, Kapil D (2017) A critical survey of live virtual machine migration techniques. J Cloud Comp 6(23):1–41. https://doi.org/10.1186/s13677-017-0092-1.

[8] Hines MR, Deshpande U, Gopalan K (2009) Post-copy live migration of virtual machines. ACM SIGOPS Oper Syst Rev 43(3):14–26.

[9] Dawei Huang, Deshi Ye, Qinming He, Jianhai Chen, Kejiang Ye, “Virt-LM: A Benchmark for Live Migration of Virtual Machine”, ICPE’11, March 14–16, 2011, Karlsruhe, Germany. ACM 978-1-4503-0519-8/11/03.

[10] Felix Salfner, Peter Tröger, Andreas Polze, “Downtime Analysis of Virtual Machine Live Migration”, DEPEND 2011: The Fourth International Conference on Dependability, ISBN: 978-1-61208-149-6, 100-105.

[11] Timothy Wood, K. K. Ramakrishnan, Prashant Shenoy, and Jacobus van der Merwe. CloudNet: dynamic pooling of cloud resources by live WAN migration of virtual machines. In VEE ’11: The 2011 ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments, pages 121–132. ACM, 2011.

[12] Ashima Agarwal, Shangruff Raina, “Live Migration of Virtual Machines in Cloud”, International Journal of Scientific and Research Publications, Volume 2, Issue 6, June 2012 1 ISSN 2250-3153.

[13] Divya Kapil, Emmanuel S. Pilli and Ramesh C. Joshi, “Live Virtual Machine Migration Techniques: Survey and Research Challenges”, 3rd IEEE International Advance Computing Conference (IACC), 2013, 963-969.

[14] Wenjin Hu, Andrew Hicks, Long Zhang, Eli M. Dow, Vinay Soni, Hao Jiang, Ronny Bull, Jeanna N. Matthews, “A Quantitative Study of Virtual Machine Live Migration”, CAC’13, August 5–9, 2013, Miami, Florida, USA, ACM 978-1-4503-2172-3.

[15] Rakesh Kumar Mishra, Sreenu Naik Bhukya, “Service Broker Algorithm for Cloud-Analyst”, Rakesh Kumar Mishra et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3), 2014, 3957-3962.

[16] Christina Terese Joseph, Chandrasekaran K, Robin Cyriac, “A Novel Family Genetic Approach for Virtual Machine Allocation”, International Conference on Information and Communication Technologies (ICICT 2014), Procedia Computer Science 46 (2015) 558 – 565.

[17] Zhou Lei, Exiong Sun, Shengbo Chen, Jiang Wu ID and Wenfeng Shen, “A Novel Hybrid-Copy Algorithm for Live Migration of Virtual Machine”, Future Internet 2017, 9, 37; doi:10.3390/fi9030037 Source: URL: www.mdpi.com/journal/futureinternet.

[18] Nagamani H Shahapure, P Jayarekha, “International Conference on Computational Intelligence and Data Science (ICCIDS 2018)”, Procedia Computer Science 132 (2018) 728–737.

[19] Naga Malleswari TYJ and Vadivu G, “Adaptive deduplication of virtual machine images using AKKA stream to accelerate live migration process in cloud environment”, Journal of Cloud Computing: Advances, Systems and Applications (2019) 8:3 https://doi.org/10.1186/s13677-019-0125-z.

[20] Amro Al-Said Ahmad and Peter Andras, “Scalability analysis comparisons of cloud based software services”, Journal of Cloud Computing: Advances, Systems and Applications (2019) 8:10 https://doi.org/10.1186/s13677-019-0134-v.

[21] Jyoti Prakash Mishra, Snigdha Rani Panda, “Load Balancing Using Cloudsim Simulator in Cloud Computing”, International Journal of Scientific & Technology, Volume 9, Issue 01, January 2020, ISSN 2277-8616 2773.
