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Virtual Machine Migration Techniques in Cloud Computing Environment: A Review of Load Balancing Algorithms

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Abstract

Virtual machine migration is a core feature of virtualization that plays a vital role in cloud computing environment; migration must be without interruption to provide continuous services. Live migration moves the VM without disconnecting with the client. Current techniques face many challenges such as overloaded VM's. This research work is based on review of nine load balancing algorithms use in virtual machine migration in cloud computing environment and Modified Throttled Load Balancing Algorithm was found to be the best algorithm in virtual machine migration.

Keywords - Virtual machine migration, load balance and cloud computing.

1. INTRODUCTION

Cloud computing can be used to develop new applications and services, store, back up and retrieve data, host website and blogs, stream audio and video, pattern analysis and prediction of data.

Cloud computing is a major change in the conventional way that businesses think of it as a tool, some of the advantages of cloud computing is:

Cost: it eliminates the capital expenses of buying hardware and software and setting.

Speed: most cloud computing service are on demand so vast amount of computing resources can be delivered in munities.

Reliability: Cloud computing makes data backup, disaster recovery and business continuity easier and less expensive, since data can be mirrored at multiple redundant sites on the cloud provided network. In our paper we have the following objectives –

i. Review different types of algorithm used in implementation of load balancing in cloud computing.

ii. Types of virtual Machine load balancing Algorithm modeling in cloud.

2. LIVE VIRTUAL MACHINE

Live virtual machine (VM) migration is a technology that allows VMs to be transferred from one physical host to another while continuing to run, even after migration, without any loss of connection to the user. It demands to move all the state information of the VM being migrated (memory state, network state, and storage stat) from one physical server to another within the same data center or across remote data centers. Virtual Machine live migration is usually made in the data centers of the Cloud for the following purposes: load balancing, Power management, hardware maintenance and system up gradation. The aims

are to distribute load across the physical servers to improve scalability, reliability and availability of virtual machine.

3. LOAD BALANCING STRUCTURE

Load balancing is the process of redistributing the entire workload between cloud cluster computing nodes in order to make use of the resources and reduce response time. Live virtual machine migration is a technique for the balancing of dynamic load algorithms. Load balancing is taken into account as a vital part of managing income demand, Improve the efficiency of the cloud network, and rising energy costs. There are three key factors for load balancing, task resubmitting and job transfer to optimize the cloud cluster; heterogeneity of resources, dynamic nature of resource's performance and diversity of applications Load balancing in clouds is a process that ideally-balanced distribution of the excess dynamic local workload across all nodes. The key aim of load balancing is to maximize the application response time by managing workload according to resources. Efficient load balancing ensures uniform load distribution on nodes, enhances overall system efficiency, improved user satisfaction, quicker response, system reliability and reduced carbon emissions (Garima& Rama, 2015).

Load balancing is a process of distributing the workload dynamically and uniformly across all the available nodes in the cloud.

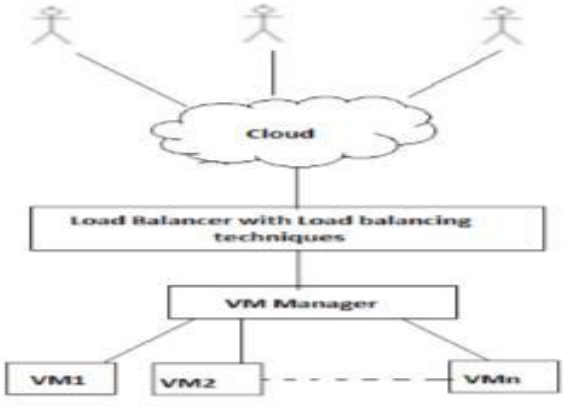

Fig.1 General Structure of Load balancing in Cloud Environment (Garima& Rama, 2015)

4. CLASSIFICATION OF LOAD BALANCING ALGORITHMS

Load balancing algorithms are many. Load balancing algorithms are classified into two types based on the system state (Ivanisenko& Radivilova,2015)

Static Algorithm: Static Algorithms are good for homogeneous and stable environment. **Dynamic Algorithm:** Dynamic Algorithms are good for heterogeneous environment.

- **STATIC ALGORITHMS**

Static algorithms are best used in homogeneous and stable environments. Static algorithms are not flexible and cannot consider dynamic changes to the attributes. Algorithms in this class are also noted as offline algorithms, in which the VMs information are required to be known in advance. Thus, static algorithms generally obtain better overall performance than dynamic algorithms. When assigning tasks to the nodes, static load balancing algorithms will not check the state and functionality of the node in previous tasks (Kanakala, Reddy &Karthik ,2015).

Some Static Algorithms are:

1. Round Robin Load Balancing Algorithm (RR)
2. Load Balancing Min-Min Algorithm (LB Min-Min)
3. Load Balancing Min-Max Algorithm (LB Min-Max)

1. Round Robin Load Balancing Algorithm: In this algorithm, fixed quantum time is given to the jobs. It allocates jobs to all nodes in a circular design. Processors are assigned in a circular order and hence there is no starvation (Sidra &Munam). This algorithm provides faster response in the case of equal workload distribution among processes. However, some nodes may be over loaded while others remain idle and under-utilized.

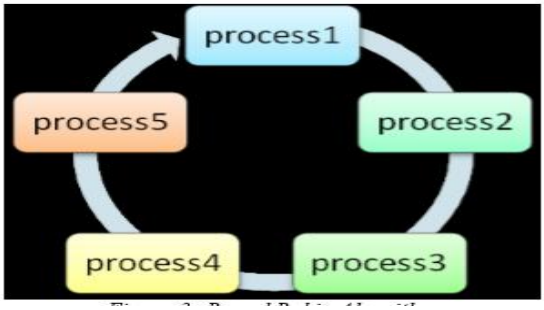

Fig. 2 Round Robin Load Balancing Algorithm (Durgesh&Anand ,2015)

2. MIN-MIN Load Balancing Algorithm: A list of task is maintained and minimum completion time is calculated for all the available nodes. A task with minimum completion time is assigned to the machine (Kanakala, Reddy &Karthik, 2015). It provides good results when small task is more (Sidra & Munam,2015).

3. MIN-MAX Load Balancing Algorithm: A list of task is maintained and minimum completion time is calculated for all the available nodes. A task with maximum completion time is assigned to the machine. Hence the name of the algorithm is min-max. Update the list and running time of the machine (Kanakala, Reddy &Karthik, 2015).

- **DYNAMIC ALGORITHMS**

Dynamic algorithms provide better results in heterogeneous and dynamic environments. These algorithms are more flexible. are also noted as online algorithms, in which VMs are dynamically allocated according to the loads at each time interval. The load information of VM is not obtained until it comes into the scheduling stage. Dynamic algorithms consider the dynamic changes of the attributes. However, these algorithms are more complex (Kanakala, Reddy &Karthik, 2015). Main advantage of this is that selection of task is based on current state and this will help to improve the performance of the system. Dynamic algorithms can be implemented in two ways. (Jaiswal& Sanjeev, 2015).

1. Distributed System: All the nodes interact with each other and load balancing algorithm is executed by all the nodes in the system. The task of load balancing is distributed among all the nodes involved. Interaction among nodes can be cooperative or non-cooperative (Jaiswal& Sanjeev,2015). If any node fails in the system, it will not stop the functionality. In cooperative distributed system, all node works together while in non-cooperative distributed system, each node works independently

2. Non-distributed System: Non-distributed system can be centralized or semi-distributed (Jaiswal& Sanjeev, 2015). In centralized system, central node is responsible for load balancing of the whole system while the other nodes interact with this central node. If the central node fails all the functionality stops. In the case of failure, recovery will not be easy (Shridhar&Mohana, 2013). In the semi-distributed system, nodes are grouped into cluster. A central node of each cluster performs load balancing for the whole system. If the central node of a particular cluster fails, it will stop the functionality of that cluster only (Jaiswal& Sanjeev, 2015).

Some dynamic algorithms are:

1. Honeybee Foraging Behavior Load Balancing Algorithm
2. Throttled Load Balancing Algorithm
3. ESCE (Equally Spread Current Execution) Load Balancing Algorithm
4. Ant Colony Load Balancing Algorithm
5 Biased Random Sampling Load Balancing Algorithm
6 Modified Throttled Load Balancing Algorithm

1. Honeybee Foraging Behavior Load Balancing Algorithm: This algorithm was derived from the behavior of real honey bees in finding their food sources. After finding the food sources, the honey bees come back to the bee hive to inform the food source. They do this by performing group movement. This group movement is also known as "waggle Dance". They perform waggle dance to inform other bees of the exact location of the food source. This waggle dance shows the quality, quantity of the food and the distance of the food source from the bee hive (Sidra &Munam, 2015).

2. Throttled Load Balancing Algorithm: The best suited algorithm for virtual machines is throttled load balancing algorithms. Load balancer manages the system's entire inventory of virtual machines. When a request is issued by load balancer it scans the indexing list. If there is a virtual machine available then that machine is assigned the job. After each resource allocation and de-allocation Load Balance updates the indexing table.

3. **ESCE (Equally Spread Current Execution) Load Balancing Algorithm:** The Load balancer maintains the list of the entire virtual machines and jobs in the system. When the load balancer receives a request, it scans the list of VM's. If a VM is found which can handle the client's request, the request is allocated to that particular VM. This algorithm distributes the load equally among all VM's (Surbhi&Chetna, 2015).

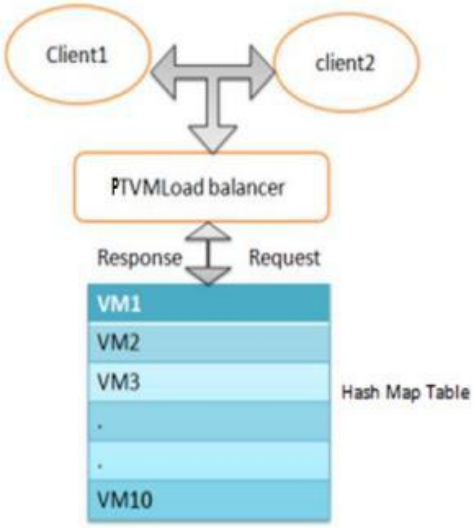

Fig. 3 Throttled Load Balancing Algorithm (Durgesh&Anand , 2015)

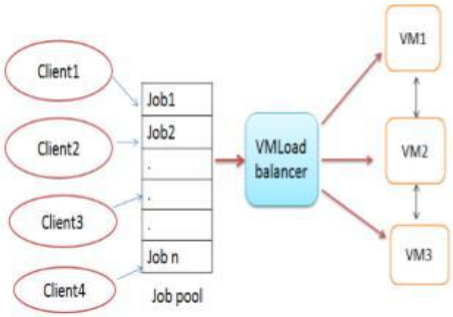

Fig. 4 ESCE (Equally Spread Current Execution) Load Balancing Algorithm (Durgesh& Anand,2015)

4. ANT COLONY Load Balancing Algorithm: Real ant selects a shortest path in search of its food. This algorithm is based on the behavior of real ants. When request is initiated ant starts its movement. Ant continuously checks whether the node is overloaded or under loaded. If ant finds any overloaded node, it turns back. And if ant finds any under loaded node, it proceeds. In this way behavior of ant is used to collect the information from different nodes (Kanakala, Reddy &Karthik, 2015).

5. Biased Random Sampling Load Balancing Algorithm: This algorithm balances the load through random sampling of the system domain. Virtual graph of the system is constructed. In a directed graph, each node is represented as a vertex and each in-degree represents free resources of each node. The load balancer allocates the job to the node which has at least one in-degree. The in-degree of the node is incremented and decremented when job is completed and when job is allocated respectively. This is done by the process of random sampling (Jaiswal& Sanjeev, 2015).

6. Modified Throttled Load Balancing Algorithm: This algorithm focus on how jobs are allocated to the available VM's intelligently. The algorithm maintains an index table of VM's and also the state of VMs (BUSY/AVAILABLE). The algorithm selects a VM at first index depending upon the state of the VM. Available VM is assigned to the request. If the VM is not available -1 is returned. If the new request arrives, the VM at the previous VM index + 1 is chosen depending on the state of VM. It is the best algorithm used in cloud computing. (Sidra &Munam, 2015).

5. DIFFERENCES BETEEN VARIOUS LOAD BALANCING ALGORITHMS

Table 1 shows the differences between various load balancing techniques.

6. CONCLUSION

Cloud computing allows wide range of users to access distributed, scalable, virtualized, hardware and software resources over the Internet. Load balancing is one of the most important issues of cloud computing. It is a mechanism which distributes workload evenly across all the nodes in the whole cloud. The goal of load balancing is to increase client satisfaction and maximize resource utilization and substantially increase the performance of the cloud system and minimizing the response time and reducing the number of job rejections. Various new algorithms can be proposed for the load balancer so that the load is evenly distributed to every node resulting in better response time and user satisfaction. We also conclude that modified Throttled VM load balancing algorithm is best among others.

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Algorithms	Disadvantages	Advantages
MIN-MIN Load Balancing Algorithm	o There is starvation. Smaller tasks will get executed first, while the larger tasks keep on waiting in the waiting stage. o Poor load balancing	o It works better for smaller task o It is a simple and fast algorithm.
Round Robin Load Balancing Algorithm	o Each node is fixed with a time slice. o It is not flexible and scalable.	o It uses Simple algorithm and emphasis on fairness. o It works in a circular form. o Fast response on equal workload distribution
MIN-MAX Load Balancing Algorithm	o Selects the tasks having the maximum completion time. o There is a starvation. Larger tasks will execute first, while the smaller tasks need to wait.	o It runs short tasks concurrently.
ANT COLONY Load Balancing Algorithm	o Network overhead o Delay in moving forward and backward	o Decentralized o Under loaded node is found at beginning of the search
Biased Random Sampling Load Balancing Algorithm	o Performance is reduced with an increase in diversity	o Suitable in large network
ESCE Load Balancing Algorithm	o Central point of failure o Not fault tolerant.	o Maintains equal load at all VMs o Maximize the throughput
Modified Throttled Load Balancing Algorithm	o Does not consider the current load on VM.	o Index table is parsed from the index next to already

		assigned VM. o Faster response than throttled algorithm.
Throttled Load Balancing Algorithm	o Scans the entire list of VMs from the beginning. o Does not consider the current load on VM.	o List of VMs is maintained along with the status of each VM o Good performance o Better resource utilization
Honeybee Foraging Behavior Load Balancing Algorithm	o Increase in resources will not increase the overall throughput	o Performance will be achieved by increasing the system size. o Suitable for heterogeneous environment.