Enriched Load Balancing Approach by Implementing Virtual Machine Migration Using DIJKSTRA’S Algorithm in a Cloud Environment

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Abstract
Cloud computing mechanism helps to use the resources efficiently. It provides access to large amount of data with minimal efforts and limited
budget. The main challenges faced by this are security, service quality, data backup and recovery, cloud data migration, Downtime and accessibility, access to data, transition to cloud, etc. Load balancing is the process of dispensing workloads and resources of computing across more than one server. This makes maximum throughput in minimum response time. A system based on a dynamic load balancing approach method and double threshold based system works by consuming the host and thereby calculating the threshold value. And the number of migrations should be reduced. The main load balancing challenges includes distribution of automatic services, Data management services, virtual machine migration, Small data centers, and cloud nodes distribution. In this paper we are proposing a load balancing technique using the live migration of the virtual machine from the overloaded physical machine to the less loaded one by finding the shortest path using Dijkstra’s algorithm.

**Key Words:** Cloud computing, virtualization, VM migration, load balancing.
1. Introduction

Cloud computing provides access to large amount of data with minimal efforts and limited budget.

The essential characteristics of cloud computing includes on-demand self-service, resource pooling, rapid elasticity, measured service. Various services provided by the cloud architecture are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The deployment models of cloud incorporate public cloud, private cloud, hybrid cloud, and community cloud.

Virtualization is a task of generating a virtual environment version of some objects like operating system, server, storage device, or network resources. Six different types of virtualization are present. They are Network virtualization, Storage virtualization, Server virtualization, Data virtualization, Desktop virtualization, Application virtualization. The benefits in using virtualization technique are noticing.

It brings down the budget cost, minimizes downtime, increases IT productivity, efficacy, agility and receptiveness, supply applications and resources faster. It enables business succession, decipher data center management, and construct a software defined data center.

Load balancing is an efficient way of dispensing incoming network traffic athwart a class of servers.

The workload is parted amidst two or more servers, thus permit adequate resource usage and response time. A load balancer can perform certain functions such as distributing client requests or network load effectually across multiple servers.

Different load balancing algorithms are Round Robin algorithm, Least connection algorithm, Source algorithm, Static algorithm, Dynamic algorithm, Weighted round robin algorithm, Opportunistic algorithm, Minimum to Minimum algorithm, Maximum to Maximum algorithm, etc.

The notable advantages of load balancing technique are system firmness maintenance, system performance and system failure protection capability. It also has high performing applications and increased scalability. It has the capability to get rid of from unexpected traffic congestion issues.

The main load balancing challenges includes distribution of automatic services, Data management services, virtual machine migration, Small data centers, and cloud nodes distribution.
2. Literature Survey

The existing system is on the basis of a dynamic load balancing method and double threshold based system. On the basis of consuming the host the threshold is calculated.

Here the number of migrations is to be reduced. The main concept to be aware of is that when host load is less than upper threshold then all other virtual machines running on that host gets migrated to other hosts. And if the host load is greater than upper threshold then host gets overloaded. At this stage some VM is to be migrated.

VMs hang up for a short time gap at the time of migration which results in the system performance degradation. The main objective of a dynamic load balancing approach must be minimization of number of migrations.

Virtual machine migration includes the transmission of virtual machines from one host to another host. This process never challenges the functioning of client or application.

It is of different types. They are cold migration, warm migration, live migration, etc. The two possible ways to transfer the virtual machines memory state from one source to another destination are pre-copy memory migration and post-copy memory migration.

Self-aggregation algorithms help to develop and prolong a group of similar nodes which are aware of their adjacent nodes and execute the appropriate load balancing algorithms when needed.

Multiple Regression Host Overload Detection is an algorithm that helps to minimize the energy consumption while safeguarding a great allegiance to SLA. On the basis of CPU, memory and bandwidth it gives a clear idea about the host utilization.

Dynamic migration of VMs considers various factors which affect its regular activities like consumption of energy, communication between VMs, and cost of migration, etc.

The DM-VM problem is partitioned into two components: create VM into groups; and forecast the efficient path to allocate those groups into certain physical nodes.

Unified ant colony system helps to determine the overloaded node within a short span of time and helps to balance the load within nodes with efficient resource utilization.
Load Balancing

Load balancing is the process of dispensing workloads and resources of computing across more than one server. This makes maximum throughput in minimum response time. The workload is partitioned among two or more servers, hard drives, network interfaces or other computing resources, which enables efficient resource utilization and system response time. Thus, for websites with high traffic rate, effective utilization of load balancing can make business continuity. The different types of load balancing are static load balancing and dynamic load balancing. In Dynamic load balancing the server having the least weight is searched and selected for load balancing. Here system’s current state is used for decision making regarding load. So processes are allowed to move from an overexploiting machine to an under utilizing machine.

The Static load balancing algorithm is suitable for system with low load variations. Algorithm needs details about the system resources and performance, which is determined at the initial stage of execution. The system’s current state does not depend on the load shift. The frequently found objectives in deploying load balancers are:

- Maintaining the system firmness.
- Improve the system performance.
- Protect the failures that occur in a system.

**Advantages of Cloud Load Balancing**

- High Performing applications.
- Increased scalability.
- Ability to handle sudden traffic spikes.
- Business continuity with complete flexibility.

**VM Migration**

VM migration is the most important feature of virtualization. With this feature an OS state is transferred from one computing node to another physical node. It is of two types.

They are Live VM and Non-Live VM migrations. In Non-Live VM, vm at the source host is paused and then transfer all states of source host to destination and then work gets continued at the destination. In Live VM, vm is transferred from source to destination with limited number of interruptions. The factors affecting live vm are preparation time, Resume time, Pages transferred, Downtime and Total migration time.

The live virtual machine techniques are: 1) Pre-copy migration: It consists of two phases warm-up phase and stop-and-copy phase. In warm-up phase the hypervisor initially create copies of memory pages that are required in order to send from source to destination. Here the virtual machine’s working is not stopped by the hypervisor. During this process there is a chance of getting the...
data duplicated. In stop-and-copy phase, the vm is stopped at the source node itself and then the remaining data are moved to the destination. After that, process is continued at the destination node. 2) Post copy migration: vm is stopped for some time at the source node and then is transferred to destination node. If vm tries to retrieve pages which are not sent by the destination node, then it results in creating page faults. 3) Hybrid virtual machine migration: It is the combination process of both pre-copy and post-copy migration techniques. It passes through phases like preparation phase, bounded pre-copy round phase, virtual machine resume phase, and On-demand paging phase. 4) Post copy variations: It consists of three various stages like post copy through demand paging, post copy through active pushing, post copy through pre-paging.

### 3. Problem Statement

The present system is a double threshold based load balancing approach. In this approach the threshold value is calculated based on the host utilization. If load on host is less than upper threshold then virtual machine running on that host is moved to other host. If load on host is greater than upper threshold host then host is overloaded. Therefore some vm is to be migrated. For this system, time consumption for migration is comparatively high. Not only that it does not take into consideration about the nearest suitable physical machine.

### 4. Proposed Work

The process virtual live migration is the process of migrating virtual machine across different countries. We propose a system which consists of a particular threshold. When the load increases, downtime also increases. In order to decrease the down time, we transfer the virtual machine to the nearest physical machine which contains comparatively less load than the host machine. We are using Dijkstra’s algorithm to find the shortest path between each physical machine.

The advantage of this system while comparing to existing one is that by using this we can increase the speed of transmission of virtual machines and decrease the downtime by calculating the smallest distance. The procedures include:

1. Calculate the PM no, create ID.
2. Calculate the VM no in each PM, create VM ID.
3. Calculate the VM capacity.
\[ VM_{cpu} = \frac{Total\ requested\ MIPS}{Total\ MIPS\ of\ the\ PM} \]
4. Find the free space in PM
5. Find the shortest path to each PM by algorithm (Dijkstra’s algorithm).
6. Sort the PM according to the shortest path.
7. Transfer the VM to the desirable PM according to the shortest path.
8. Update PM.
9. Sort it again according to the number of VM and PM.
Load Calculation for the Physical and Virtual Machine

Considering the factors like CPU, memory and bandwidth, we can calculate the load of physical and virtual machine. Each VM has its own CPU, bandwidth and memory. Load on VM is calculated by,

\[
VM\_cpu = \frac{\text{Total Requested MIPS}}{\text{Total MIPS of the PM}}
\]

\[
VM\_bw = \frac{\text{Bandwidth used by VM}}{\text{Bandwidth of host}}
\]

\[
VM\_ram = \frac{\text{ram used by VM}}{\text{Total ram of host}}
\]

Load on each VM depends on the utilization of VM, i.e., VM load is directly proportional to the cpu utilization.

\[
VM\_load = \frac{\text{Total Requested MIPS}}{\text{Total MIPS of the PM}}
\]

The total VM load calculated is used to find out the total load of the host. Consider n number of VM on a host A, then average load on that host A is calculated by

\[
PM\_load = \frac{\sum_{i=1}^{n} VL_i}{n}
\]

Lower and Upper Threshold Calculation

VM migration and threshold value are directly proportional i.e., if threshold value increased then chance for migration also increases. We take into consideration all the three factors cpu, bandwidth, and ram equal priority.

Virtual Machine Selection

Each host can have multiple VM’s. The thing is that which VM is selected for migration as it affects both the migration time and downtime. The time period which a user can’t make use of his/her VM is termed as downtime and the time period required to transfer then whole machine is referred to as total migration time. Total migration time and downtime increases with the size of the VM i.e., if the size of the VM is large then both downtime and total migration time increases and reverse-versa. So we choose the VM whose size is greater than or equal to the difference between the upper threshold and host utilization.

Algorithm

1. Start.
2. Find the available PM’s in the network.
3. Calculate and store the distance and route of each PM’s in the network for implementing Dijkstra’s algorithm.
4. Calculate the threshold value of each PM’s in the network.
5. Calculate the capacity of the VM.
6. Assign task to VM and check the load of PM with VM’s.
7. If the PM is overloaded with VM’s then the VM will be migrated to another PM using the shortest path cost from the source PM (Dijkstra’s algorithm).
8. Repeat step 5, until all PM’s are fully occupied with VM’s.
9. Stop.

Flow Chart

5. Conclusion and Future Work

Cloud environment help us to store large amount of data and can retrieve the same whenever we need to access from different location of the world with the help of internet. At present, load balancing is one among the challenges which we are facing today. As discussed previously, to overcome this situation, within a minimum time, we surmise with the idea of implementing the shortest distance algorithm for the better and fastest performance. By considering the factors like CPU, memory and bandwidth the load of the virtual and physical
machine has been calculated. Dijkstra’s algorithm is used to determine the shortest path between the physical machines. The down time is decreased by finding the nearest physical machine which contains comparatively less load than the host machine.

As the forward view, this theoretical framework will help in the implementation using the tool Cloud Analyst for the effective live migration of virtual machines.

References


