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A Survey on Live Virtual Machine Migrations and its Techniques

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Abstract

Today's world is internet world. Almost all the people uses internet for accessing different services. In Cloud Computing various cloud consumers demand variety of services as per their dynamically changing needs over the internet. So it is the job of cloud computing to avail all the demanded services to the cloud consumers. But due to the availability of finite resources it is very difficult for cloud providers to provide all the demanded services in time. From the cloud providers' perspective cloud resources must be allocated in a fair manner. So, it's a vital issue to meet cloud consumers' QoS requirements and satisfaction. Virtualization mainly abstracts the resources like CPU and Memory through Virtual Machine for efficient resource utilization. Virtual Machine Migration is one of the key technique for dynamic resource management in cloud computing. This paper mainly addresses key performance issues, challenges and techniques for live virtual machine migration in cloud computing. It also focuses on the key issues related to these existing live virtual machine migration techniques and summarizes them.

Keywords: Cloud Computing, Migration, Virtualization, Virtual Machine, Physical Machine, Resource Management, Live Virtual Machine Migration.

1. Introduction

Because of the advancement in Information and Communication Technology (ICT) over past few years, Computing has been considered as a utility like water, electricity, gas and telephony. These utilities are available at any time to the consumers based on their requirement. Consumers pay service providers based on their usage [1] [2] [3] [4].

Like all the other existing utilities, Computing utility is the basic computing service that meets the day to day needs of the general community. To deliver this vision, a number of computing paradigms have been proposed, of which the latest one is known as Cloud Computing. Cloud is nothing but large pool of easily accessible and usable virtual resources [2] [3] [4] [5].

Dr. Rajkumar Buyya says "A Cloud is a type of parallel and distributed system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resource(s) based on service-level agreements established through negotiation between the service provider and consumers." [3]

In cloud computing various cloud consumers demand variety of services as per their dynamically changing needs. So it is the job of cloud computing to avail all the demanded services to the cloud consumers. But due to the availability of finite resources it is very difficult for cloud providers to provide all the demanded services in time. From the cloud providers' perspective cloud resources must be allocated in a fair manner. So, it's a vital issue to meet cloud consumers' QoS requirements and satisfaction. The ultimate goal of efficient resource utilization in cloud computing is to maximize the profit for cloud providers and to minimize the cost for cloud consumers.

Traditional resource allocation techniques are not adequate for cloud computing as it is based on virtualization technology with distributed nature. Cloud computing introduces new challenges for manageable and flexible resource allocation due to heterogeneity in hardware capabilities, workload estimation and characteristics in order to meet Service Level Objectives of the cloud consumers' applications.

Virtualization itself can be one of the solutions to provide resources to the cloud consumers efficiently by running multiple VMs on top of single physical host. The term "virtualization" refers to the sharing of same physical host across multiple concurrently running OS instances. Virtualization mainly abstracts the resources like CPU and Memory through Virtual Machine for efficient resource utilization [8][14]. Virtualization multiplexes computing resources on a single cloud platform.

Virtual Machine has been a research topic since past few years as it is independent of hardware implementation and configurations. Migration is the process of transferring VM from one physical host to another physical host. If the same can be achieved without interrupting its execution then it is said to be "live". Live Virtual Machine

Migration is one of the key technique for dynamic resource management in cloud computing [8][14].

The rest of the paper is organized as follows: Section II discusses various live virtual machine migration techniques proposed by researchers'. Section III gives summary of all these live virtual machine migration techniques with their used tools and possible improvements. Section IV presents conclusion and discussion on live virtual machine migration techniques.

2. Literature Survey and Related Work

Sujesha Sudevalayam and Purushottam Kulkarni [9] argued that network affinity-awareness is required in resource provisioning for virtual machines. Authors have quantified their work of benchmarking of link network usage for both Xen and KVM virtualization technologies. Authors have also focused on building affinity-aware models that can predict expected CPU resource requirements based on its location relative to its communicating set of virtual machines – upon colocation and dispersion of virtual machines.

Pablo Graubner, Matthias Schmidt and Bernd Freisleben [10] presented a novel approach to virtual machine consolidation based on energy efficient storage migration and live virtual machine migration. Authors tried to save energy through virtual machine consolidation in IaaS cloud computing environment. Authors have implemented the same approach using Eucalyptus which is an open source clone of the Amazon Elastic Compute Cloud (Amazon EC2).

Tiago C. Ferreto, Marco A. S. Netto, Rodrigo N. Calheiros and Cesar A.F. De Rose [11] a new approach named Dynamic Consolidation with Migration Control. Authors have discussed that current techniques like static consolidation and dynamic consolidation doesn't consider the steady usage of virtual machines. Due to which problems may arise like migration cost and penalty to physical server. So, Authors claimed that for steady usage migration can be avoided but for variable usage migration can be performed. Authors had used Linear Programming Formulation and Heuristics approach for the same. Authors had evaluated their proposed approach with TU-Berlin Workload and Google Workload.

Mayank Mishra, Anwesha Das, Purushottam Kulkarni and **Anirudha Sahoo** [12] discussed that live virtual machine migration plays a vital role in dynamic resource management of cloud computing. Authors mainly focused on efficient resource utilization in non peak periods to minimize wastage of resources. In order to achieve goals like server consolidation, load balancing and hotspot mitigation, authors discussed three components – when to migrate, which VM to migrate and where to migrate – and approaches followed by different heuristics to apply migration techniques. Authors also discussed virtual machine migration over LAN and WAN with their challenges.

Haikum Liu, Hai Jin, Xiaotei Liao, Chen Yu and Cheng-Zhong Xu [13] had designed, implemented and evaluated a novel approach that minimises virtual machine migration downtime and network traffic. Authors had adopted check pointing/recovery and trace/reply technologies for the same and implemented a transparent virtual machine checkpoint with copy-on-write (COW) mechanism. Authors claimed that their proposed method can be used in both LAN and WAN. The experimental results showed that a novel approach gives better performance.

Kejiang Ye, Xiaohong Jiang, Dawei Huang, Jianhai Chen and **Bei Wang** [14] proposed resource reservation based live migration framework of multiple virtual machines. The target machine in the framework holds four virtual machines: Migration Decision Maker, Migration Controller, Resource Reservation Controller and Resource Monitor. Authors focused on improving the migration efficiency through live migration of virtual machines and proposed three optimization methods: optimization in the source machine, parallel migration of multiple virtual machines and workload-aware migration strategy. To improve the migration efficiency authors had considered parameters like downtime, total migration time and workload performance overheads. Authors claimed that resource reservation strategy is required at source machine and target machine.

Febio Checconi, Tomasso Cucunotta and Manuel Stein [15] addressed real time issues in Live Virtual Machine Migration. Authors had presented a technique for live migration of real time applications. The main factor that had been considered by authors is down time of virtual machines due to live migration. Also authors have introduced probabilistic model for migration process to find out new set of migration policies by building a sound mathematical theory. Deeper evaluation of the fully implemented proposed technique is still has to be done by the authors.

3. Summary on Live Virtual Machine Migration Techniques

Table 1 summarizes the work done by various researchers and future work and/or gaps in their existing work.

Table 1 Summary on Live Virtual Machine Migration Techniques

Year	Author	Techniques/Algorithms	Tools and/or workload used	Future work and/or gaps in existing technologies
2013	Sujesha Sudevalayam and Purushottam Kulkarni [9]	Affinity aware modelling of CPU usage with communicating VMs	Xen and KVM	Heterogeneity of PMs are not considered. Benchmarking of 100 Mbps link network usage is done (1 Gbps – not done)
2013	Pablo Graubner, Matthias Schmidt and Bernd Freisleben [10]	VM consolidation through energy efficient storage migration and live VM migration	Eucalyptus	Resource management at higher layer and overhead VM live migrations.
Year	**Author**	**Techniques/Algorithms**	**Tools and/or workload used**	**Future work and/or gaps in existing technologies**
2011	Tiago C. Ferreto, Marco A. S. Netto, Rodrigo N. Calheiros and Cesar A.F. De Rose [11]	Dynamic Server Consolidation with Migration Control	TU-Berlin and Google Workload	Can easily be implemented on VMWare and Citrix Tools.
2012	Mayank Mishra, Anwesha Das, Purushottam Kulkarni and Anirudha Sahoo [12]	Live Virtual Machine Migration	Not Mentioned	Only load on the virtual machine for migration is considered. Consumer requirements and priority of job is not considered.
2011	Haikum Liu, Hai Jin, Xiaotei Liao, Chen Yu and Cheng-Zhong Xu [13]	Virtual Machine Checkpoint with copy-on-write mechanism.	On LAN and WAN	Multiprocessor virtual machine migration and design a hybrid scheme that can apply heuristics to choose alternative algorithm between precopy and proposed method.
2011	Kejiang Ye, Xiaohong Jiang, Dawei Huang, Jianhai Chen and Bei Wang [14]	Live Migration of Virtual Machines	Xen and VMWare	Intelligent live migration machine can be future work.
2009	Febio Checconi, Tomasso Cucunotta and Manuel Stein [15]	Real Time Issues in Live Virtual Machine Migration (new set of migration policies)	KVM	Deeper evaluation of the fully implemented proposed technique is still has to be done by the authors.

4. Conclusion and Discussion

Cloud Computing is the new era of computing for delivering computing as a resource over the today's internet world. The success and beauty behind cloud computing is due to the cloud services provided with the cloud over the internet. Due to the availability of finite resources, it is very important for cloud providers to manage and assign all the resources in time to cloud consumers as their requirements are changing dynamically.

Live Virtual Machine Migration is one of the key notions for efficient dynamic resource management. Many authors have proposed algorithms and methods for Live Virtual Machine Migration. In summary, all the authors tried to achieve very low and predictable downtimes. They also tried to avail resources to the cloud consumers during migration process.

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