Virtual Machine Migration and Placement Schemes-limitations and challenges

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Abstract— Cloud-Computing refers to the technology that provides different services as per demand via different web-based tools. Cloud computing can be thought of as a pool of resources that delivers software, data, storage, servers, computing resources etc as a service. Virtualization is a technology that acts as a ground for cloud-computing. Virtualization is a technique that enables the division of devices or resources such as servers, operating devices, memory into multiple instances and each one behaves as a whole single machine independent of each other (called virtual machine). Virtualization creates these virtual versions of devices and resources with the help of a middleware. The machine on which a middleware runs one or more virtual machines (VM) is called the Host Machine. In the life cycle of a virtual machine there may exist a necessity to transfer a virtual machine from one host machine to another host machine due to different reasons like fault tolerance, load balancing, energy management, system-maintenance etc. and this is called virtual machine migration. The two main techniques of migrating a VM between different hosts are pre-copy and post copy. In virtual machine migration, the placement of virtual machine between hosts play a critical role as it puts a straight effect on the performance, power consumption and application of resources of the physical machine on which VM is placed. This research paper provides the survey and analyses of existing techniques of virtual machine migration and also throws some light on virtual machine placement schemes. Different virtual machine migration techniques are also compared in the paper. Finally, the proposed work and conclusion are highlighted.

Keywords— Cloud-Computing, virtualization, virtual machine migration, machine migration techniques, virtual machine placement schemes.

I. INTRODUCTION

Cloud-computing represents a technology that provides different services as per demand via different web based tools and applications [10]. Cloud computing means accessing and storing the data, programs, devices over the Internet instead locally on your computer's hard drive. Cloud computing is computing technology in which number of remotely distributed servers are networked together to enable the centralized storage of data and access to large number of services online. Thus, cloud computing is a pool of resources that we can use as per our need and pay as per our utilization. The term —cloud‖ in cloud computing is based on two important concepts:

- *Abstraction:* Cloud computing hides the specifics of system operation from its consumers as well as designers. Applications run on machines that aren't listed, information is stored in places that are not known, management of systems is contract out to others.
- *Virtualization*: Virtualization enables creation of more than one virtual machines on a single machine

which forms the basis for providing the access to the large number of resources. The resources are used on basis of meter system.[16]

Cloud computing is separated into two different sets of models. Figure 1 below gives the NIST model given by U.S National Institute of Standards and Technology.

Thus, cloud computing is a delivery of different software, data, computing resources etc as a service. *Software as Service (SaaS)* is a delivery of services through web browser. *Platform as a Service (PaaS)* delivers computing platform like servers, Operating system, programming language environment etc. *Infrastructure as a Service (IaaS)* provides hardware, servers, storage etc over internet.[1]

Virtualization forms the basis of cloud computing. Virtualization is a technique that enables creation of virtual rather than actual versions of any resource.[2] It provides means to use the resources by combining a number of VMs to run on the same host machine independent of each other. With the help of cloud, users can start their Virtual machines at any time and can use pay-as-you-go service as

per their need. So we can say that cloud is always in state in which multiple resources oscillate among different users. *Virtual Machine Migration* (VMM) serves as a ground that keeps the Cloud usable for both cloud service consumer and provider. Virtual Machine Migration is the migration of virtual machines from one physical machine to other without the interruption of current work.It is classified as: *Offline VM Migration*: In offline Virtual machine migration(VMM), virtual machine at one physical machine is stopped then the memory and network state is moved from source machine to the target or destination machine. After the transfer, the working is resumed at the destination VM. The major drawback here is the downtime is increased and therefore total migration time is also increased [13]. *Live VM Migration*: In Live machine migration, the Virtual machine is migrated to the target physical machine from the source physical or host machine with minimal interruption of services[3][11][12].

The Research study is divided into six sections. In this study section II presents the review details of techniques of virtual machine migration and the limitations of post copy migration approach. The comparison of different virtual migration techniques on the basis of certain parameters are discussed in section III. Section IV presents various virtual machine placement schemes. Some of the important terms used in the paper have been defined in Section V. Furthermore, the conclusion and future work are highlighted in the last section.

Figure 1: NIST definition of cloud computing

II. LIVE VIRTUAL MACHINE MIGRATION TECHNIQUES

There are two main virtual migration techniques that are used to shift the virtual machine from one physical node to other as shown in figure 2:
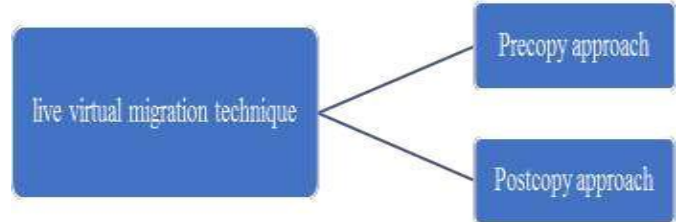

Figure 2: Virtual Machine Migration Techniques

A. Pre-Copy Machine Migration

In this approach, VM's memory state is shifted to the target machine first while VM remains active at the source VM. If the sent page is dirtied, it is resent to the destination in the next round. After the memory transfer VM is stopped for a while and its processor state along with the pages that are left behind are transferred to destination machine. Finally, VM is started again and the copy at the source is annihilated. It takes place in two phases:

i)   *Warm-up phase: Pre*-copy technique starts with the warm-up phase where the hypervisor creates the copies of the memory pages and sends them to the destination node. During this process the virtual machine continues to work at the source machine. If there occur some variations in the pages at source machine, then the pages are duplicated again and again until all the pages are copied properly.

ii)   *Stop and copy phase:* The Warm-up phase is followed by the stop and copy phase. The virtual machine is halted at the source machine and the changed pages that are left will be sent to the destination machine. Finally, VM is started at destination node. [3][8]
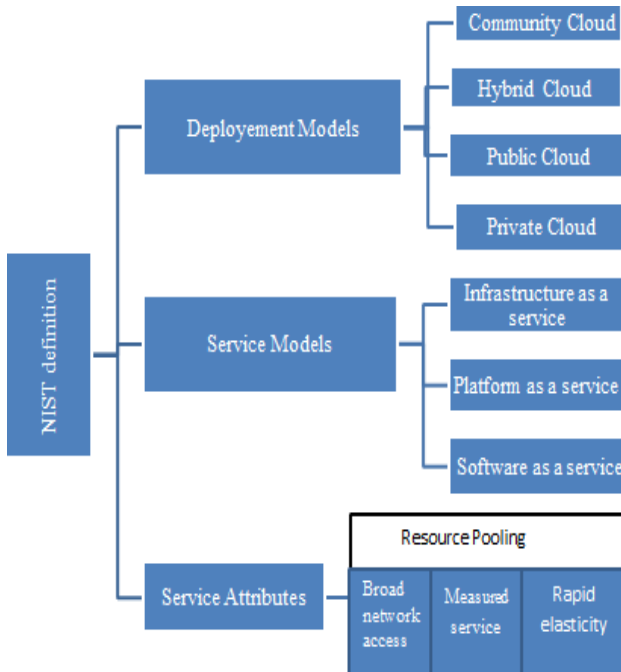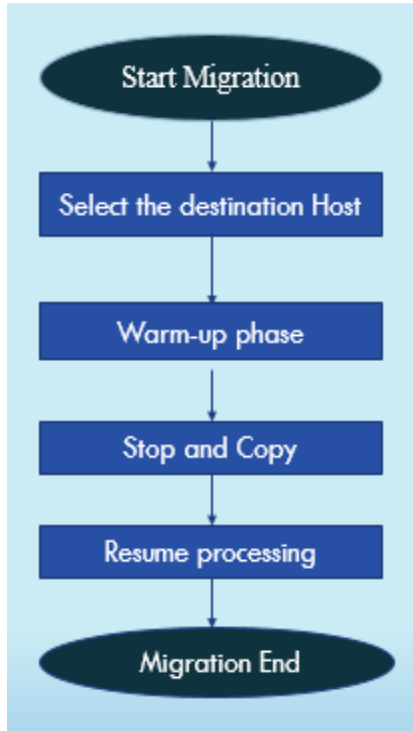
Figure 3: Pre Copy Migration Technique

B. Post-Copy Machine Migration

Post copy migration first transfers the execution state to the target host, starts the execution at target host then pushes the memory pages that are dirtied from source machine to target machine. When the VM at the target host tries to fetch the page that is not present at destination node It creates page faults. These page faults, also known as network faults are catched at destination host node and reoriented to the source node which acts to these page faults and sends back the faulty pages to the destination machine. It makes sure to transfer each page at maximum once hence avoiding the overhead of transmitting the pages more than once happens in pre-copy migration approach. Occurrence of too many page faults deteriorates the performance of the virtual machine and in turn the application that is running on it [15].
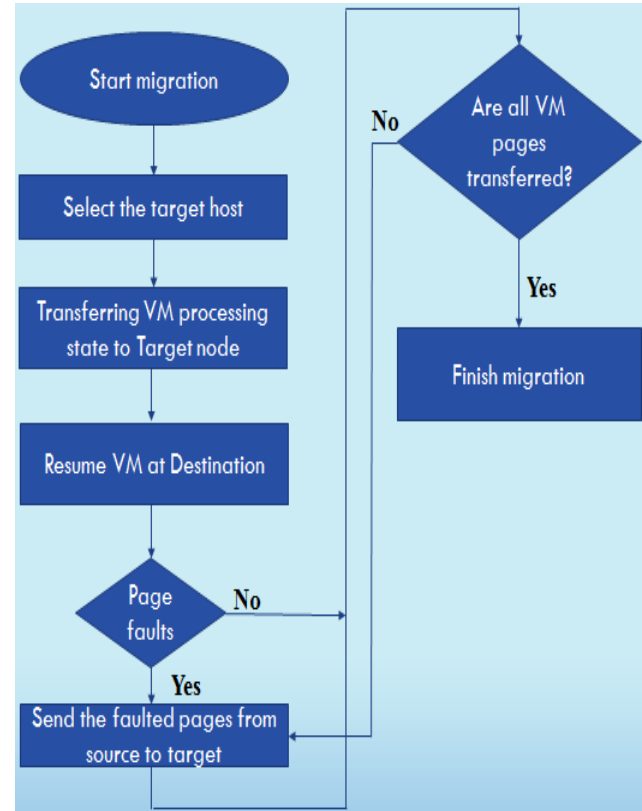

Figure 4: Flowchart of Post copy approach

Limitations and challenges of migration techniques:

- In Precopy approach , the pages are sent again and again when changes occur as the execution continues at source node while the memory is already transferred to the destination host.

- In post copy migration technique when a VM at destination host attempts to access the pages that are absent at destination host, it results in the creation of page faults that degrades the performance of the application that is running on a target host. [3]

- During the post copy migration technique, the VM runs on target host and hence VM applications with incoming migration traffic at target physical host rises up the overall migration time that deteriorates the performance of Virtual Machine.[4]

III. COMPARISON OF MIGRATION TECHNIQUES: PRE-COPY AND POST COPY

Table 1: Comparison of migration approaches on the basis of certain parameters

Migration Technique	Method	Down Time	Memory transferred	Total migration Time	
Pre -Copy	In this method the memory state is directed from source to destination host prior to the execution state.	Long	Before the execution state.	Shorter	
Post -Copy	Here, execution state is relocated first to the destination host followed by the memory sate.	Short	After the execution state on creation of page faults.	Longer due to network contention .	

IV. VIRTUAL MIGRATION PLACEMENT

Virtual machine placement holds an important place in virtual machine migration to keep up the promised agreement with the cloud consumers up to the mark [9]. When a Virtual machine requests certain resources that a present physical machine cannot supply then the VM is transferred to other host node to fulfil the resource requirements of a VM. The physical machine is selected such that it best suits the requirements of a VM and improves the working of the application that is executing on the virtual machine[5]. There exist various virtual migration placement schemes and these placement schemes use certain placement algorithms to satisfy some objectives like proper resource utilization, reduce traffic, increase performance etc. The virtual placement schemes face different challenges like keeping up the services and meeting the SLA, proper usage of servers, reducing over and underutilization etc. It is very important to choose a appropriate machine to host a virtual machine so that suitable performance is attained. There are different schemes through which we can place the VM to different hosts, Some virtual machine placement schemes are:

i) *Constraint Programming-based Placement Scheme* : This is the placement scheme in cloud computing which is best suited for combinatorial search problems. Constraint based programing is used in a variety of domains like scheduling, Timetabling, resource allocation, Production planning etc. The main idea of constraint -based programming is that a real-world problem is formulated as a Constraint Satisfaction problem(CSP) and solution is calculated by constraint solver. CSP are mathematical problem which are defined as a set of objects that must satisfy a set of constraints. The definition of placement of virtual machines and the idea of CSP are combined to solve the virtual placement problems.[6]

ii) *Bin packing based VM placement:* Several virtual machine placement problems can be considered as a bin packing problem where the host machines are the bins and different VMs that are to be placed to host machines are objects. Bin packing problem is a NP hard problem in which a set of objects are packed in number of finite bins such that minimum number of bins are used. In **Xiaoli** and **Xhanghui (2012)**, the authors enhanced the bin packing algorithm and presented a different resource allocation and energy-aware approach in cloud data center. Another approach of bin packing based VM placement concentrates on resource utilization. The bin packing method tries to curtail the requirement of number of servers to fulfil the requests of VM user and hence minimizes the job completion time. [7]

iii) *Banker-algorithm based VM placement:* This algorithm concentrates on deadlock prevention and checks whether the system is in safe state while the allocation of VM. There are number of algorithms that are based on bankers algorithm and concentrate on number of objectives like minimization of energy consumption and to fulfil the SLA.

iv) *Graph theory based VM placement* : The Graph theory based VM considers the security of virtual machines. The infected virtual machine can infect other VMs, host machine, hypervisor also that are present in its vicinity. The authors **Abazari** and **Analoui** presented a placement scheme that is based on Agent based model and graph theory for studying the Epidemics in cloud and to regulate the infectious spread. The concept of *Epidemic theory* is used in VM placement to guesstimate the number of infected machines based on collaboration graphs [14].

V. PROPOSED WORK

The migration of virtual machine between hosts faces a lot of challenges like the existence of page faults in postcopy that surges the downtime of the machine. In proposed research work the concept of ballooning and pre -paging is applied on the hybrid approach that is the amalgam of both precopy and post copy. *Ballooning* is a technique of memory management. In this technique when the VM is short on memory, the balloon driver exaggeratedly causes the pressure on memory and causes OS to reflect that there is even a smaller amount memory left that results in switching of pages that are not very important and hence freeing the memory. This cuts the down time by eradicating the need of transmitting the free memory pages that in turn reduces the total migration time. *Prepaging* deal with the page faults by sending the pages ahead in time before they are fetched by target host, hence refining the performance of the VM by shrinking the over -all migration time. Earlier the concept of ballooning and prepaging was applied on the post copy approach of machine migration [12]. The proposed research would apply the concept of ballooning and prepaging on hybrid approach that uses Markov model for the prognosis of how the memory is accessed, it has also used a factor called Switched decision factor (SDF) in order to reckon the time at which Precopy would stop and post copy would be kicked to make the migration process better.[17]

VI. CONCLUSION

In this paper, different virtual migration techniques have been discussed. Further these virtual migration techniques are compared in terms of different parameters like down time, total migration time, memory transfer. The research paper also provides the desc ription about virtual machine placement schemes. The challenges and the limitations of migrating the VM through the existing techniques are also discussed in the paper. This research paper also proposes a new hybrid model which includes the concept of ballooning and pre paging on hybrid pre copy and post copy to elevate the performance of migration process.

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