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RESEARCH ARTICLE

A Duplication Reduced Pre-copy Strategy for Live Migration of Virtual Machine in Cloud Computing

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ABSTRACT

In Cloud Computing, Large scale data centre's have been widely used to host cloud services, which are typically allocated to different virtual machines (VMs) through resource multiplexing across shared physical servers. The fast growing rate of the usage of large-scale computing machines on cloud platform results in need for a optimized load balancing strategy. One way to optimize the load balancing process is by implementing the migration of virtual machines across multiple hosts. Migration at the level of an entire VM means that in-memory state can be transferred in a consistent efficient fashion. Iterative pre-copy is a major mechanism for achieving live migration of virtual machines. The page duplication activity has an adverse impact on computing internet-related applications. To reduce this adverse effect a Duplication Reduced Pre-Copy strategy is proposed.

Keywords: Cloud computing, Virtual machine, Migration, Duplication Reduced Pre-copy

1. INTRODUCTION

Cloud computing is a way to increase the capacity or add capabilities dynamically without investing in new infrastructure, training new personnel, or licensing new software. Along with the advancements of cloud technology, the new possibilities for Internet based applications development are emerging. Various applications like social networking sites and e-commerce can benefit greatly from cloud infrastructure services to minimize costs and improve service quality to end users. Cloud has become an alternative means of internet for most of us. Cloud represents ubiquitous computing. The two main entities involved in cloud computing are the cloud user and the cloud service provider. Sometimes a cloud broker may also exist. Any resources required by the user are delivered by the cloud service provider. The main aim of cloud provider 2 is to maximize his revenue and at the same time, optimize the usage of the datacenter. The data center consists of processors, RAM, storage resources network resource, computing resource. The user gets the Quality of Service from the provider on the PaaS-you-use basis. Cloud services are provided to the cloud users as utility services like water, electricity, telephone using pay-as-you-use business model. These utility services are generally described as XaaS (X as a Service) where X can be Software or Platform or Infrastructure etc.

1.1 CLOUD COMPUTING

Cloud computing can be defined as an extension of parallel computing, distributed computing and grid computing. It is meant to provide a secure, quick, convenient data storage and net computing service. Cloud itself consists of physical machines in the data centers of cloud providers. Virtualization is provided on top of these physical machines. These virtual machines are provided to the cloud users. Different cloud provider provides cloud services of different abstraction level. E.g. Amazon EC2 enables the users to handle very low level details where Google App-Engine provides a development platform for the developers to develop their applications. So the cloud services are divided into many types like Software as a Service, Platform as a Service , Infrastructure as a Service Cloud Computing defined by NIST as, "A Model for enabling ubiquitous, convenient, on-demand network access to a share pool of configurable computing resources (Ex. Network, Servers, Storage, Applications and services) that can be rapidly provisioned and released with minimal effort or service provider interaction".

1.2 CHARACTERISTICS OF CLOUD COMPUTING

- On-demand self-service
- Broad network access
- Resource pooling
- Rapid elasticity
- Measured service

1.3 CLOUD SERVICE MODELS

Cloud means the applications and services that are offered from the datacenter to all over the world. These applications and services are offered over the internet. The services provided by cloud computing are Infrastructure

as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) that are made available as pay-as-you-go model to clients.

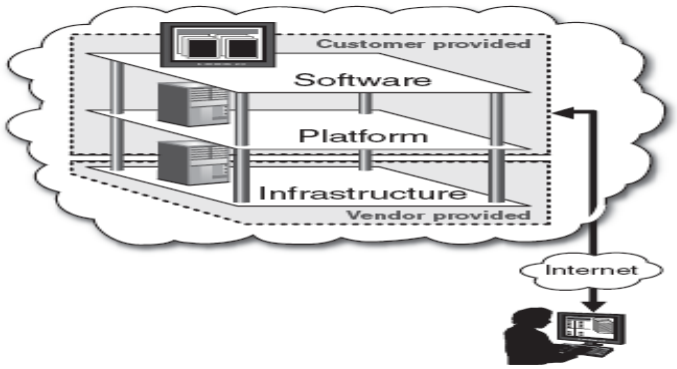

Figure 1.1 Structure of service mode

- ***Infrastructure-as-a-Service (IaaS)***

A service model that involves outsourcing the basic infrastructure used to support operations including storage, hardware, servers, and networking components. The service provider owns the infrastructure equipment and is responsible for housing, running and maintaining it. The customer typically pays on a per-use basis. The customer uses their own platform (Windows, Unix) and applications.

- ***Platform-as-a-Service (PaaS)***

A service model that involves outsourcing the basic infrastructure and platform (Windows, Unix). PaaS facilitates deploying applications without the cost and complexity of buying and managing the underlying hardware and software where the applications are hosted. The customer uses their own applications.

- ***Software-as-a-Service (SaaS)***

It is also referred to as "software on demand," this service model involves outsourcing the infrastructure, platform and software/applications. Typically, these services are available to the customer for a fee, pay-as-you-go, or a no charge model. The customer accesses the applications over the internet.

1.4 CLOUD DEPLOYMENT MODEL

- Public Cloud
- Private Cloud
- Community Cloud
- Hybrid Cloud

1.5 CLOUD STAKEHOLDERS

There are three types of stakeholders cloud providers, cloud users and the end users. Cloud providers provide cloud services to the cloud users. These cloud services are of the form of utility computing i.e. the cloud users uses

these services pay-as-you-go model. The cloud users develop their product using these services and deliver the product to the end users.

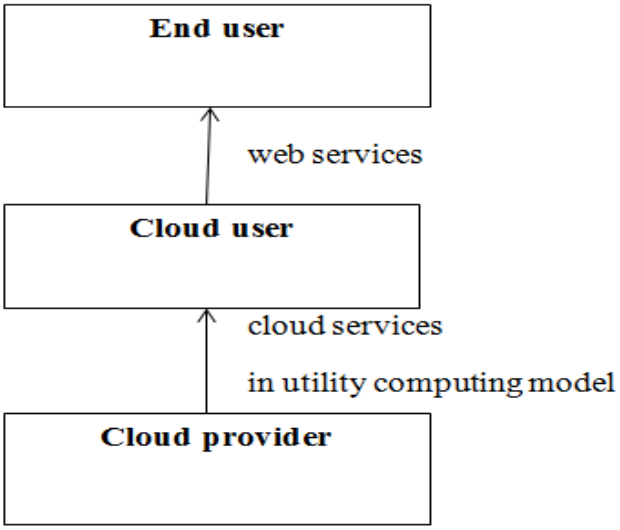

Figure 1.2 Cloud stakeholders

1.6 VIRTUALIZATION

Virtualization enables the migration of virtual image from one physical machine to another physical machine and also creates the virtual version of operating system, a server, a storage device and network resources. It is the creation of a virtual version of an operating system. It is a technique for hiding the physical characteristics of computing resources to simplify the way in which other systems, applications, or end users interact with those resources. This feature is useful in optimization and taking backup. Cloud computing use virtualization to minimize the initial and maintenance cost.

1.6.1 Types Of Virtualization

- Full virtualization
- Para virtualization

1.6.1.1 Full Virtualization

Full virtualization is a type of Virtualization approach to provide Virtual Machine environment that completely relays on Hardware. In full virtualization, hardware is reflected in virtual machines which includes instruction set, I/O Operations Etc.

1.6.1.2 Para Virtualization

Para Virtualization is virtualization technique that allows multiple Operating systems to run on the hardware at the same time using the system resource such as processor, memory. The created virtual machine has separate APIs that talk with Virtual Machine Monitor which sends the virtualization request to the hardware. So the Virtual Machine Monitor does not need a resource intensive translation of instructions

1.6.2 Hypervisor

In Cloud Computing, Virtualization is achieved through hypervisor. A hypervisor, also called a virtual machine manager, is a program that allows multiple operating systems to share a single hardware host. Each operating system appears to have the host's processor, memory, and other resources all to itself. However, the hypervisor is actually controlling the host processor and resources, allocating what is needed to each operating system in turn and making sure that the guest operating systems (called virtual machines) cannot disrupt each other.

There are two basic types of Hypervisor

- Native Or Bare Metal Hypervisor
- Hosted Hypervisors

1.6.3 *Terms Used In Virtualization*

- Host Machine
- Virtual Machine(VM)
- Host OS
- Guest OS

1.7 LIVE VIRTUAL MACHINE MIGRATION

During the peak loads, there will be a need of migration of VM to another physical machine for fulfilling the requests. Migration is the process used to transfer a VM from the host on which it resides to a different one.

There are two types of Virtual Machine Migration

- Hot (live) migration
- Cold (non-live) migration

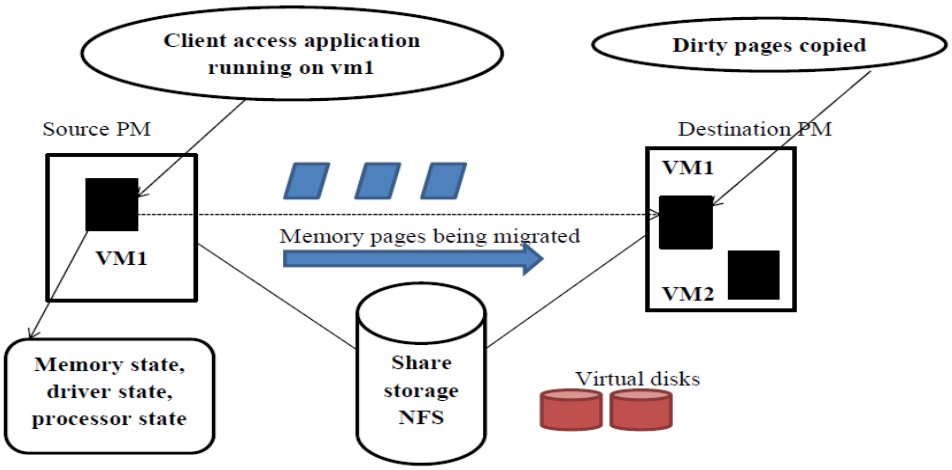

Figure 1.5. Live VM migration procedure

1.8 EXISTING LIVE VIRTUAL MACHINE MIGRATION MECHANISMS

1.8.1 Pre-copy live migration

Pre-copy migration process pauses the execution of VMs at the source end during the process of migration. The iterative pre-copy mechanism copies the dirty pages into the destination host by marking them as clean while the VM is still running. It allows the pages to be concurrently written again and again through the network in next iterations leading to a dirty page rate. The Xenalike KVM (Kernel VM) and Service Level Managed KVM have followed a method of forcing the pre-copy iteration if the system does not converge within a reasonable time. It resulted in significant increase in service levels preventing VM thrashing thereby trading off migration delay and down time even for higher workload intensities.

1.8.2 Post-copy live migration

Post-copy migration maintains the liveliness of the VMs during the migration process. It improves upon the important metrics like pages transferred, total migration time and the network overhead. The four mechanisms utilized by post-copy migration of VMs across a Gigabit LAN for fetching the memory pages from the source and overall improved performance are, demand paging for ensuring that each page is sent only once through the network, active push to ensure that the residual dependencies are removed from the source host as quickly as possible, pre-paging for reducing the number of major network faults and dynamic self-ballooning for reducing the number of free pages transferred during duration.

1.8.3 Memory management based live migration

The proper management of the memory during the live migration of virtual machines is the prime concern since it mainly affects the performance of the migration process thereby leading to more energy consumption and cost. We classify the memory management based live migrations by considering the nature of operation used to reduce the amount of data transfer as Memory compression based mechanisms, Memory re-use based mechanism and Memory pruning based mechanism.

1.8.4 Network aware live migration

An approach for placement and migration of VMs in order to minimize the data transfer time in data-intensive applications during the communication due to network I/O performance places VMs on physical machines with due considerations to the network conditions between the physical machines and the data storage. It also considers the instable network condition resulting in changed data access behaviors deteriorating the application performance by dealing it with migration to other physical machines thereby leading to improved task completion time. We classify the network aware live migrations mechanisms based on the network structure and the address translation rule as Topology based mechanisms, transparent migration based mechanism and Network paging based mechanism

1.8.5 Energy Management Aware Live Migrations

The live migration of VMs results in more energy consumption thereby leading to higher cost if the sufficient measures are not considered while selecting the VMs for reducing total migration time, minimizing down time and minimizing the number of active servers. We further classify the Energy management aware live migration based on the nature of energy optimizations as Energy consumption aware mechanisms, Load aggregation based mechanism, Application placement based mechanism and Workload adaptive mechanism.

1.8.6 Security Aware Live Migration

A method leveraging Intel vPro and TPM for improving security in live migration contains an attestation service for running hypervisor to cryptographically identify itself to a remote hypervisor for trusting the application. It also contains a sealed storage for encrypting the data using the private key of the tamper resistant TPM that is responsible for attestation.

1.8.7 Application specific live migration

The live migration of virtual machines can also be performed based on the type of applications specific to the need of the consumers. We classify them based on the nature of applications as Multitier and I/O intensive.

1.8.8 Decentralized approach based live migration

The peer-to-peer (P2P) network of physical systems based decentralized Virtual Machine Consolidation (VMC) algorithm uses a novel migration-cost aware Ant Colony Optimization (ACO) algorithm resulting in less number of migrations with efficiency closer to the centralized system. It assumed that PMs are interconnected by means of a high-speed LAN and the hardware can be either homogeneous or heterogeneous.

1.8.9 VM placement based live migration

The mathematical model based approach by considering migration overhead for recalculating and executing VM allocations over time considers operational 20 server hour as a prime metric for quality of the VM reassignment model. It considers three different servers as small, medium and large with CPU overhead as (20%, 10%), (30%, 20%), and (40%,30%) for numeric experiments using static VM assignment and the proposed VM scheduling model. The model proved to be saving 50% of the operational server hours by comparing it with the statistic VM assignment model.

1.8.10 Business aware live migrations

The live migration of the VMs must consider the benefits of the cloud computing services from both the service provider and the consumers' perspective by utilizing mechanisms that limit the migration cost without compromising the performance. We classify the Business aware live migrations based on the nature of business quality involved as Cost aware mechanisms and QoS aware mechanism.

1.8.11 Stable Matching based live migration

The general stable matching framework enables finding a stable matching fair to both VMs and servers instead of favouring either side as a result of the deferred acceptance procedure.

1.9 CHALLENGES IN CLOUD COMPUTING

There are several challenges in Cloud Computing that need to be resolved before exploiting the features this technology. Some challenges include

- Security issues
- Legal and compliant issues
- Performance and QoS
- Interoperability issues
- Load balancing
- Data management issues

1.10 ADVANTAGES OF USING CLOUD

The advantages for using cloud services can be of technical, architectural, business

2. LITERATURE SURVEY

The fast growing rate of the usage of large-scale computing machines on cloud platform has resulted in increased consumption of energy and emission of carbon. Such negative effects should be curbed for a more environmental friendly computing platform, e.g. a green cloud computing platform. One of the important features that need to be optimized in regards to scheduling is the load balancing process that emphasizes on optimal resource utilization, maximum throughput, maximum response time and prevention of overload. One way to optimize the load balancing process is by implementing the migration of virtual machines across multiple hosts, in which utilization of CPU resources can be optimized. The appropriate use of two different classes of resources e.g. low-powered and high-powered machines based on their Million Instructions Per Second (MIPS) metrics, will lead to minimal process execution time if both types of resources are being efficiently used and effectively mapped to suitable types of processing. According to different machine performance, the migration of virtual machines will be computed based on the current CPU utilization following three different conditions, i.e. when the CPU usage reaches its 90%, 10% and 0% marker.

3. EXISTING SYSTEM

In pre copy approach, the VM continues to run, while its memory is iteratively copied page wise from the source to the target host. Iteratively means, the algorithm works in several rounds. It starts with transferring all active memory pages. Pre-copy is well proven for read intensive workloads. Live migration of virtual machines by using the Pre-copy algorithm consists of six steps:

STEP 1

- Pre-migration: In this step, it is assumed that a virtual machine on a physical host A has been activated. At this stage, the pre-specified target machine resources needed to be free to migrate.

STEP 2

- Reservation: This step includes reservation of required resources and preparing to begin the migration.

STEP 3

- Iterative Pre-Copy: The algorithm consists of repeated iterations before copying for memory migration from origin to destination is desired. In the first repeat, all the plates, transferred from A to B and in the next repeat, the damaged pages will be re-migration.

STEP 4

- Stop-and-Copy: Virtual machines on host A been suspended and the remaining Incompatible pages between A and B and status of the CPU will be migrated to the destination machine. At the end of this stage, transferred plates between A and B are compatible. But also in case of failure migration, A will be considered as the main host.

STEP 5

- Commitment: Host B message that migration done correctly, for Host A sends and Host A turn main virtual machine's off and from this time onwards B will be known as the main host of the virtual machine. The fourth and fifth steps show the downtime.

STEP 6

- Activation: The last step, the migrated virtual machine will be active and work is resumed.

4. PROPOSED SYSTEM

A virtual machine under migration may compete with internet-related applications for communication bandwidth. A intensive page duplication activity across hosts degenerates the performance of internet-related applications. The ultimate aim of duplication reduced pre-copy strategy is to reduce the page duplication in a short period of time. The duplication reduced pre-copy strategy duplicate a page if the page have kept clean for two consecutive iterations after it has been dirtied. At the last iteration all the accumulated pages are duplicated. The duplication rule of duplication reduced pre-copy strategy is given as **(di j-3 /\d' i j-2 /\d'i j- 1) = 1** Page Pi is duplicated across hosts in iteration j if the condition. We also define di-2 = 1, di-1 = 0 and di0 = 0 for all the pages to be duplicated in the first iteration.

4.1 HARDWARE REQUIREMENT

System	:	INTEL I5
System Architecture	:	x86
RAM	:	8 GB
Hard Disk	:	1 TB

4.2 SOFTWARE REQUIREMENT

Operating System	:	Linux
Language	:	Java -1.7
IDE	:	Net Beans 8.0.1
Cloud Simulation Tool	:	CloudSim
Hypervisor	:	xen

5. SOFTWARE DESCRIPTION

5.1 CLOUDSIM

CloudSim is a famous simulator for cloud parameters developed in the CLOUDS Laboratory, at the Computer Science and Software Engineering Department of the University of Melbourne.

5.2 NETBEANS

The Net Beans Platform is a reusable framework for simplifying the development of Java Swing desktop applications. The Net-Beans IDE bundle for Java SE contains what is needed to start developing Net-Beans plugins and Net-Beans Platform based applications; no additional SDK is required. Applications can install modules dynamically. Any application can include the Update Center module to allow users of the application to download digitally-signed upgrades and new features directly into the running application. Reinstalling an upgrade or a new release does not force users to download the entire application again.

5.3 THE JAVA FRAMEWORK

Java is a programming language originally developed by James Gosling at Sun Microsystems and released in 1995 as a core component of Sun Microsystems' Java platform. The language derives much of its syntax from C and C++ but has a simpler object model and fewer low-level facilities. Java applications are typically compiled to byte code that can run on any Java Virtual Machine (JVM) regardless of computer architecture. Java is general-purpose, concurrent, class-based, and object-oriented, and is specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere".

6. SYSTEM DESIGN

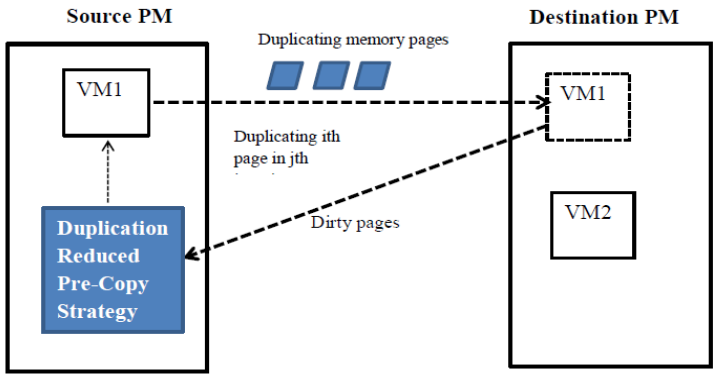

Figure 6.1 Overview of System Architecture

6.2 UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

6.2.1 Use Case Diagram

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. The main purpose of a use case diagram is to show what system functions are performed for which actor.

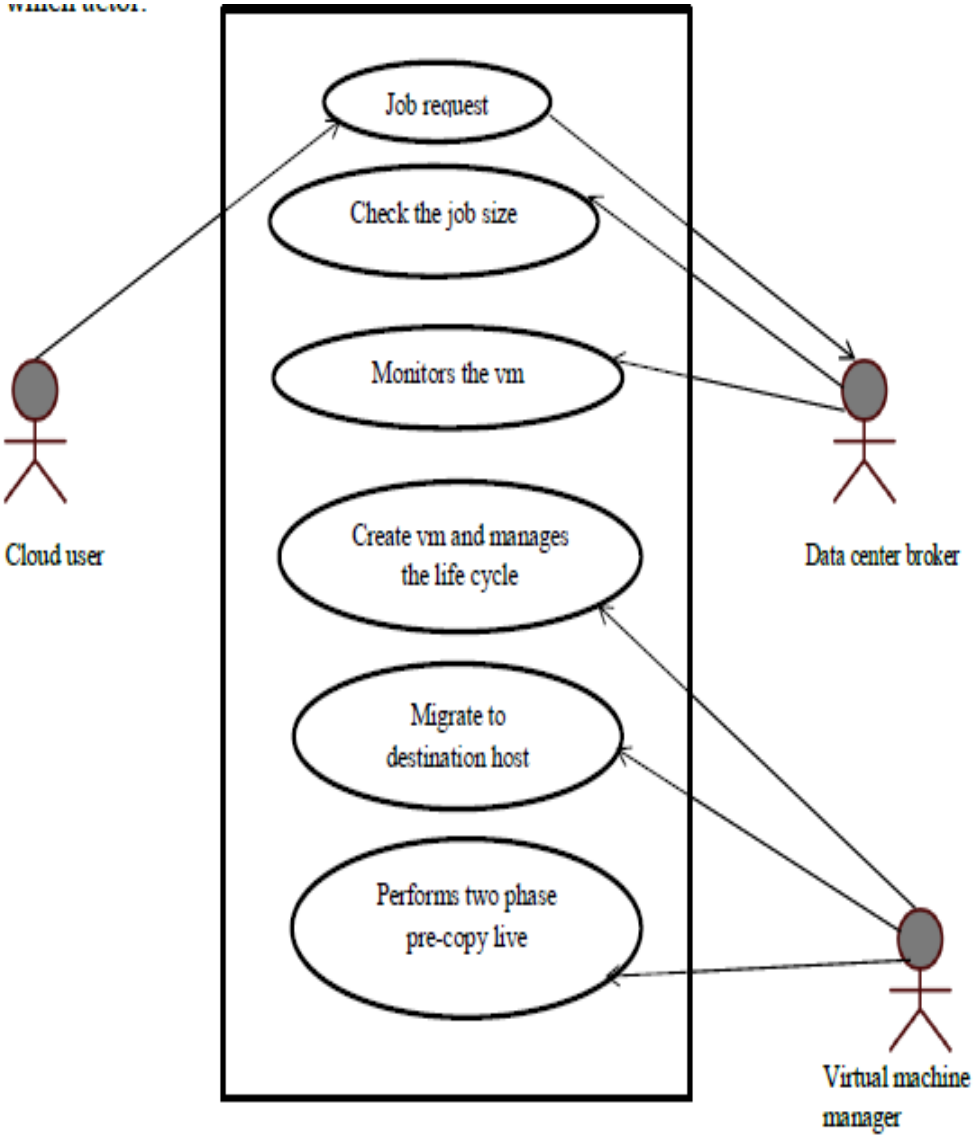

Figure 6.2.1 Use Case Diagram

6.2.2 Data Flow Diagram

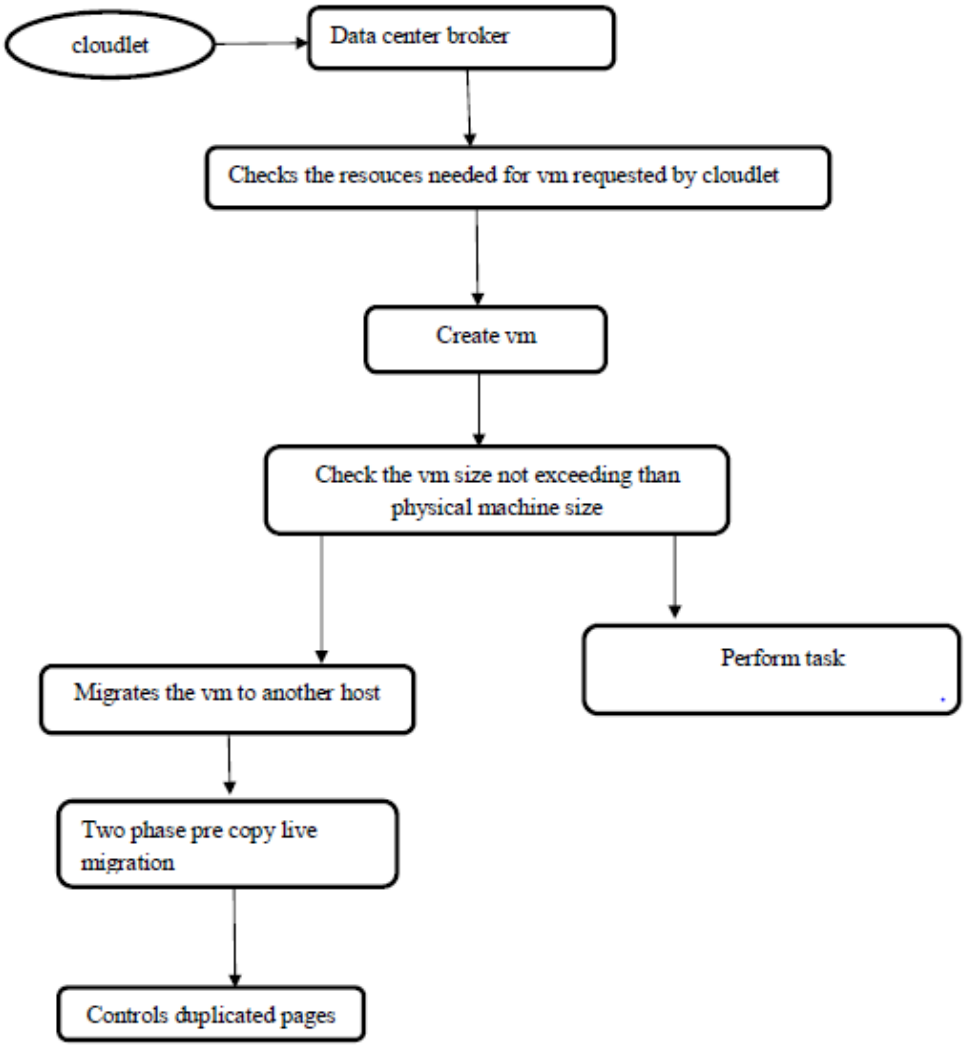

Figure 6.2.2 Data Flow Diagram

7. SYSTEM TESTING

7.1 TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

7.2 TESTING TECHNIQUE

In this process the appropriate testing process is selected from various testing methodologies and the selection is done by the means of analyzing the nature of the project. The process steps are bent upwards after the coding phase, to form the typical V shape.

8. SYSTEM MODULES

- Datacenter Creation
- Datacenter Broker Creation
- VM Creation
- Cloudlet Creation
- Pre-copy with duplication reduction condition

9. CONCLUSION

A Duplication Reduced Pre-Copy Strategy for Live Migration of Virtual Machine in Cloud Computing is proposed and implemented in cloud computing environment using CloudSim toolkit, in java language. The proposed system mainly aims at reducing the memory page duplication from source physical machine to destination physical machine using a enhanced Pre-Copy strategy. On comparing the downtime and migration time with typical pre-copy, the proposed system takes reasonable amount of downtime and migration time. The performance graph is generated and it compares amount of duplication in the typical pre-copy and the duplication reduced precopy. On evaluating the graph it seems to know that duplication is drastically reduced.

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