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A Theoretical Comparison of Different Live Virtual Machine Migration Techniques in Cloud Computing

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Abstract— Cloud computing is most fascinating technology which attract more attention of users by offering services over the internet. It is a practice to store, manage, and process data by using a network over the internet consisting of remote servers, rather than a private computer. Virtualization is the key technology behind the cloud computing for providing services in cloud surroundings. The process of live migration consists of transferring an active virtual machine across different bodily hosts. Different techniques are summarized in this paper which deals with the performance metrics like minimum total migration time, down time to reduce service degradation. The main objective of this paper to examine gaps associated with existing techniques based on live virtual machine migration.

Keywords— Cloud computing, Virtualization, Migration, Live migration, Pre-copy, Post-copy

INTRODUCTION

Cloud computing is a term mainly used for the delivery of hosted services over the net. It is a practice to store, manage, and process data by using a network over the internet consisting of remote servers, rather than a private pc. Cloud computing is a kind of computing system consisting of assortment and virtualized computers that are vital provision and conferred as mutually or more consolidate computing resources which supports a concession between service provider and customers called service-level agreements(SLA)[8].

Clouds are massive pool of simply useable and accessible virtualized resource (such as hardware, development platform and services). These resources can be changed back to their original state to regulate a changeable load for optimum resource utilization. As the needs of the customers or cloud consumers are changing vigorously, it is the duty of cloud service providers to handle and assign all the finite resources in time. These resources are exploited by a pay-per-use model that guarantees the custom-built service-level agreement. [1][8]

BACKGROUND

A. Virtualization

Virtualization is that part of cloud computing that permits the cloud computing paradigm, because it permits resources to on demand assigned to completely different applications and the resource sharing complexness should be hidden from cloud customers.[2][10] It provides support for the creation of customizable, isolated and secure atmosphere for the execution of applications. Virtualization offers chance to form scalable systems, which provide additional power at minimal price. Therefore, it is used extremely to offer elastically scalable environment on demand and also partition from the elementary physical machine is allowed by a request for a service made by the service users.[10]Virtualization has some major characteristics such as increased security, portability and managed execution which includes isolation, emulation, sharing and aggregation.

B. Virtual machine migration

Virtual machine Migration [18] plays a vital role for proper use of resources in cloud systems.[9][8]Migration of VM can be divided into two categories: a)non-live migration (Off-line) method : this method pause the VM and transfer all the states of VM to focus on host then finally resume the VM within the new host. The advantage is easy procedure and disadvantage is long downtime. b) Live Migration method: In this method, state of virtual machine is conveyed with minimum service disruption from one to another host. Main advantage of live VM migration is user-invisible downtime with quick network [17]

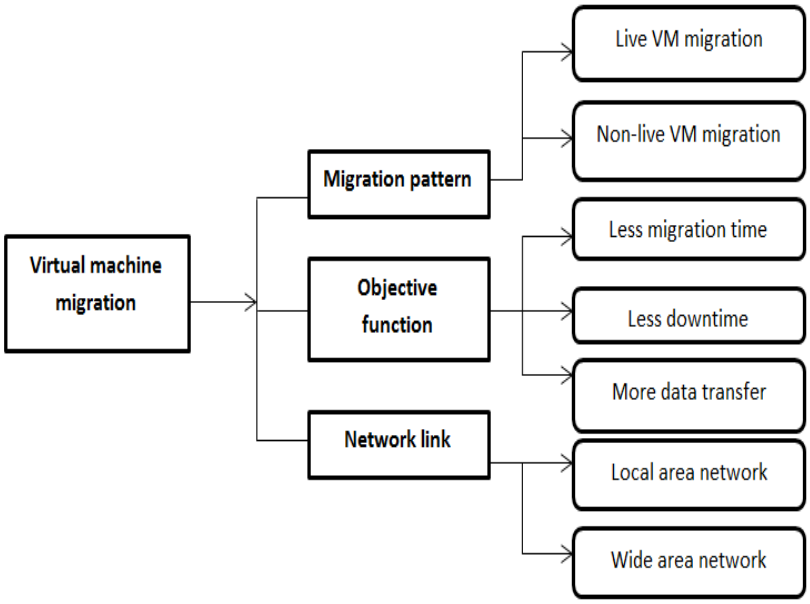

Figure1. Virtual machine migration schemes

C. Live migration

In virtualization, live virtual machine migration is one amongst the inmost characteristics of this technology [17]. It comprehends an approach of moving the all states of running virtual machine from two different hosts. This approach permits a supervisor to necessitate a VM offline for sustentation or promoting while not contenting the system's users to downtime. This offers fascinating benefits that includes [4]:

1) Load balancing: under this productive usage of resources are provided while during migration of VMs.
2) Power efficiency: power off resources are permitted when Virtual Machines with less workload are centralize to less host machines
3) Maintenance: supervisor can dislocate virtual machine to other nodes without any prominent interruption of service for users, before machines are carrying forward for maintenance purpose.

D. Approaches employed for Live Migration:

The two mainly used approaches for live migration are –

1) Pre-copy approach and
2) Post copy approach

In the Pre-copy approach, the mixture of push phase with halt and copy phase is served .[3] Pre-copy approach iteratively copies pages of memory from the source machine and then transfer it to the destination machine, this whole process occurs without even stopping the migration process of the virtual machine once. As in Pre-copy approach there is a copy of memory page on each side, hence it provides with high trustworthiness in opposition to system slip-up. In the post-copy approach every single memory page is transferred just only one time, which is its key advantage over the pre-copy approach. Memory page can be found at single side solely in the post-copy approach. Whereas as it is also opposite to the former approach as it serves the mixture of pull phase with halts and copy phase. [3].There is basically three sections of the Memory Transfer process [3]:

1) Push phase: A certain number of pages are pushed earlier to the new destination prior to the source virtual machine when it transfers to destination and also a number of tailored pages are resent to ensure reliability.
2) Halt and copy phase: Halt and copy phase is the simplest approach in which at the source the source virtual machine is stopped and entire virtual machine is copied or transferred to the destination so resumed it at its designated destination.
3) Pull phase: In this particular phase the page is pulled across the network from the source virtual machine when a page is required which is not copied earlier during the implementation on target machine which is initiated by the virtual machine.

ANALYSIS OF LIVE MIGRATION TECHNIQUES

For migration of Virtual Machine from one host to other, there has been an active research of live migration and a range of techniques are projected. To gauge the performance of live virtual migration strategy subsequent metrics may be employed.(a)Downtime: migration downtime is the period of time for which user have to wait to keep working on virtual machine;(b)Total Migration Time: the total time needed for the migration of virtual machine to destination machine and hence to begin it on same is known as Total Migration Time;(c)Total Data Transmitted: this term is used to designate the total amount data is which is transferred whilst synchronizing the both virtual machine condition and the memory image accounts for the immense majority[15]. Relating to the concept of Live Migration several studies has been done:

A pre-copy technique [2] which is based on time series which is better than the former is discussed. To satisfy Service Level Agreements (SLAs) live migration is the suitable technique to migrate virtual machines swiftly and plainly. With the assistance of the time series forecasting procedure, recently uploaded dirty pages (high dirty pages) are known more exactly, and hence they are transmitted into the last round of iteration, so as in order to cut back redundant, repetitive broadcast of dirty pages. The total migration time will be considerably reduced by performing this method.

In [3], author argued about the migration of data from one virtual machine to a different virtual machine. There exists several methods that makes process of migration seemingly effective but however still throughout migration, variety of copied pages are transmitted that results in increasing total migration time and total downtime. Hence there is utter requirement for process that cut back moving of copied pages. To reduce the superfluous transfer of pages an approach was projected which termed modifying the optimized pre-copy and its mixture with Characteristic Based Compression (CBC) algorithm two parameters will be handled viz. (i) total downtime and (ii) total migration time which will create migration process more realistic

By accumulating a bitmap page [4] which marked the regularly updated pages gave a better pre-copy method on Xen3.3. In the iteration technique, regularly reorganized pages are placed into the bitmap of the page, and that placed pages can solely be transferred within the final round of the iteration technique which assures that often reorganized pages are transferred only one time that reduce total downtime and total migration time.

The modified the pre-copy method [5] through the usage common memory storage. The assumption that was taken was that connection of each and every physical host with the common storage and then transmission of merely those pages which are not available in shared storage. A method has been proposed by them to trim down the overall time needed to transfer an operating VM from one host to different whilst maintaining the minimum downtime. On the basis of the recent observation that trendy working systems utilize the higher fraction of the physical memory to cache data from the secondary storage, hence this procedure records the Virtual machine's input output operations to the storage device which is attached to the network and hence regulates an up to date tracking of memory the pages that presently exists in indistinguishable form on the storage device. Rather than moving pages from source to the designated host, in the iterative pre-copy migration process the memory-to-disk tracking is distributed to the designated host which further then collects the constituents straightly from the network-attached storage device. Therefore, resulting in reduction of total data transferred.

The two phase strategy [6] that employs Second Chance (SC) method for determination of high dirty pages. Verification of To-send and To-skip will occur in the first phase. If each of the parameters are equivalent to one and zero respectively after that they are passed to second chance. The page gets migrated to the target only if the page is found clean during this stage. Therefore, by using this strategy duplication of frequently modified pages is averted by using two phase method.

A technique [7] that lessens the quantity of transmitted memory of live migration is discussed. They named that technique "memory reusing". The memory image of the virtual machine is kept within the source host when a VM is migrated to different host. Memory pages will be reserved incase when the VM returns back to the initial host later so that the reserved memory image could be reused. They also employed a scheme called "Miyakodori". It utilizes the memory reutilizing in live migrations which results in reduction of the number of transmitted memory of live migrations and also when once incorporated with dynamic VM consolidation system 87% of additional energy consumption will be reduced.

The two major performance metrics [8] that the customers of a VM service care about the foremost is total migration time and downtime. As a result they are anxious regarding degradation in quality of service and the extent for which the service is entirely not available. They used a pre-copy approach however this technique is economical only in the scenario when the page dirtying rate is exceptionally towering as the total migration time also increases with it. They putted forward a way during which the

migration time can be trimmed down by moving the page that don't seem to be lately used and by sending the register reports of modifications rather than sending the dirty pages again.

A memory exploration and encoding [9] approach is proposed. In this approach firstly valuable pages are identified and after that compression using run length encoding (RLE) algorithm is applied. Pre- copy being the existing method, which memory page is used cannot be distinguished, leading to transfer massive amounts of useless memory pages. For various Guest OS, ME2 is required to write Exploration Module .This technique helps in reducing the migration time and downtime.

In [10], author described implementation of the function of delta compression throughout the transport of memory pages in order to lengthen migration throughput and thus reducing the downtime. This algorithm for live migration is enforced as an alteration to the KVM hypervisor. A major decrement is indicated in the migration downtime when its performance is evaluated by migrating operating VMs with absolutely different kind of workload. They indicate that there is high risk of interruption in service when VMs migrate with high workloads or over low-bandwidth networks. As in delta compression as data is kept in the form of changes among versions, peril of service will be minimized. Either the dirtying rate has to be minimized or the network throughput has to be increased in order to obtain best performance.

In [11], author projected that using post-copy technique with flexible pre-paging which is engaged to shun moving of copy pages and to shun the moving of free memory pages dynamic self-ballooning process is used in order to enhance the total migration time and total pages being transferred. The comparison between post-copy against the typical pre-copy method on top of the Xen Hypervisor is done extensively. By utilizing a variety of VM workloads development is exhibited in several migration metrics also the pages which were transferred, in addition to that total migration time and network overhead. The rate of migration will surely be increased by this.

In [12], author showed a blueprint and execution of a unique memory compression (MECOM) that initially uses memory compression to present quick, firm virtual machine migration, whereas ensuring the services of virtual machine up to some extent exaggerated. On the basis of memory page uniqueness, they manufactured a flexible zero-aware compression algorithm for leveling the efficiency and the charge of virtual machine migration. In each round at the source node data which is being transferred is compressed by their algorithm and after reaching at the target it is decompressed. Due to this compression algorithm system overhead could get amplified.

A technique [13] is projected a technique with efficient VM migration referred to as bitmap matrix. This approach deplete the overall migration time in live migration. Traditional pre-copy approach further improved by taking sample number of times. A fixed time-slot variable they used for determine a period of time with each sampling. By demonstrating many experiments they conclude that there is intensive decrease in both migration and downtime.

In [14], author projected an improved virtual machine consolidate system which uses a post-copy live migration strategy that intensively help to reduce performance downfall. Due to usage of dynamic resources, VM positions are heavenly efficient. In this strategy a model of consolidation system has been formed and its feasibility is checked with the help of doing certain experiments. As a result by using post copy strategy, consolidation system gained a better performance assurance rather than pre-copy migration.

In [15], author discussed about the strategy of migration with data duplication in virtual machine According to the author, the self-similarity of moving memory image of machine is checked by this technique. Here hash key based fingerprints technique is used to seek out selfsame pages. Total data transferred rate is to be minimized. Another encoding scheme (RLE) is used mainly for minimizing data transfer rate. Overall by comparing with another system like Xen's default Pre- Copy mechanism, this technique will lower down more total data transferred throughout migration.

In [16], author implemented a scheme where downtime and total migration time is to be minimized for live migration. They proposed a scheme where threshold values are set-to see that the pages should be moved within the halt-and-copy phase on the basis of memory alteration prediction method. By incorporating the likelihood of memory alteration, the chance of memory modification may be determined and might also the pages with the largest range of alteration can be determined.

COMPARITIVE ANALYSIS

The various famous techniques that are used by various researchers are categorized and their merits and demerits are outlines in below table 1:

Table 1: Comparative Analysis of Live Virtual Machines Strategies

S No	Techniques	Conclusion	Merits	Demerits
1.	Enhanced time-series pre-copy strategy**[2]** J. Arpurtharaj et al. **(2013)**	Constantly contemporize dirty pages that find out more accurately Transfer in last round of replication	Minimized total migration time	Downtime overhead.
2.	Optimized pre-copy **[3]** Megha R. desai et al. **(2015)**	Reduce unnecessary transfer of pages. Characteristic Based Compression (CBC) algorithm is used.	Overall migration time and is reduced Down-time is minimized	Compression overhead may arise
3.	Improved pre-copy**[4]** F. Ma et al. **(2010)**	Constantly updated pages transferred at the end of last round and only one time.	Migration time and downtime get decreased	Send pages on basis of previous iteration not current.
4.	Live migration **[5]** C. Jo et al. **(2013)**	Attachment of physical machines with shared storage is taken into consideration	Total data transferred get decreased.	Migration time is more.
5.	Two-phase pre-copy strategy**[6]** Lin C-C et al. **(2012)**	Two phase strategy used by giving second chance to the used pages Heavily dirty bit rate is of pages are identified	Duplication of frequently updated pages are avoided	More service Downtime
6.	Reusing memory approach for VM consolidation**[7]** Soramichi Akiyama et al**. (2012)**	Memory image of physical machine is kept on host and reused it again in every iteration Results in minimization of transferred memory	Downtime and migration time has been reduced	More Data to be transferred
7.	Optimized pre-copy approach using log records**[8]** Anju mohan et al. **(2013)**	Pages that are not recently used are transferred Firstly Log records of alterations are taken and send for final results.	Migration time is reduced	Still exist downtime overhead
8.	Compression based on run length encoding(RLE)**[9]** Y. Ma et al. **(2012)**	Differentiate VMs useless memory Result in decrease in total transferred memory	Reduced downtime and migration time	Existence of Compression overhead.

9.	Delta memory compression approach**[10]** P. Svard et al. **(2011)**	Modified KVM hypervisor is used. Compression leads to more data transfer	Reduced downtime Increases migration throughput	Compression operations introduced additional overhead
10.	Post-copy approach**[11]** R.hines et al. **(2009)**	Prosecution states of virtual machines are migrated first Overall pages in the memory are transferred once	Amount of memory pages reduced during transfer.	Downtime overhead
11.	Adaptive memory compression approach**[12]** H. Jin et al. **(2009)**	Memory pages are compressed first and transfer large amount of pages.	It provides quick and steady VM migration. Minimizes the downtime and total migration time.	Compression operations introduced additional overhead.
12.	page bitmap**[13]** Cui W et al. **(2010)**	Pages which are changing Continuously are kept simultaneously as a bitmap. They are further moved at end in last round	Reduced migration time Minimized total data transfer rate	In wide-areas ,VM migration is not suitable
13.	Post copy approach**[14]** T. Hirofuchi et al. **(2011)**	To resolve the excessive use of server nodes, Virtual machines are suddenly lashed among the hosts.	Performance degradation less. Memory-intensive workloads also reduced to half.	Live migration may not be completed properly. Introduced some overheads.
14.	Migration with data de-duplication**[15]** X. Zhang et al. **(2010)**	To find similar memory pages, fingerprints using hash mechanism is employed. Run Length Encoding mechanism is taken into consideration to remove the duplicate information	Reduce migration time, total transfer rate and downtime.	Compression overhead
15.	Pre-copy approach**[16]** Tin-Yu et al. **(2013)**	On the basis of the memory alteration forecast approach, different threshold values are assumed.	Decreases downtime and total migration time	Performance degradation.

SECURITY CONCERN DURING MIGRATION

The major concern while shifting virtual machines from source machine to destination machine is their security. Some of the major security threats while transferring of virtual machine from source machine to destination server are stated below:

1. Assailant steals the Bandwidth by taking control over source virtual machine and hence transferring its virtual machine to destination.
2. By advertising false resource accessibility, assailants may attract more virtual machines towards it.
3. Active exploitation.
4. Passive intrusions.

To provide high level of data security, the Cloud Service Providers generally use the process of cryptography. As cloud service provider give them surety of confidentiality and integrity to transmit the data. Therefore, secure data migration is most important issue. During the migration process, to avoid attacks certain Cryptographic algorithms and authentication keys are used. The initiator of migration and the destination machine strictly enforce the following during migration:

- Migration initiator legitimacy.
- During migration, maintenance of trust chain among entities.
- Secrecy of Migration process.

Legitimacy, secrecy and confidentiality of source and destination are the main three steps for effectively implementing the security of the migration process.

GAPS IN LITERATURE

Various shortcomings in the former techniques are listed below in the succeeding section.

a) In the previous approach downtime and the migration time used to be same since Virtual Machine is not started on target host until all its pages are sent to target. Drawback of this method was that Virtual Machine services are completely unavailable until it is started on destination causes increased downtime.

b) The major flaw of present migration techniques is that they transport a hefty amount of data to migrate a Virtual Machine. Due to transferring of data in such huge amount causes two issues:

- Performance of the applications running in the Virtual Machine is degraded during the process of migration because it accesses memory.
- Consolidation gets delayed because several Virtual machines get consolidated into the host at once which results in congestion in the network of the host.

c) Compression leads to distortion of the information so in existing techniques compression is overhead.

CONCLUSION

By the virtue of Virtualization, several resource provisioning capabilities which are flexible as well as dynamic are supplied to the end users. The process of live migration consists of transferring an active virtual machine across different bodily hosts. Achievement of least down time and migration time is the main aim of the migration process. This paper has presented a review on various live virtual machine migration approaches. The assessment has clearly indicated that each approach has its own pros and cons. On several parameters proportional study has been done of virtual machine migration. The other key concern during the virtual machine migration process is security. The communication is exposed to assailants during the virtual machine data transfer. In order to minimize the loss of data on memory space to assailants and to increase the privacy of the data which is being migrated, a secure migration is done by using the cryptographic algorithms in future. In the existing approaches compression of data is done but compressing the data will lead to some distortion in the information. So during the memory transfer, a performance model, focusing on reducing the data amount transfer size and the memory that is stored on the host for time in advance used by restating and then using the existing data will be proposed. This will prove to be useful in the pursuit of minimizing the migration time as well as downtime.

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