A Comprehensive Survey on Virtual Migration Techniques in Cloud Computing

Raju C, Krishnamoorthi M

Abstract-In recent growth of business challenges the landscape of the cloud computing under major change. Especially the management of datacenter is challenging task because of its increase in capital and operational expenses due to the spending on its workforce. The paramount importance of any data center is to reduce energy cost and computation cost by effectively utilizing the available physical machines. Virtualization is a key technology in datacenter to provide demand specific virtual resources as per application requirement. Migration helps in avoiding under utilization of resources also in overloaded conditions from the flood of requests coming in these days. The trend in choosing the right migration techniques in cloud data center depends on the nature of the deadline it follows from the utilization of the resources. The goals in virtual migration are the effective management in load balancing of servers, reduced power consolidation of server by right model, faster recognition to the server failure and minimizing the overall system maintenance. In this paper, we discuss some of the latest techniques used in the virtual migration based on their key performance metric like total transfer data, migration time and total down time.

Keywords: Cloud Computing, Migration, Pre-Copy, Post-Copy and Hybrid Copy.

I. INTRODUCTION

The fast changing nature of physical layer requirements such as total processing power, storage, memory and network connectivity needs additional cost to the enterprise owners [1]. Thus brings up clients requesting on-demand resource provisioning from the cloud service providers. This can be immediately processed to support their dynamic varying workload nature of their applications [2]. Also when a large enterprise, look for enhancing the productivity by reducing the mundane tasks of allocating resources on need basis, the concept of server virtualization came into existence [3]. The optimal use of their administrative man power and capital is fully benefited from virtual machine technique. The scenarios when the advents of internet of things, automotive advancements in vehicular communication share the virtual machine resources from the dynamic infrastructure networks available on roads [4]. Virtual use of resources are transferred from the physical systems available, actually used as individual systems with the on-demand resource requirements [5]. In earlier stages the limited capacity of backhaul hinders the utilization of virtualization technology across servers and clients. But now increased use of fiber optic transmission allows easier adaptation of virtual machine schemes transforms limited capacity servers to highly scalable resource rich servers in all storage, memory and computational aspects [6]. Nowadays most of the users choose cloud based infrastructures to avoid their total spending on buying their own hardware and labor cost of maintaining those on varying network loads for their current scenario [7]. Since different sectors from scientific background, business enterprises and educational institutions deploy their applications in cloud based services, it utilizes software or hardware or data on cloud. Nature of workloads and utilization of resources may be different for applications hence migration schemes for one service may not be beneficial to other, because of the heterogeneity nature of the allocated resources. This resource management directly affects the efficient deployment of cloud services [8]. Challenges in resource management are 1) overloaded servers need sharing their workload on different server, 2) Some servers may under-utilized and idle, this must be well aware by the system administrator. 3) The disaster of one server may worsen the situation of currently running applications, Hence highly reliable system with data de-duplication is necessary [9].The remaining paper is organized as follows. Section 2 discusses relevant knowledge about VM migration process involved. The existing works on live migration are described in Section 3. The techniques used for optimization of VM migration processes are analyzed in Sections 4. The open research trends on live VM migration are given in Section 5. At last we summarizes our research findings in Section 6.

II. VIRTUALIZATION AND VIRTUAL MACHINE MIGRATION TECHNIQUES

Virtualizing the available resources of physical systems using modern hypervisor or virtual machine monitor enables the best management of datacenter resources. Hypervisor fulfils the request of on-demand resources as per the current workload from directly on the hardware and also emulating from the operating system. This benefits the above mentioned problem of overloaded jobs assigned to other newly configured VM and makes load balance across the server. Hypervisors namely Xen, KVM, VMWare and Microsoft Hyper – V supports live migrations [2], [10], [11]. The Virtualization concept is depicted in the figure 2.1, where oracle illustrated the virtualization for the dynamic provision of available resources. Virtual machine monitor helps in analyzing the utilization of the resources also support in making decisions on increasing the availability of resources as required.

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Raju C, Department of Electronics & Communication Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India

Krishnamoorthi M, Department of Computer Science & Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India

Type 1 Hypervisors runs on the hardware above on top of it we can run OS and applications.

Conversely in Type 2 Hypervisors, Hypervisor runs along with the one of the application in OS. On top of the application we can emulate virtual physical machine as per available capacity [11].

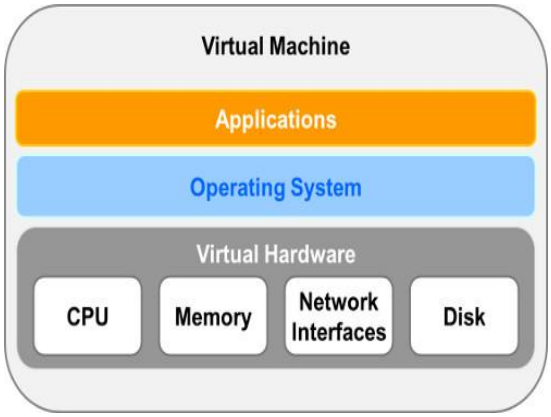

Figure. 2.1 Virtualization

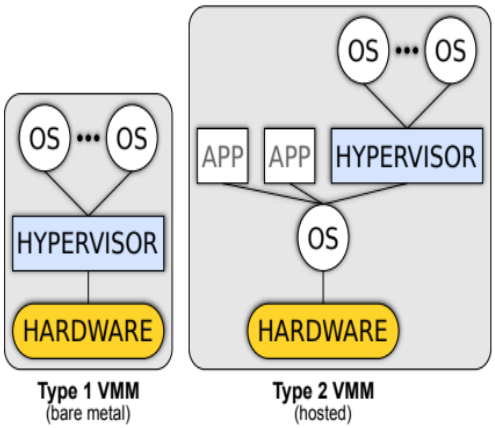

Figure 2.2 Type 1 & Type 2 Hypervisor

A. Migration

Migration is the process of the changing one service point to another service point, means shutting down one VM and restarting another with no waiting time usually in milliseconds. At this time user application cannot be stopped from running, In this way there are two different VM migration approaches normally used namely hard migration and soft migration. However, soft migration approaches valid only where systems runs delay tolerant applications [12]. Here delay interruption caused due to migration may not bring performance issues. But when the application includes heavy critical workloads lags from degradation of service. In this case the system is not delay tolerable in nature, their comes the need for faithful uptime of the new VM. In the process of making new place for demanded resources for existing workload will be maintained in the same IP [12], [13]. In figure 2.3 the migration of VM between intranet systems is shown where non-interruption of service is expected [14].

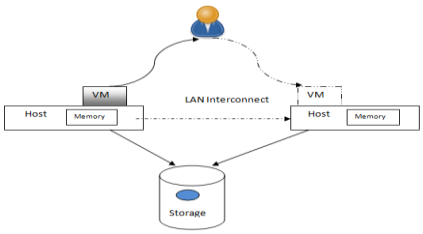

Figure 2.3 LAN Migration Scheme

In figure. 2.4 Non – Live Migration scheme is illustrated where the VM in the source is suspended for a while then the copy process of memory pages are started, once the copying process over then destination server VM activated and come alive.

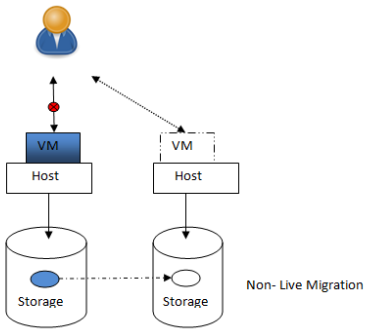

Figure 2.5. Non- Live Migration scheme

In figure 2.6 the present migration policies are reviewed thoroughly. This diagram shows techniques available live migration possibilities for both LAN networks and WAN networks. From the review we understood the memory migration is possible in WAN with available network connectivity but storage transfer we run out of capacity for live virtual migration. So while deciding solution for live migration, it is mandatory to follow more than one policies for better uptime in migration services [12].

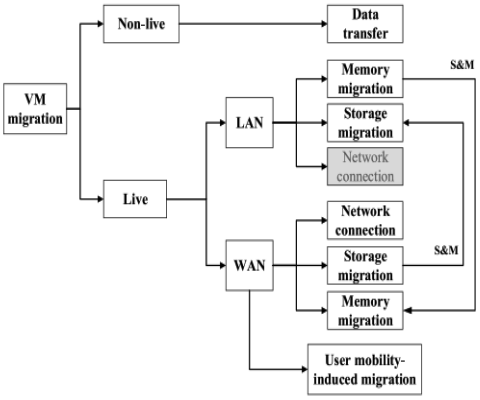

Figure 2.6 VM Migration review

Live migration or also called hot migration must provide the user seamless connectivity to the application it serves,

so that shared computing and shared resources can be accessed using intra LAN or supposedly in WAN systems where usually the migration schemes need more attention.

Since the far away nature of heterogeneous distributed systems we come across different challenges in the migration process such as online maintenance, power management and fault tolerance. The limitations in distance allow only memory migration in LAN and additionally storage in WAN network. Hence we need enhancement techniques in memory VM migration systems because storage migrations are fully take care of the data centers. The problem in memory migration is the applications modify the memory pages more frequently than the storage systems [15].

III. LIVE MIGRATION

Use of optimization methods for VM Migration for improving key metrics like total data transfer, suspended time and up-time is considered for objective functions for arriving to best technique[15]. Three methods mostly considered for migration as follows pre-copy, post-copy and hybrid approach. The requirements for optimization is vary with the type of host and destination systems like within the same rack using ToR switches or between data center core network [16].

A. Pre-Copy Approach

The steps in executing the process are collecting the states of the storage, memory and virtual device states. For non live migration first suspend the system to migration, later destination resumes the workload in the new location, here user notices the interruption during the migration process [16]. The live migration challenges in pre-copy approaches are listed

1) Continuous update of memory states in each iteration till it reaches the limit of memory pages threshold or iteration preset number
2) After reaching the above point the VM suspended for some time then the migration occurs for remaining pages, CPU and registers.
3) Finally VM fully restored at the destination host.
4) Source copy is removed
5) Pre-copy technique focuses on the downtime minimization while migration takes place

Also the bandwidth consumed in the process and total time elapsed for duplicated pages are key performance metrics. The advantage of using pre-copy migration techniques, at any cost source keep state information which is useful in data recovery if host crashes.

B. Post-Copy

The shortcomings of the pre-copy approach of VM migration is made better with the post-copy technique. This method focuses on decreasing the total downtime that is caused in transit of dirty memory pages from source network system to destination network system [16]. Here the first step involves transporting the VM state to destination, then at the host the fault page request is initiated to correctly maintain consistent data between migrations. In this way the duplication is avoided like in the pre-copy method. This technique can be the best method when the application as a whole used for write intensive application. But the disadvantage is the interruption caused by migration will be high, if host sends many page faults in the entire process. Mostly system failure in the host degrades the application by losing original data, with available data in the source it cannot run like in pre-copy [17]. Therefore post-copy migration never be aborted in the middle hence it is less frequently used comparatively than pre-copy method as a standard for reliable migration

C. Hybrid approach

This hybrid approach significantly improves performance in the reduction application migration time and downtime.

This method transfer pages which is more frequently used and thereafter keeping the minimum VM state information of source to destination [18]. This approach brings best results in improving performance without any lower than post-copy method. Also the remaining pages transferred after resuming the system at host leads to poor consistency in the migration. The performance improvement by static check pointing hybrid method results in 10% increase in uptime with very less degradation.

IV. OPTIMIZATION TECHNIQUES

Migration does not simply provide an advantage but also overheads in the running VM in terms of CPU cycles, occupies extra space and consumption of bandwidth for some time. Hence there requires some optimization to improve the total transfer time and effective network utilization. Here we provide advantages and disadvantages of some of the optimization methods namely compression, de-duplication and check pointing.

A. Compression

This optimization significantly reduces total data transfer rate and thus reducing migration time by adding some regularities in source memory pages. The introduced source encoding techniques brings down the total data to minimum level thus reduced time in total migration.[14]. Besides this benefit provided by compression there also added CPU overhead and increased utilization of network bandwidth. Memory compression technique implemented for conditions where the similar pages exceed beyond certain limit, so that better compression ratio will be indentified [15]. The key performance metrics after optimization reduced to 27 % ,68.8% and 34.93% for downtime, total amount of transferred data, total time needed for migration respectively with a cost of 30% increase in extra CPU overhead [19].

B. De-duplication

The de-duplication method [20] uses XOR technique between similar pages, adds zero blocks for redundant data and therefore reduces total downtime. Here run length encoding algorithm is used for encoding the similar pages which bring performance benefits of 26 % in total downtime, 56 % in total data transfer time and 32% in migration time at the cost of 47.21 % in CPU overhead.

C. Check pointing

By introducing many check point options in the source end, the memory pages events recovered at the destination end using log information called trace and replay motion [14]. The main point is that host memory pages is recorded in event logs which further reused in the destination for data migration. This check pointing method[21] benefits by reducing 72 % in total downtime, 95 % in total data transfer time and 31% in migration time at the cost of merely 8.54 % in CPU overhead. Recycling is also one of the methods used, when migration initiated from destination to source, where the local disk of the source still has its previous states that information again used in reverse migration [19].

V. OPEN ISSUES AND CHALLENGES

We have presented many of the available virtual machine migration techniques. The key performance metric may vary

for different categories of the application and not limited to for downtime, total amount of transferred data, total time needed for migration. The cost value of migration may change for the different parameters other than those three mentioned parameters. Validation environment is still not specific in the calculation of real problem scenario, quality of performance and power requirement. Also security is another concern when moving virtual machine from source machine to destination.

VI. CONCLUSION

In this survey we analyzed some of the virtual migration techniques with key metrics to evaluate the performance in cloud data center while considering availability of resources and network connectivity. The existing techniques for both live and non-live migration are taken for the analysis and some best methods considered. In terms of the reliability and performance benefits of live migration schemes is superior for many real time application scenarios but still non-live migration techniques are also widely used to benefit the delay tolerable application environments. Still there is a need to compare many of the optimization techniques used for better decision on selection of virtual migration in future.

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