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Algorithmic Standards and Execution Characteristics of Live VM Migration

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Abstract: ***The extent, to which technology has grown has given rise to many ways of getting connected to the internet and has also lead to the use cloud computing to access services or data remotely. Cloud computing is taking over the industry rapidly and will only grow in days to come. Companies are adapting to this technology in order to make use of it in the best way possible. NIST defines cloud computing as a model for on-demand services to a shared pool of configurable computing resources. This has helped companies move from the traditional ways of storing data or providing services, to an easier way for the customers to access their applications.***

VMs can manage accessibility requirements significantly more smoothly than their physical reciprocals. While physical hosts must be shut down for support, the VMs that they serve can relocate to execute on other physical nodes. It is additionally regular to move VMs when load balancing is required in the physical plane. The purpose of this work is to simulate cloud migration based on a bio-inspired algorithm through the CloudSim tool.

Index Terms: Live migration, PSO, virtual machine, virtualization, pre-copy, post-copy.

I. INTRODUCTION

Cloud computing is a hardware and software that is available to the user via the Internet (or LAN) as a service, allowing the user to make use of it through a web-based interface for remote access to the allocation of resources.

Several parameters are taken into consideration when an organization wants to move their resources or services to the cloud. A major reason why many organizations are choosing cloud over the age old method of processing data is also because of the fact that cloud provides a “pay-as-you-go” service model. With framework being kept up at various excess destinations, it gives more certainty to business associations concerning business continuity and disaster management. The goal of the concept of cloud computing is to provide end users with remote dynamic access to services, computing resources and applications over the Internet.

Virtualization is an approach to pooling virtual resources and sharing them to simplify management. This increases asset use so that IT resources can more easily meet business demand. With servers or networks, virtualization is used to take a single physical asset and make it work as if it were multiple assets.

A virtual machine (VM) is a software program that runs on a machine such that the computer is capable of performing various tasks. These can run applications and programs like a separate compute. A virtual machine, generally known as a guest is made inside another processing condition alluded to as a "host".

Multiple virtual machines can exist inside a solitary host at once.

Migration of a VM is always dependent on the state in which it is transferred, from one source to another. Whenever a VM is being migrated, be it hot or cold migration, a few characteristics or standards must be considered in order to finish the process of migration successfully, with less downtime and a good balance of the load.

Some of these standards have been assessed in the process of cold migration as a part of this project. Though the project speaks of live migration, the standards taken into consideration are apt for both hot and cold migration of virtual machines from one host to another. The characteristics are low resource usage, robustness, predictability, transparency and continuous service. These play a major role for an organization when it comes to deciding whether to go ahead with hot or cold migration and also, if the necessary resources are available for the migration process.

Bio-inspired computing is a research methodology that aims at solving problems using computer models based on the principles and mechanisms of biology and the natural world.

This can also be compared to bio-mimicking. Bio-inspired computing often takes a small foundation of set rules and builds upon them by ways of unsupervised deep learning in training. This approach of solving issues related to computing resources is used to develop new and robust computing techniques.

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II. BACKGROUND

VMs are programmed to run almost always, with a good reduce in the down time, proper load balancing and the process of migrating VMs without any perceptible downtime is known as Live Virtual Machine Migration.
Live migration can be performed using three different approaches namely pre-copy, post-copy and hybrid.

A. Pre-copy

Pre-copy iteratively moves virtual machines from the source to the target host. It follows three major phases. First phase being first iteration in which it completes the transfer of the image of the VM. In the second phase, the 2 to n-1 iterations take place and all updated or dirty pages are transferred. The last and third phase include includes stop and copy in which all remaining pages are transferred. This approach can recover the VM if there are any failures at the destination host.

B. Post-copy

Here, the migration is initiated by suspending the VM at the source. With the VM suspended, a small subset of the execution state of the VM is transferred to the destination. The VM is then resumed at the destination. Concurrently, the source actively pushes the remaining memory pages of the VM to the destination and this action is called pre-paging. At the destination, if the VM tries to access a page that has not yet been transferred, it generates a page-fault. This approach cannot recover the VM if there are any failures at the destination host.

C. Hybrid

This is a combination of both the pre-copy and post-copy approach. The first step is to get the result of pre and post copy. These are analyzed and then VM chooses which mechanism is followed. If the result produced by the pre copy approach is effective then it is used for the transfer otherwise the post copy approach is followed. After this the checkpoint mechanism is applied for recovery.

III. CHARACTERISTICS OF LIVE MIGRATION

Live migration has majorly replaced the traditional ways of migrating VMs from one host to another, irrespective of whether it is located in the same datacenter or a different one.

A. Continuous Service

Services provided to the customers using the hosted VMs and the applications running on them are given continuously despite migration downtime On account of interactive services, this implies the live migration procedure ought to not make clients be detached or experience performance degradation to such an extent, that it influences the typical execution of applications running on the VM. This means that the interruption in service must be short enough to not be perceivable by the users of services hosted in the migrating VM.

B. Low Resource Usage

The live migration process consumes resources on both the source and destination machines and this resource usage, sometimes referred to as migration noise, should be kept to a minimum. In the event that an over the top measure of assets is expended, execution and activity of applications in the VM just as any co-facilitated VMs may be influenced, in this manner forcing execution penalties for the VM or any arranged VMs.

C. Robustness

The hypervisor, the VM or any hosted applications should not risk crashing or freezing due to the migration process.

D. Predictability

It should be possible to predict the duration of the migration process and how much resources it will consume. This includes predicting the total migration time and the migration downtime as well as the amount of network and CPU resources required by the migration process on both the source and destination hosts. Post-copy migration is predictable in the sense that as the witch of execution always happens at the start of migration and the amount of transferred data is known.

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E. Transparency

The VM's operating system and its hosted applications should not need to be migration aware. The migration process should be transparent to both the VM and any connected users and the performance of any hosted applications should not be affected.

Though all the above characteristics can practically not be met, any migration process that considers these principles or characteristics can be termed as live migration. The hybrid approach to live migration reduces downtime to a larger extent as it combines the features of both post-copy and pre-copy approaches.

IV. vMOTION AND LIVE MIGRATION

VM migration on vMotion is as easy as 4 clicks on the mouse but the process that goes on in the background is the same as discussed in this dissertation that is related to the normal migration process. Applications like vMotion make it easier for the user to decide on what parameters to consider while migrating a VM from one host to another.

Live migration or hot migration as its also called, is performed on vMotion only if all the virtual resources are placed in a shared storage. if the resources to be migrated are stored on the local machine, vSphere would block vMotion from using the resources to migrate.

The entire project is based out of the migration process shown on cloudsim, as the toolkit doesn't support the live migration process, the procedure has been explained using cold migration. But tools like the vMotion, consider larger bandwidth based on the resource being migrated over the virtual environment network.

The process of migration described through this project is dependent on the 5 major characteristics described in this chapter. Once these characteristics are met, the migration can be termed to be live migration.

V. EXPERIMENTAL EVALUATION

The amount of importance given to virtualized environments in an organization has increased greatly in the past few years and the major reason being that a virtualized environment has proved to reduce the cost on physical resources for any organization. When an organization uses virtualized resources, it surely doesn't need a lot of people who are technically sound but will need to look into the systems on a regular basis.

In case of any issues with the physical resources, they must be stopped and the virtual machines should be moved to another host. In order to manage and maintain the services that the organization is providing the customer, the virtual resources must be moved and maintained efficiently and effectively.

Many solutions have been given for issues related to the movement or migration of these virtual resources. One such solution or approach is by using a bio inspired algorithm called the Particle Swarm Optimization.

We humans have always mimicked the nature to live our lives. This has also been used in the field of computing. So this project will show how a bio inspired algorithm is used to migrate virtual machines, keeping in mind the essential standards and principles. Though the experimental setup is for cold migration, the entire process is holistically applicable for hot migration (live migration) as well.

The main criteria here is to provide a bio-inspired algorithm as an approach to live migrate the VMs and that this algorithm must be leveled with all the necessary characteristics that can make it easier to evaluate the process of the transfer.

VI. ALGORITHM USED

Particle swarm optimization or also known as PSO, is a computational intelligence oriented, stochastic, population-based global optimization algorithm that was proposed by Kennedy and Eberhart in the year 1995 [1]. It is inspired by the social behavior of bird flocking searching for food or even a school of fish. PSO has been holistically applied to many optimization areas due to its unique searching mechanism.

The algorithm proves to be a simple concept, having computational efficiency and also easy implementation.

In PSO, the term ―particles refers to population members which are of lesser volume and are subject to velocities and accelerations towards a better mode of behavior.

Each particle in the swarm represents a solution in a high-dimensional space with four vectors, which is its current position, best position, the best position found by its neighborhood so far and its velocity and adjusts its position in the search space based on the best position reached by itself (pbest or personal best) and on the best position reached by its neighborhood (gbest or global best) during the search process.

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The algorithm for the process can be stated in the following manner:

1) *Step 1:* Initialization for each particle
2) *Step 2:* Do the below until maximum criteria or minimum error criteria is reached For each particle calculate data fitness value, if fitness value is beter than pBest then set pBest to current fitness value and if pBest is better that gBest then set gBest to current pBest.
3) *Step 3:* Calculate the particle velocity, for each particle,

Then use the gBest and particle velocity to update particle data.

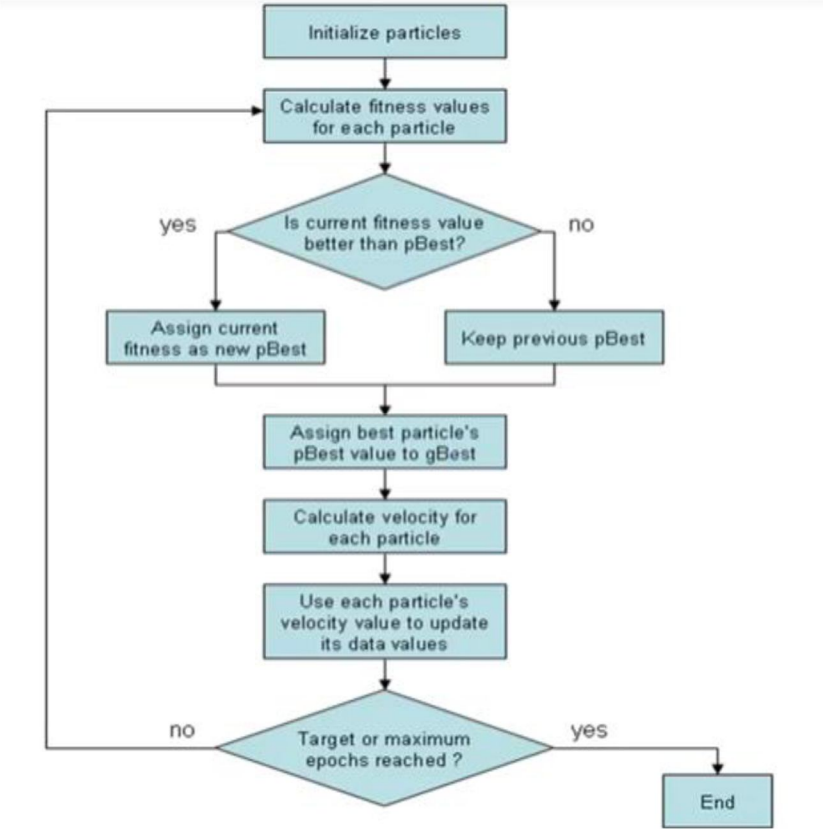


Figure 6.1: The general flow diagram for PSO [2]

The process of resource scheduling in a cloud computing environment is effectively performed by proposing a layered architecture integrated with particle swarm to improve the performance. It uses the global agent, local agent and monitoring layer to handle the resource requests and resources are distributed dynamically using the local agents to the cloud consumer and then the loads are balanced by the global agents [1].

VII. FUTURE ENHANCEMENTS

Future enhancements can be considered with respect to the security of the data being migrated. Depending on the resource being migrated (i.e. storage or OS), security measures can be enhanced including the security of the network being used to transfer the resources over the network. The project is partially based on the pre-copy approach for migration of the VMs and can be further considered for implementations using the post-copy or hybrid approach for the migration process.

VIII. CONCLUSION

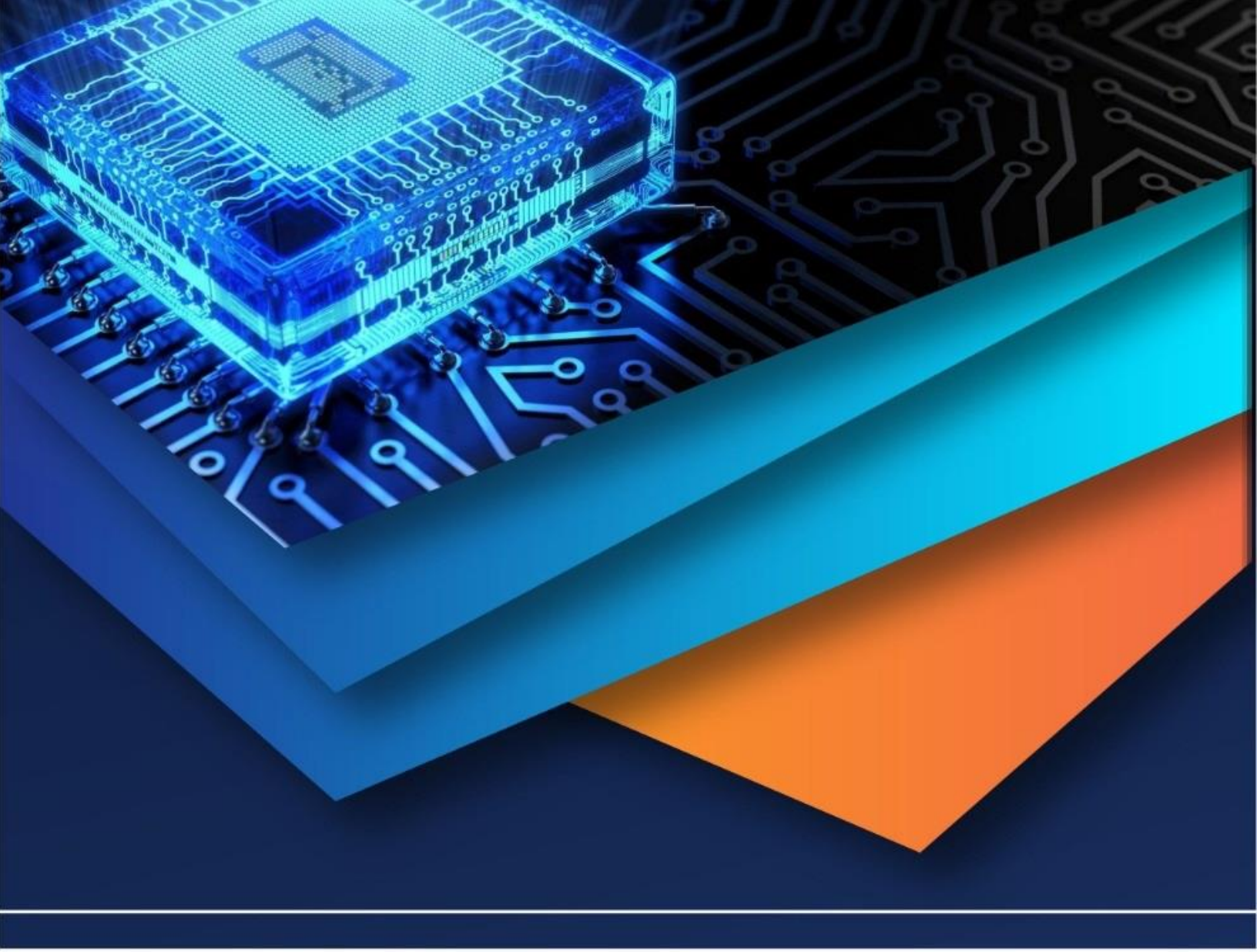
The project discussed in this dissertation was based on the characteristics of virtual machine migration and the particle swarm optimization algorithm. The simulation of the cloud environment was implemented in the CloudSim toolkit. This toolkit offers resources for executing the project to show the migration process as is seen in the real world datacenters. Though the toolkit doesn't support the live migration process, the simulation offers an overview of the actual process. The output of the project focuses on downtime reduction of a VM migration.

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