LIVE VM MIGRATION TECHNIQUES IN CLOUD ENVIRONMENT – A SURVEY

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Abstract

Cloud computing is a service where storage and computing resources can be accessed on subscription basis. Cloud computing is powered by the concept of virtualization technology. The virtual machines (VM) are hosted in servers so that user's requests are serviced in an optimal manner. The process of moving a running virtual machine or application between different physical machines without disconnecting the client or application is referred to as Live Migration. System resources memory, storage, process and Network resources like connectivity that are allocated to the virtual machine are transferred from the original host machine to the destination machine. Live Migration is performed for achieving Energy efficiency, Load Balancing and High availability of physical servers in Cloud Data center. This paper presents a detailed survey on Live Migration of Virtual machines in cloud environment

Keywords – Cloud Computing, VM Migration, Energy efficiency

I.INTRODUCTION

Cloud computing is an emerging paradigm where Infrastructure, Platform and software can be accessed as a service. The user accessing the service, pay for what they use. Cloud computing uses the concept of virtualization and utility computing. Virtualization enables multiple isolated and secure virtualized servers to run on a single physical server. Many virtual machines are hosted on the same physical server for optimal resource utilization thereby reducing the cost of deploying a Datacenter. It also enhances the security of physical servers in Data center. Virtual machines are migrated from one physical server to another for achieving energy efficiency, load balancing and high availability of physical server in Cloud Data center. This paper presents survey of techniques used for migration of virtual machines in cloud environment. It also discusses about the security concerns in Live Virtual machine migration techniques.

Section II presents various virtual machine migration techniques in Cloud environment. Section III describes various migration techniques to efficiently conserve energy in cloud Data center. Section IV discusses various migration techniques to achieve load balancing among the physical servers in Cloud data center. Section V details various migration techniques that achieve the availability of physical server when the system is prone to the sudden failures. Section VI overviews various migration control techniques that improves migration metrics like migration time and down time and Section VII discuses about various security threats and challenges that occurs during the process of migration. Section VIII gives a conclusion of this research article.

II.DIFFERENT CATEGORIES OF MIGRATION TECHNIQUES

Live Virtual machine Migration is a technique that migrate the entire OS and its associated application from one physical machine to another. The Virtual machines are migrated lively without disrupting the application running on it. The benefits of virtual machine migration include conservation of physical server energy, load balancing among the physical servers and failure tolerance in case of sudden failure. The different virtual machine migration techniques are as follows

A. Energy Efficient Migration Techniques

The power consumption of Data center is mainly based upon the utilization of the servers and their cooling systems. The servers typically need up to 70% of their maximum power consumption even at their low utilization level. Therefore there is a need for migration techniques that conserves the energy of servers by optimum the resource utilization.

B. Load Balancing Migration Techniques

The Load balancing migration techniques aims to distribute load across the physical servers to improve the scalability of physical servers in cloud environment. The Load balancing aids in minimizing resource consumption, implementation of fail-over, enhancing scalability, avoiding bottlenecks and over-provisioning of resources etc.

C. Fault Tolerant Migration Techniques

Fault tolerance allows the virtual machines to continue its job if any part of system fails. This technique migrates the virtual machine from a physical server to another physical server

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based upon the prediction of the failure occurrences. The benefit of fault tolerant migration technique is to improve the availability of physical server and avoids performance degradation of applications.

III.ENERGY EFFICIENT MIGRATION TECHNIQUES

The power consumption and cooling infrastructure constitute 42 % of the total cost of Data centers.

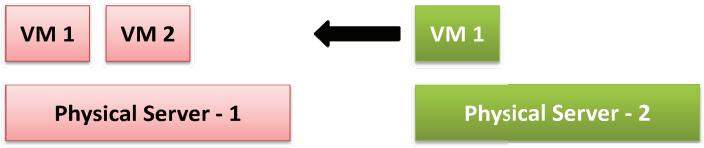

Fig 1.a Energy Efficient Migration [Before migration]

Fig 1.b Energy Efficient Migration [After migration]

The key current technology for energy efficient operation of servers could be live virtual machine migration. Virtual machines are copied, moved and deleted based on the management decisions. The Figure 1 depicts the virtual machine migration from physical server 2 to physical server 1. Figure 1.a shows two physical servers: physical server 1 and physical server 2. The Physical Server-1 has the capacity to accommodate three virtual machines but it runs only two virtual machines. The physical server-2 runs only one virtual machine utilizing very little of its resources. In order to have maximum resource utilization of Data center the virtual machine from physical server-2 is migrated to physical server-1 and physical server-2 is put to an idle state. Servers utilize less energy when they are idle state than it is half utilized. This process of migrating the virtual machine from low utilized physical server to a high utilized physical server is termed as server consolidation which is a NP-HARD Problem.

Many literatures have discussed about Energy efficient migration techniques and analyzed its performance. Jose E.Moreira and John Karidis [2] proposed that Data centers can be build with servers of good response time. However, server consolidation to achieve energy efficiency is still a challenge to the research community. Anton and Buyya [4] proposed utilization threshold for consolidating servers. Based on the utilization of servers, the virtual machines are grouped and migrated from one server to another. The technique has two phases: The first phase select the virtual machine to migrate from a low utilized physical server and the second phase optimize the allocation of physical machines among the servers

Jeffrey and Darrell [5] proposed a technique to manage resources in energy efficient manner. The resources are managed in which services bid for resources as a function of delivered performance for resource management. The system continuously monitors the load and allots the resources in such a way that the without compromising the performance of the service. This method reduces the energy utilization by 29% or more for a typical web workload.

TABLE 1
COMPARISON OF ENERGY EFFICIENT TECHNIQUES

Techniques	**Energy Consumption (Kw/h)**
Threshold Based Approach	1204
Managing Energy and Server resources	1.69
Energy Efficient Allocation	1.14
Energy Efficient Management of Resources	1.14

The comparison of energy consumption of various migration techniques are listed in Table I. The table shows threshold based approach is has high energy consumption than the other energy efficient techniques. This is due to the fact that the threshold based approach considers higher utilization threshold for migration. But in energy efficient technique the migration is based upon lower and upper threshold level.

IV.LOAD BALANCING MIGRATION TECHNIQUES

Virtual machines can be migrated from one server to another server to balance the load among the servers.

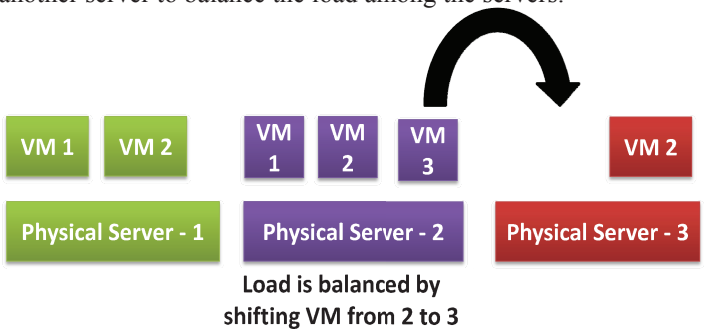

Fig 2.a Load Balanced Migration [before Migration]

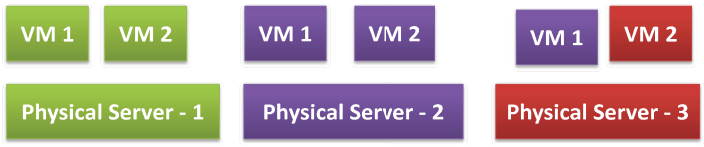

Fig 2.b Load Balanced Migration [After Migration]

Various literatures have studied about the load balancing migration. Timothy and prashant [16] proposed a technique where profiling engine collects information about the

TABLE II
COMPARISON OF LOAD BALANCING MIGRATION TECHNIQUES

Method	***Event for Migration***	***Selection of overloaded Physical server***	***Target Physical server***	***Performance Metrics used for Evaluation***
Sandpiper[25]	Resource usage > Threshold	VM having minimum VSL	To under loaded Physical Machine(PM)	Number of hotspot relieved
Application-performance[26]	Resource usage>threshold	VM having minimum L	To PM with less residual capacity	Migration cost
Load Imbalance[27]	Variance of Physical Machine load > threshold	Overloaded VM	To under loaded PM	Throughput
Server-Storage[28]	Network bandwidth usage > threshold	Overloaded VM	To under loaded PM	Throughput Transfer Packet loss

resources utilization of all the virtual machines. Hotspot detector detects the virtual machine that takes high resource consumption and migration manager migrates such virtual machines from highly utilized servers to less utilized servers. Khanna and kar [17] proposed a technique that solve server sprawl and migrate virtual machine from heavily loaded servers to lightly loaded servers for load balancing load. The server calculates the value of L which is a product of migration cost and utilization of resources. The Virtual Machines are migrated to physical server having less value of L.

$$L = Migration\ cost * Utilization\ of\ resources$$

In the above technique the virtual machines are arranged in the decreasing order of resources utilized and the physical servers are arranged in the increasing order of its migration cost. The load is balanced by migrating virtual machine with high to physical server with low migration cost.

Emmanuel and David [18] proposed a technique that assigns weight to all the resources utilized by the servers. The resources utilized by virtual machines are clearly predicted only by the hypervisor layer. The Virtual Server Load (VSL) is metric that is computed using the resources utilized at the hypervisor layer.

$$\boldsymbol{VSL} = \sum \boldsymbol{\alpha} * \frac{\sum \boldsymbol{\beta}}{\sum \boldsymbol{\gamma}}$$

Where α indicates the weight allotted to resources of physical server, β indicates the utilization of resources by virtual machines running in a physical server and γ indicates the resource capacity of a physical server. The VSL value is calculated for each Server in the cloud Data center. Based on the VSL values the virtual machines are migrated from highly utilized servers to less utilized servers.

Table II depicts the comparison of various load balancing migration techniques. It provides the comparison of parameters viz. *event to migrate, selection of source virtual machine, target virtual machine and performance metrics used for evaluation*. The *event to migrate* is based upon the resource usage threshold in the first two techniques and variance of physical machine usage threshold in third technique. The fourth technique migrate the virtual machine using network bandwidth utilization. The *selection of overloaded physical server* parameter provides the method of selection of the overloaded physical server that migrates the virtual machine to the *target physical server*. The first technique selects the overloaded physical server that holds minimum VSL. The virtual machine from the selected minimum VSL physical server is migrated to under loaded physical server. The second technique selects the overloaded physical server based upon the value of L. The virtual machine from the selected physical server with low L value is migrated to underutilized physical server. The third and fourth technique selects the overloaded physical server that has high network bandwidth utilization. The highly network bandwidth utilized server migrates the virtual machine to the under loaded physical server. Therefore the load balancing was accomplished by avoiding the bottleneck of the overloaded server.

V.FAULT TOLERANT MIGRATION TECHNIQUES

Virtual machines are migrated from one server to another to achieve high availability of physical servers. It predicts the failure and migrate the virtual machine to another server preventing the performance degradation of the applications.

Sung Fu [22] proposed a system to enhance availability of the physical server so as to improve the overall performance of the cloud data centers. The Failure predictor module predicts the failure based upon the history of data and informs the Virtual Machine coordinator module about the health condition of the nodes. The health condition states the lifetime of the physical server. On receiving the failure predictions from the failure predictor module VM coordinator migrates the virtual machine from that server to the nearer server that has good health condition.

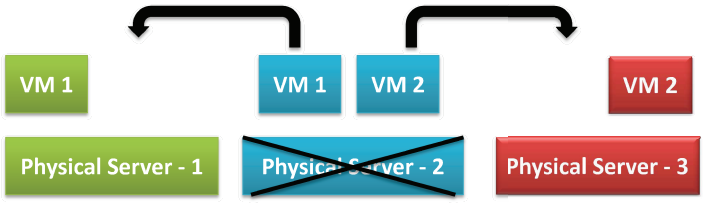

Fig 3.a Fault tolerant Migration [Before Migration]

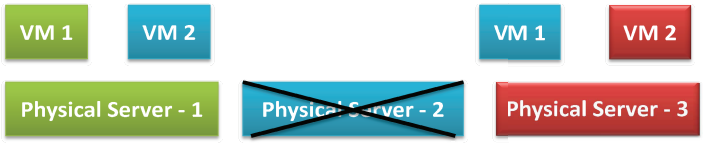

Fig 3.b Fault tolerant Migration [After Migration]

Arun babu and Frank [23] proposed a technique with a Broadband management controller that is responsible for monitoring the health of the server. Based upon the health of the nodes virtual machines are migrated from one physical server to another. Troger and Salfner [24] propose a technique where failures are predicted in different layer of the physical server. The hardware layer, Virtual machine monitor layer, operating system layer and application layer are monitored by the corresponding predictor of that layer. The predicator of each layer collects the information and sends it to the health indicator modules which intern forward the information to migration controller for further action.

VI.MIGRATION CONTROL TECHNIQUES

The migration control technique focus on reducing the migration time and downtime during the migration process. The migration time is between the start and finish of the migration process and the downtime could define as the time for which the execution of virtual machine is stopped. The Virtual machine Migration can be performed by means of two techniques

- Pre-copy Migration Technique
- Post-Copy Migration Technique

In Pre-Copy migration technique, bulks of memory pages are copied from source to destination while the process is in running state in the source machine. The process in the source machine may require some of the pages that are already transferred to the destination machine. So it tries to alter some of the required pages that generate a page fault. Such altered pages are called dirtied pages. These dirtied pages are transferred on iterative basis from source to destination machine. This copying continues until either a small number of memory pages or fixed rounds of copying is reached. The virtual machine is then suspended in the source machine and their processor state and the remaining memory pages are copied to the destination machine. Later the suspended process resumes in the virtual machine of the destination machine.

In Post-copy migration technique, initially the processor state and minimal memory pages that are required to operate the virtual machine at the destination server are copied. Concurrently the pages required for the operation of the destination virtual machine are demanded from the source virtual machine. There are some shortcomings of both the techniques. The migration time is very high in terms of pre-copy migration technique and the down time is high in case of post-copy migration technique.

Various migration control techniques that enhance the migration time and down time have been proposed. The Pre-copy Migration technique, consumes more bandwidth as it iteratively transfers the memory pages from source to destination. Since the Pre-Copy technique consumes more bandwidth Jin and Deng [25] proposed a technique to reduce bandwidth consumption by identifying the characteristics of pages as zero bytes, strong regularity and weak regularity. Based upon the characteristics the pages are compressed using the appropriate compression algorithm. Therefore this technique reduces the migration time of the migration process.

Liu and Jin [26] proposed a technique which comprises of three phases: Pre-Processing phase, Push phase and stop and copy phase. The Pre-Processing phase transfers the last recently used pages in the working set list. The push phase transfers the memory pages that are not in the working set list from source virtual machine to destination virtual machine. The stop and copy phase migrates the processor state and working set list to the

destination virtual machine. In this technique effectively reduce the number of iteration by retaining the required memory pages of the source machine till the last step of migration

In check point/Replay technique proposed by Liu and Liou [27] maintains the logs that contain the activities of the source virtual machine. These logs of the source virtual machine are migrated to destination virtual machine instead of memory pages thereby reducing the bandwidth consumption and enhance the migration time of the process. The optimizing technique proposed by Jin and Gao [28] states that the speed of the processor can be reduced if the dirtying rate is higher.

VII.SECURITY CONCERN IN MIGRATION

Security is an important concern when virtual machines are migrated from source machine to destination machine. Some threats that involves during migration of virtual machine from source to destination server are as follows

- Attacker takes control of source virtual machine and migrate its virtual machine to destination stealing its bandwidth.
- Attackers may attract more virtual machine towards itself by advertising false resource availability
- Passive snooping.
- Active manipulation.

Cryptographic algorithms and authentication keys avoid attacks during the migration process. When Migration is initiated, the initiator of migration and the destination machine strictly enforce the following

- Authenticity of migration initiator.
- Preservation of trust chain among entities during migration.
- Confidentiality of Migration process.

The security of the migration process is effectively enforced by authentication, privacy and confidentiality of source and dectination

VIII.CONCLUSION

This article presents an extensive survey on virtual machine migration techniques. The migration techniques are categorized into energy efficiency, load balancing and fault tolerant and migration control techniques. A comparative study was made between energy efficient migration techniques and it is found that energy efficient migration technique consumes less energy compared to other techniques. A comparative study has been made on different parameters of load balancing migration techniques and each method follows a different strategy to balance the load effectively among the physical servers of the cloud Data Center. Many fault tolerant migration techniques have also analyzed to prevent failure and achieve high availability of physical servers .In order to reduce the migration and down time various migration control technique have been analyzed to improve the overall performance of the Cloud Data center. The security is also a major concern during the migration process. Some of the threats have also been stated to enhance the security of the Cloud Data center.

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