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Framework for Provenance based Virtual Machine Placement in Cloud

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Abstract

Due to the high availability of resources in the Cloud Computing platform, there is a tremendous increase in the underutilization of these resources. Improving the throughput and effectively utilizing these resources are two main challenges in the cloud computing scenario. This paper proposes a methodology for improving the throughput and effective utilization of resources by appropriately placing the Virtual Machine in the server that would be more productive. The proposed solution is based on VM placement algorithm and an exclusive framework is designed for this algorithm. This algorithm refers to the history of data which is available in a global provenance database. By utilizing this provenance data, the system performance is improved.

Index Terms: Cloud computing, resource wastage, VM Placement, Provenance.

1. Introduction

Cloud Computing is a recently evolved computing terminology or metaphor based on utility and consumption of computing resources. Cloud computing is not a personal computer or an individual application server instead it is a distributed worldwide computation server. Most of the IT companies are using Cloud environment for their application development, deployment and to store their information. Who are cloud providers? Companies that have their own Data centers are known as Cloud Providers.

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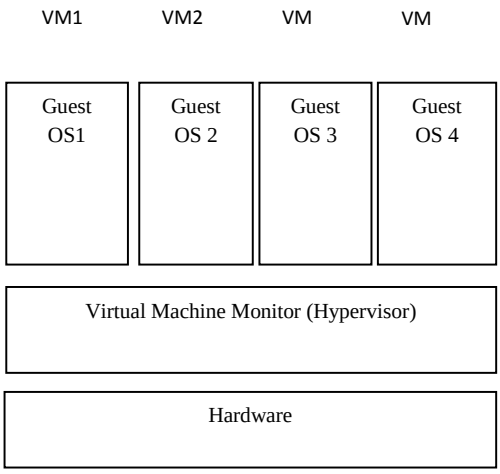

Fig.1. General Architecture for Cloud infrastructure

Cloud Providers offer services of cloud computing. According to several service models, these services are known as Delivery Models. Mostly used cloud delivery models are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This research paper will be based on IaaS delivery model. Infrastructure as a Service delivers the resources of cloud computing such as computing, storage and networking on demand. Due to its elastic nature, Cloud environment has numerous issues and challenges. The fundamental problem is the placement of Virtual Machine. By using virtualization concept, Physical Machine is logically divided into multiple parts using Virtual Machine monitor (VMM). These Parts are called as Virtual Machine. Virtual Machine is a self-contained operating system that behaves as a separate computer. Virtual machine plays a significant role in cloud infrastructure.

Cloud Computing has some imperative research issues related to Resource management, Performance, Data, Bandwidth and Security. This proposed graft focus primarily on Resource Management. Resource management itself has significant problems that need to be resolved. Resource allocation is one of the research challenges in source management. Solving problems related to VM placement, VM Consolidation and Load balancing will result in the solution for Resource allocation. This paper proposes the technique for solving the VM placement Problem. The Fig. 1 explains the general architecture of the Cloud infrastructure. To support IT industries for managing scientific resources and to save the energy and cost, mapping the Virtual Machine to Physical machine is required. Selecting a proper host and placing it in the correct Virtual Machine is Virtual Machine placement problem. For mapping Virtual Machine to Physical Machine, the suitable algorithm is required.

Solution for Virtual Machine Problem have been given in many paper by various authors [5][6][8][9][10]. Most of the papers enlightened the Virtual Machine placement problem as Bin-Packing Problem. There are some bin-packing algorithms such as First Fit Decreasing and Best Fit Decreasing and its variation are mostly used in literatures. Along with this, VM Placement problem is classified based on its data usages and VM's dependency. They are classified into three types namely 1. Prediction based that refers to the particular duration data. 2. Provenance based that refers the Full history of data. 3. Affinity aware VM Placement which is based on the dependency among the VM's. This paper, proposes the algorithm based on Provenance based VM Placement Algorithm and all the above revealed algorithms are used for provenance based VM Placement Problem. They are Heuristic Scheduling Algorithm, Provenance based VM Placement algorithm and VM Migration algorithm.

The remaining part of this paper is organized as follows: Section 2 describes the related work. Section 3 provides a description of the provenance based VM placement algorithms and its framework. Section 4 details the evaluation of the algorithm. Section 5 closes the paper with conclusions.

2. Related Work

The growing interest in Cloud Computing and emergence of the new architecture laid a path for more algorithms and techniques. A.Shanker et al[5] investigated the selection of most suitable host for the virtual machine for virtual machine placement. The goal is to save the power either by shut down of some servers or increasing the usage of available resources. The VM placement is broadly categorized into two placement approaches. They are Power Based approach and Application QOS based approach. Power based approach is classified into Migration (dynamic) and non-migration (static). The process of migration comes from the approaches like Constraint Programming, Bin Packing Approach, Ant Colony Optimization Algorithm and Genetic Algorithm. The VM placement is derived by two steps such as

- The first step is to synthesize infrastructures out of existing promising physical machines and it dynamically forms physical infrastructures, termed cohorts and host the user request.
- The second step is to determine the special characteristics of the most promising selected cohorts and final VM-to-PM mapping considering all low-level constraints arising from the particular user requests.

Generally, Virtual machine placement are of two types: they are Initial Virtual Machine Placement (Static) [6][9] and Dynamic virtual Machine Placement. Allocating the VM according to the number of user jobs to available physical resources is a big predicament. Virtual Machine that are freed or de-allocated because of their completion of tasks or if their lifetime has expired or if they are not completely used by previously allocated VMs are allocated for new requests. Below objectives are considered for performance improvement and evaluation. They are resource wastage, utilization ratio of resource, total completion time, reliability, power consumption and revenue acquisition. According to the number of objectives considered for performance evaluation, algorithm is classified into Single objective algorithm and Multi-objective algorithm.

The main objective is to minimize the total energy consumption and reduce resource wastage [6][9] by running of PMs, which indicates the resource utilization and reduce expenditure. According to the multiple dimensionalities of physical resources, there exists wastage of resources, which results in the use of multi-dimensional resources from the imbalanced condition. The characterization of the multi-dimensional resource usage states of PMs presented a multi-dimensional space partition model and also gave a virtual machine placement algorithm EAGLE, which can balance the multidimensional resources utility, decrease the number of running PMs, and thus lower the energy consumption.

Therefore, the proposed system focuses on the framework design of the provenance based VM placement algorithm, which gives the solution to the Virtual Machine allocation problem and also improve the throughput and resource wastage.

3. Provenance Based VM Placement

3.1 System Design

VM Placement is mapping of Virtual Machine to Physical machine. This can automatically happen based on on-demand requirements. In usual scenarios, whenever a request is made for a resource in a Cloud Computing Server, the server performs allocation based on FCFS scheme, i.e., the first detected space that is sufficient for the request, is allocated to the request irrespective of its size. This scheme generates a large amount of fragmentation, which means that, there exists a large amount of unused resource for each request. One way of overcoming such a drawback is to use Provenance based Virtual Machine Placement which keeps track of the amount of resource that has to be allocated for a particular request, based on historical data of the Virtual machine that is making the request. Therefore, under such Virtual Machine Placement scheme, whenever a request is made by a user or client to the Cloud Server for resources, allocation is performed based on the Virtual

machine's historical data and not on FCFS scheme but on the Virtual Machine space which is perfectly suitable for the request.

Provenance based Virtual Machine Placement in Cloud Computing provides Cloud Servers as an efficient way of allocating resources to a user or client request based on historical data. This historical data is unique to each client request and each data is formed as a result of gradual monitoring of data usage of the client such as amount of resource required, duration of usage of resource etc.

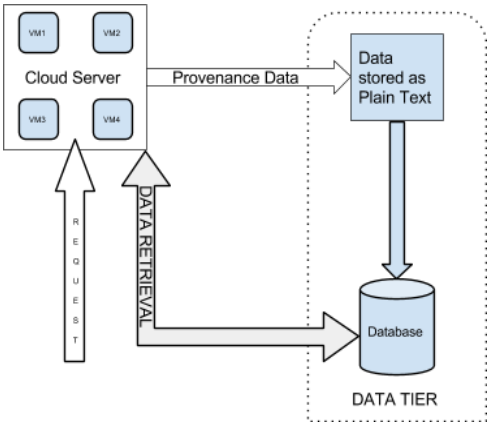

Fig.2. Provenance data collection

The main functionality that has to be performed under such a scheme is to maintain historical data of each Virtual Machine and retrieve the respective data as and when further requests are made. Historical data is generated by the Cloud Server by continuous monitoring of the Cloud environment. Whenever a request is made, the server must derive resource usage information such as time, load etc, and maintain a Data Tier which stores the derived data.

The data derived is in the form of Plain Text, these data must be converted into a Sequential Database format. The reason behind such a conversion is to facilitate easy and quick retrieval of desired information for the next session of requests through queries. Now the Cloud Server contains Virtual Machines that are ready to be allocated to client requests based on the Provenance Data shown in Fig.2. When the request is made, rather than allocating the first available virtual machine, the cloud server refers the information about the request and matches its requirements with the available provenance data and then allocates the most desirable virtual machine, thereby significantly reducing resource fragmentation. One of the main characteristics that require citation is that all these data retrieval processes occurs to and fro the data tier and the Cloud Server process the request dynamically in the back-end without the client side being acknowledged of such an occurrence.

3.2 Architecture Diagram

Provenance Virtual Machine placement algorithm uses initial resource allocation scheme and Virtual Machine migration algorithm while the client is utilizing the resource. For example, when the cloud controller or cloud broker receives the request, it has to find the virtual machine and place the request. But the virtual machine is oversized than the request. Cloud Broker then refers the global provenance database, request requires a less amount of resource than it has currently been allocated to, the server immediately detects the suitable virtual machine and migrate Virtual Machine to another Virtual machine that will suit the requirements. Such migration occurs without the knowledge of the customer side. This concept is known as dynamic reconfiguration. The Fig. 3 depicts the architectural diagram of Provenance based Virtual Machine Placement. The following are the building blocks of the architecture.

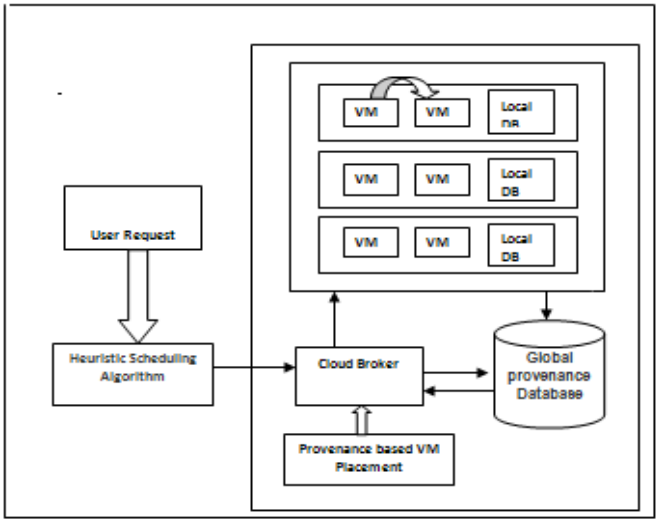

Fig.3. Architecture of Provenance based VM placement

Cloud User:

Cloud Users are the users of the Cloud Infrastructure for their application deployment or Business purposes.

Cloud Broker:

Cloud Broker is a third party who supports the cloud users for their business needs. It is an intermediary between users and available cloud services.

Data Center:

Data center is having the collection of physical server used to share the information.

Virtual Machine:

The Physical server is logically divided into multiple logical machines using the concept of virtualization. It shares the physical components such as OS, user interface, Memory, apps, etc., from the physical server.

Local Data Base:

It is a data base used to collect event log of the each physical server at particular period once. Then, that information will be transmitted to the global provenance database.

Global Provenance Database:

Global provenance database collects the log information of the local database. The log information is in unstructured format. It converts into structured format for easy access. This structured information will be analyzed frequently and the parameters supported for placing the Virtual Machine are calculated. For example, set the levels of usage of Virtual Machine for identifying frequently used Virtual Machine.

3.3 Algorithm

The following are the steps for the Provenance Virtual Machine Placement algorithm,

Provenance data collection:

1. Resource usage information such as time, load, etc., is collected from the Virtual Machines of cloud environment.
2. The information is in the form of unstructured and is converted into a Sequential Database format (Structured).
3. Then, it is stored in the local database of the server.
4. It is transferred to the global provenance database which is available in cloud data tier at the particular time period.
5. Frequently, these data are analyzed and set the frequently used attribute.

Provenance Virtual Machine Placement:

1. The user sends the request to the Cloud Controller/Cloud Broker.
2. Cloud Controller/Cloud Broker process the user request.
3. All the requests are arranged, that is deciding which request to be processed first by using heuristic scheduling algorithm.
4. Initially place the Virtual machine based on the size or beyond the size whichever is near requested by the user.
5. According to the provenance data, Cloud Controller/Cloud Broker refers the data from global provenance data base and selects the most suitable Virtual Machine.
6. Now, already placed request is reconfigured to the newly found most suitable Virtual Machine using best fit algorithm.
7. While reconfiguration takes place, VM Migration Algorithm migrates VM in the most suitable server for processing.

4. Performance Evaluation

For evaluating the Provenance based scheduling algorithm, the cloud infrastructure was utilized. These experiments have been carried using Cloud Simulator. The provenance based VM placement algorithm is simulated with 3 datacenters and 14 resource request. The parameter has to be set for Cloudlet, Virtual Machine and Data Center with some metrics.

The Parameter setting of the Cloudlet is based on the length of a task and the total number of task. Virtual Machine parameters are the total number of VMs, MIPS, VM memory, Bandwidth and number of PEs required. Data center parameters are number of Datacenter, number of host and VM scheduler. Table 1 shows the execution time of the VM Placement algorithm with parameters like Cloudlet Id, Execution time, Start time of the task, Finish time of the task execution. The execution time of the simulation work is shown in Fig. 4.

Table 1. Performance of the placement algorithm

Cloudlet ID	Execution time	Start Time	Finish Time
0	0.31	0.21	0.52
1	0.11	0.08	0.19
2	0.17	0.09	0.26
3	0.08	0	0.08
4	0.22	0.07	0.29
5	0.27	0.29	0.56
6	0.16	0.11	0.27
7	0.07	0.31	0.38
8	0.21	0	0.21
9	0.09	0.08	0.17
10	0.29	0.16	0.45
11	0.16	0	0.16
13	0.08	0	0.08

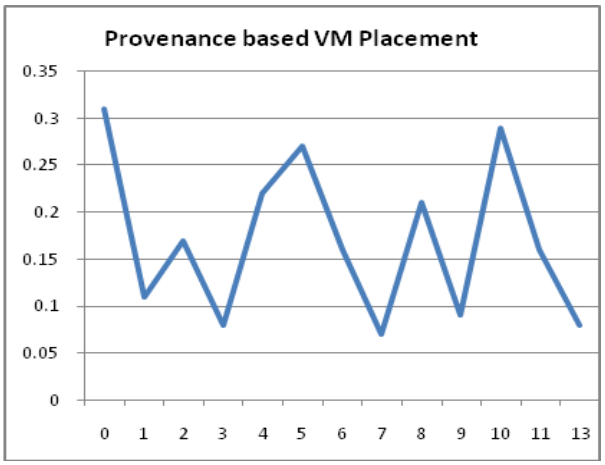

Fig.4. Execution time of the algorithm

5. Conclusion

Cloud computing is one of recent advancement in technology since it combines the advantages of both grid computing and ubiquitous computing. One of the major challenges in a cloud computing environment is the identification of the VM and placement of job. This paper aims at proposing a solution to this problem using the provenance data. A framework for provenance based VM placement algorithm has been proposed in this paper. The digital print the system leaves in the process of VM placement is utilized by the provenance algorithm in predicting the suitable VM. The placement of the VM is one of the key attribute in enhancing the performance of the system. The algorithm is aimed at optimizing the VM placement to improve the system performance. The proposed framework explains the methodology used to collect the provenance data and using the data in effectively placing the virtual machine. The results are verified in a simulated environment using CloudSim. In future, this work can be extended by applying optimization algorithm in this framework and test the performance of the system.

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