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A Review on VM Placement Strategies

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Abstract*— Cloud Computing Data-centers host voluminous virtual machines (VMs) on world situations. during this context, Virtual Machine Placement (VMP) is one in every of the foremost difficult issues in cloud infrastructure management, considering conjointly the massive variety of potential improvement criteria and totally different formulations that would be studied. In cloud computing, there are several ways used for virtual machine (VM) placement. Objectives for VM placement are to cut back the amount of physical machines needed, VM allocation time and to cut back resource and power wastage. This paper surveys numerous VM placement algorithms for reducing the specified variety of physical machines or for economical usage of resource consumption and power consumption.*

Keywords: Cloud, VM, Host, VM Placement Schemes

I. INTRODUCTION

With the development of high speed networks, there is an alarming rise in its usage comprised of Web queries a day and thousands of e-commerce transactions. A large scale data centers handle this ever increasing demand by consolidating hundreds and thousands of servers with other infrastructure such as cooling, network systems and storage. The development of this commercialization is named as cloud computing. Clouds are sky rocketing virtualized data centers and applications offered as services on a subscription basis. The characteristics exhibited by Clouds are shown in Fig 1

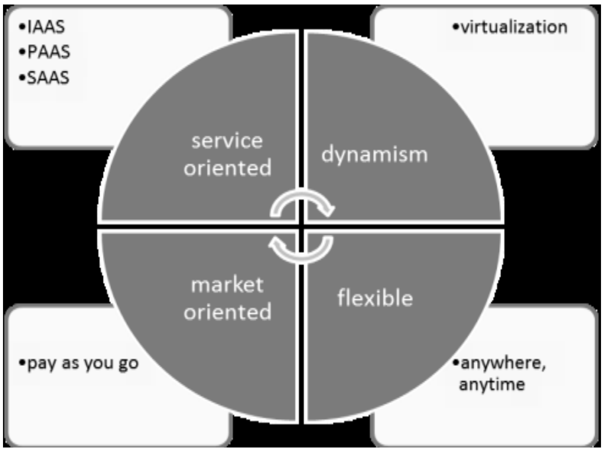

Fig 1: Characteristics of cloud computing

Cloud delivers three type of services such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [2] and can be deployed in three different ways *i.e.* private, public and protected. SaaS mainly deliver the online software application to the client, whereas PaaS gives the capability to create application services as on their desire. It allows users to develop their software using programming languages and tools supported by the provider. Infrastructure as a Service (IaaS) provides the capability to have control over complete cloud infrastructure with CPU processing, storage, networks, and other computing resources.

Cloud is a business model, which provides the on demand computing resources as a service to the clients on the rent basis. Client need to pay only for that amount that is actually used. To generating high revenue, cloud provider use virtualization technology. Virtualization [5-6] is the key technology in cloud computing, which divide the physical resources and allow the sharing of these resources. With the help of virtualization number of user can share the same resources without intervening to each other. Hypervisor is a small process also known as virtual machine monitor (VMM) is used to deploy the virtualization. It behaves like an operating system and responsible for taking all the decision related to the VM. When the user demand for the computer resources (CPU, storages, network), hypervisor create the VM and assign to the user. Number of VM can be created in the single physical machine (PM). In cloud each data center keep number of host. When a request for the VM comes to the hypervisor, where this VM is to be placed is known as VM placement problem. VM placement is a NP hard problem [8]. Therefore finding a suitable host for placing VM is a very challenging task. VM placement are required in two different situation either for placing new VM or to place a migrated

VM. Transferring the VM from one host to another host is called VM migration [8]. VM migration is needed to deal with several situations such as server consolidation, load balancing, maintenances, server failure, hot spot mitigation etc. Migrations degrade the system performance, so number of migration should be minimized as possible. VM is the main processing unit in the cloud. User's applications run on the VM and the resource requirement of these applications changes dynamically. Resources in the cloud are multidimensional (CPU, memory, bandwidth etc.). So resource required by the VM may be different in their amount and types.

II. VM PLACEMENT MODEL

In cloud environment each data center can have N heterogeneous physical nodes. Each physical node is characterized by the CPU performance measure in MIPS, RAM size and network bandwidth. Local and global manager are used to place VM. Global manager which is also known as virtual machine manager reside on the master node and collect information from the local manager for the high availability. If local manager fail then all required information can be obtained from the global manager. It divides all available host of the data center into the six clusters according to the remaining capacity of the resources. When global manager receive resource request from the user it send it to the appropriate cluster according to the resource requirement of the VM. Each cluster has its own local manager, which continuously received information from all available hosts in the data center. Based on this information local manager decide where the selected VM is placed. Load balancing and consolidation policy are resided on the local manager. If local manager fail then global manager select lightest host in the cluster, migrate all VM from that host and make it local manager for that cluster.

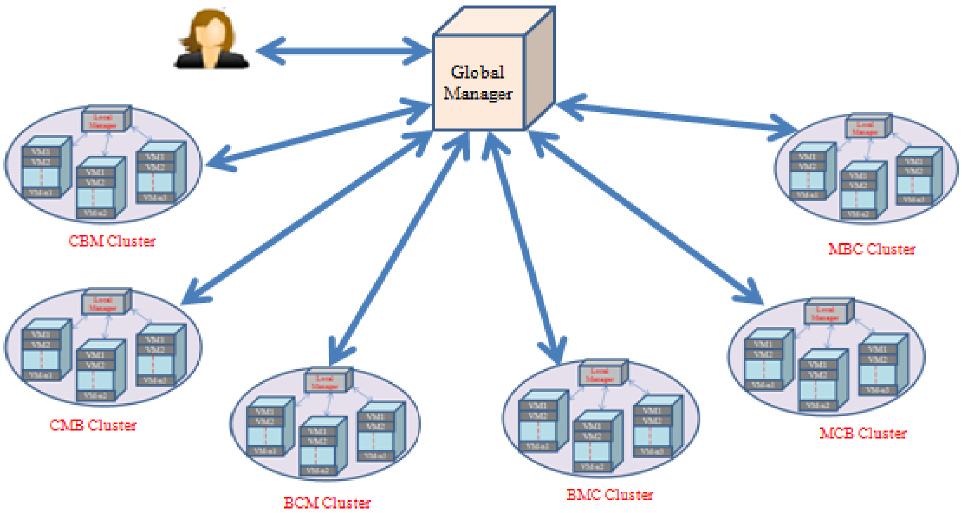

Fig 2: VM Placement Model

III. CLASSIFICATION OF VM PLACEMENT ALGORITHMS

Goal of the VM placement can either saving energy by shutting down some severs or it can be maximizing the resources utilization. Based on these goal placement algorithm are classified into two type.

I. Power Based approach
II. Application QoS based approach

Main aim of the power based approach is to save the energy. In these approach VM map to the physical machines in such a `way, that each servers can utilized their maximum efficiency and the other servers can be shut down depending on load conditions. While in the Application QoS based approach a VM map to the PM with the aim of maximizing the QoS delivered by the service provider.

IV. SMART PLACEMENT APPROACH

SPA is an approach that takes into account the availability of the whole network resource, while guaranteeing load-balancing and SLAs objectives. To achieve this, migrating Virtual DataCenter Networks (VDNs) should clearly specify its detailed resource requirements (i.e. the resource vector) to the hosting physical network. This can provide for optimal placements and satisfying services. In this context, requirements may vary from a virtual network to another, depending on the considered topologies and the provided services. However, among all the network components, the challenge for the hosting CDNs (i.e. the physical ones) mainly lies in the switching capabilities of its network, more precisely, its path processing capacities. Indeed, where for a packet to get processed through a switching device, certain resources are required. In this context, let us define the physical switch as a set of virtual switches, where each virtual switch operates a set of virtual switching paths. Mainly, a virtual switching path to operate requires a set of: (1) packet processing resources (network processor cycles, search caches, memories); (2) ports; (3) bandwidth over the ports. Typically, for a packet processing task to operate, this requires: (1) processors (for parsing and analysis); (2) memories (for the lookup tables) that can be either internal or external (e.g. TCAMs, SRAMs); (3) queues (for packets' scheduling and storage, and for the process of shaping priorities); (4) bandwidth over the busses that interconnect the aforementioned internal components. Accordingly, such physical resources will be virtually partitioned among the different virtual data paths that are allocated (reserved) to satisfy the requirements of the VDNs topologies. Hence, for efficient allocations and optimal placement decisions, such resource vectors need to be clear in order to check for resource availability at the hosting physical network.

Therefore, to simplify the presentation, the resource requirements of the migrating networks (i.e. the VDNs) will be represented by the virtual data path capacity. At the hosting side (i.e. the hosting CDNs topology), this will be translated to path processing resources, being a parameter for the placement process. Thus, having the resource victor of the migrating VDN, the hosting network administrator can break this down to: (1) ports; (2) processing engine capabilities; (3) memories; (4) internal bandwidth; all constrained by certain speed/delay limits for QoS assurance. Besides, the administrator need to specify the external bandwidth requirements (bandwidth over the links that interconnects the different switching devices), this could be defined by the Network Interface Cards (NICs) capacities.

V. LITERATURE SURVEY

VM placement problem is a non deterministic problem. Number of virtual machine placement algorithms have been studied in [4] that run under cloud computing environment. This section explains some of the exiting virtual machine placement approaches and their anomalies.

First Fit: It is a greedy approach. In this approach scheduler visits the PM sequentially one by one and placed VM to first PM that has enough resources. Each time when the new VM arrived, scheduler starts searching the PM sequentially in the data center till it finds the first PM that has enough resources. If none of the physical machine satisfied the resource requirement of the VM, then new PM is activated and assigns VM to the newly activated PM. Main problem with this approach is that load on the system can imbalanced.

Single Dimensional Best Fit: This methods use the single dimension (CPU, memory, bandwidth etc.) for placing a VM. When VM arrived, scheduler visit the Physical Machines in the decreasing order of their capacity used in a single dimension and place the VM to the first PM that has the enough resources. That means VM place to the PM which used the maximum capacity along with the given dimension. Problem with approach is that it can increase the resource imbalancing because resource in the cloud is multi-dimension (CPU, memory, bandwidth etc.). So there may be a situation where a host utilize their full CPU capacity while other resources such as memory and bandwidth are underutilized.

Volume Based Best Fit: This heuristic used the volume of the VM for placing a VM. This approach visits the Physical Machines in a decreasing order of their volume and place VM to the first PM that has the enough resources. That means Physical Machine which has the maximum volume will be considered first.

Dot Product Based Fit: In this heuristic resource requirement of virtual machine and the total capacity of the physical machine along the specified dimensions are expressed as vectors. Dot product of these two vectors is calculated and then PMs are arranged into the decreasing order of their dot product. For the proper utilization of the resources it is necessary that the virtual machine which required more CPU and less memory should be placed on the physical machine which has low CPU and more memory utilization. This method seems good, but it can choose the wrong PM, because they the not using the length of virtual machine and the remaining capacity of the physical machine.

Constraint based approach: Constraint based approaches are use in the combinatorial search problems [5]. In these approach some constraint are apply and these constraint must be fulfil during VM placement. These constraints are

Capacity Constraints: For all dimension (CPU, memory and bandwidth) of a given physical machine, sum of the resource utilize by all VMs running in that host should be less than or equal to the total available capacity of that physical machine.

Placement Constraints: All virtual machines must be placed on to the available host. SLA constraint: VM should be placed to the PM where it fulfils the SLA.

Quality of services (QoS) constraint: Some quality of services constraint such as throughput, availability etc. must be considered during the VM placement.

Constraint Programming is useful where the input data is already known. That means we know the demands of the VMs, before calculating the cost function.

Bin packing problem: Bin packing problem [6] is a NP hard problem. If PM and the VM are consider as a three dimension object, then VM placement problem is similar to the bin packing problem where item represent the VM and container represent the PM. In the bin packing problem number of item (VM) are placed inside a large container (PM). The aim is to places a number of items into a single container as possible. So that the number of container required to packing the item is minimized. Bin packing problem is different from the VM placement problem. In the bin packing problem bins can be placed side by side or one on top of the other. But in the case of VM placement, placing VMs side by side or one on top of the other is not a valid operation. This is because the resource cannot be reused by any other VM, once a resource is utilized by a VM.

Stochastic Integer Programming: Stochastic Integer Programming is used to optimize the problems, which involve some unknown data. VM placement problem can be consider as a Stochastic Integer Programming because resource demand of the VM are known or it can be estimated and the objective is to find the suitable host which consume less energy and minimize the resources wastages.

Stochastic Integer Programming can be use where the future demands of the resources are not known, but their probability distributions are known or it can be calculated.

Genetic Algorithm: Genetic algorithm is a global search heuristics. It is useful where objective functions changed dynamically. This approach is inspired by the evolutionary biology such as inheritance. Genetic Algorithm can be use to solve the bin packing problem with some constraints. It is useful for the static VM placements, where the resource demands do not vary during a predefine period of time.

Ahmad Nahar Quttoum et al. [1] 2015 presented a Smart Placement Approach (SPA) that provides for smart placement maps of VDNs over CDNs. In this, author pointed out that choosing the placement maps for such VDNs should satisfy its requirements while: maintaining load-balancing over the hosting CDNs, guaranteeing its Quality of Service (QoS) levels, and assuring low placement costs. The VDNs are usually hosted over physical networks; overlaying its resources to gain the dynamic required services. Cloud-service Datacenter Networks (CDNs) can provide such a service under a delivery model that is called Infrastructure as a Service (IaaS).

CHONGLIN GU et al. [2] 2015 proposed a tree regression-based method to accurately measure the power consumption of VMs on the same host. The merits of this method are that the tree structure will split the data set into partitions, and each is an easy-modeling subset. Cloud computing is developing so fast that more and more data centers have been built every year. This naturally leads to high-power consumption. Virtual machine (VM) consolidation is the most popular solution based on resource utilization. In fact, much more power can be saved if we know the power consumption of each VM. Therefore, it is significant to measure the power consumption of each VM for green cloud data centers. Since there is no device that can directly measure the power consumption of each VM, modeling methods have been proposed. However, current models are not accurate enough when multi-VMs are competing for resources on the same server. One of the main reasons is that the resource features for modeling are correlated with each other, such as CPU and cache.

Zhaoning Zhang et al. [3] 2014 defined that Infrastructure as a service (IaaS) allows users to rent resources from the Cloud to meet their various computing requirements. The pay-as-you-use model, however, poses a nontrivial technical challenge to the IaaS cloud service providers: how to fast provision a large number of virtual machines (VMs) to meet users' dynamic computing requests? We address this challenge with VMThunder, a new VM provisioning tool, which downloads data blockson demand during the VM booting process and speeds up VM image streaming by strategically integrating peer-to-peer (P2P) streaming techniques with enhanced optimization schemes such as transfer on demand, cache on read, snapshot on local, and relay on cache. In particular, VMThunder stores the original images in a share storage and in the meantime it adopts a tree-based P2P streaming scheme so that common image blocks are cached and reused across the nodes in the cluster.

Jiaxin Li et al. [4] 2015 proposed a Layered Progressive resource allocation algorithm for multi-tenant cloud data centers based on the Multiple Knapsack Problem (LP-MKP). The LP-MKP algorithm uses a multi-stage layered progressive method for multi-tenant VM allocation and efficiently handles unprocessed tenants at each stage. This reduces resource fragmentation in cloud data centers, decreases the differences in the QoS among tenants, and improves tenants' overall QoS in cloud data centers.

Gursharan Singh et al. [5] 2015 proposed a technique that reduces the size of data image stored on source host before migration. When a Virtual Machine migrates to another host, the data image for that VM is kept in the source host after removing unwanted data according to the probability factor. When the VM migrates back to the original host later, the kept memory image will be "reused", i.e. data which are identical to the kept data will not be transferred and comparative to existing system the size of memory image is small. To validate this approach, results evaluated using different threshold levels and probability factor of change in data. Proposed system required less memory to store the memory image and allow more VMs to be hosted.

Narander Kumar et al. [6] 2015 focused on quantitative analysis of live migration within a cloud data centre with the aim of understanding the factors which are responsible for cloud's efficiency. Various key parameters, such as, virtual machine size, network bandwidth available and dirty rate of a cloud application are discussed in detail and given the comparisons also, to give a clear view of their role in live migration's performance. The analysis presented in this paper gives a proper platform for considering future enhancements and/or modifications in the existing migration technology.

Aarti Singh et al. [7] 2015 proposed an Autonomous Agent Based Load Balancing Algorithm (A2LB) which provides dynamic load balancing for cloud environment. Cloud Computing revolves around internet based acquisition and release of resources from a data center. Being internet based dynamic computing; cloud computing also may suffer from overloading of requests. Load balancing is an important aspect which concerns with distribution of resources in such a manner that no overloading occurs at any machine and resources are optimally utilized. However this aspect of cloud computing has not been paid much attention yet. Although load balancing is being considered as an important aspect for other allied internet based computing environments such as distributed computing, parallel computing etc. Many algorithms had been proposed for finding the solution of load balancing problem in these fields. But very few algorithms are proposed for cloud computing environment. Since cloud computing is significantly different from these other types of environments, separate load balancing algorithm need to be proposed to cater its requirements.

S. Sohrabi et al. [8] 2015 introduced two new virtual machine selection policies, Median Migration Time and Maximum Utilisation, and show that they outperform existing approaches on the criteria of minimising energy consumption, service level agreement violations and the number of migrations when combined with different hotspot detection mechanisms. Applications are first assigned to virtual machines which are subsequently placed on the most appropriate server host. If a server becomes overloaded, some of its virtual machines are reassigned. This process requires a hotspot detection mechanism in combination with techniques that select the virtual machine(s) to migrate.

Mohammad Mehedi Hassan et al. [9] 2015 proposed a cost effective and dynamic VM allocation model based on Nash bargaining solution. With various simulations it is shown that the proposed mechanism can reduce the overall cost of running servers while at the same time guarantee QoS demand and maximize resource utilization in various dimensions of server resources.

Christina Terese Josepha et al. [10] 2015 proposed a novel technique to allocate virtual machines using the Family Gene approach. Experimental analysis proves that the proposed approach reduces energy consumption and the rate of migrations, The concept of virtualization forms the heart of systems like the Cloud and Grid. Efficiency of systems that employ virtualization greatly depends on the efficiency of the technique used to allocate the virtual machines to suitable hosts. The literature contains many evolutionary approaches to solve the virtual machine allocation problem, a broad category of which employ Genetic Algorithm.

Antony Thomas et al. [11] 2014 introduced an improved scheduling algorithm after analyzing the traditional algorithms which are based on user priority and task length. High prioritized tasks are not given any special importance when they arrive. Min-Min algorithm is used to reduce the make span of tasks by considering the task length. Keeping this in mind, cloud providers should achieve user satisfaction. Thus research favours scheduling algorithms that consider both user satisfaction and resources availability.

Doshi Chintan Ketankumar et al. [12] 2015 proposed a green cloud broker for resource procurement problem by considering the metrics of energy efficiency and environmental friendly operations of the cloud service provider. Author used mechanism design methods to decide the allocation and payment for the submitted job dynamically and performed experiments and show the results of comparisons of energy consumption and emission of greenhouse gases between the allocation decided by the proposed green cloud broker and a without taking the green metric into consideration.

A. I. Awad et al. [13] proposed mathematical model using Load Balancing Mutation (balancing) a particle swarm optimization (LBMPSO) based schedule and allocation for cloud computing that takes into account reliability, execution time, transmission time, make span, round trip time, transmission cost and load balancing between tasks and virtual machine .LBMPSO can play a role in achieving reliability of cloud computing environment by considering the resources available and reschedule task that failure to allocate. Our approach LBMPSO compared with standard PSO, random algorithm and Longest Cloudlet to Fastest Processor (LCFP) algorithm to show that LBMPSO can save in make span, execution time, round trip time, transmission cost.

Arunkumar. G et al. [14] 2015 outlined the existing cloud technologies, interoperability issues and possible solution to overcome the problems. Most of the consumers are analyzing the appropriateness of cloud to employ themselves for their enterprise or personalized operations. Customers are self satisfied at the inception, but expectation changes. Based on their business escalation it needs further adoption of modern cloud services the existing cloud provider fails to offer. Hence the user needs interoperability and portability to ship their assets from one cloud to other cloud. The complication faced by the customers in shifting their assets remains as a challenge to be addressed.

Atul Vikas Lakra et al. [15] 2015 proposed a multi-objective task scheduling algorithm for mapping tasks to a Vms in order to improve the throughput of the datacenter and reduce the cost without violating the SLA (Service Level Agreement) for an application in cloud SaaS environment. The proposed algorithm provides an optimal scheduling method. Most of the algorithms schedule tasks based on single criteria (i.e execution time). But in cloud environment it is required to consider various criteria like execution time, cost, bandwidth of user etc.

Narander Kumar et al. [16] 2015 proposes a demand-based preferential resource allocation technique that designs a market-driven auction mechanism to identify users for resource allocation based on their payment capacities and implements a payment strategy based on a buyer's service preferences. A comparison is drawn between the proposed allocation technique and the famous off-line VCG auction mechanism and results show a performance benefit in revenues to service provider, payments of cloud users besides ensuring an optimum resources use.

Nidhi Bansal et al. [17] 2015 developed a method to calculate cost of QoS-driven task scheduling algorithm and compare with traditional task scheduling algorithm in cloud computing environment. It also defined many parameters that are to be considered in QoS driven like makespan, latency and load balancing. But allocation cost parameter is not considered in QoS-driven scheduling algorithm. Minimizing the total allocation cost is an important issue in cloud computing.

Mehmet Sahinoglua et al. [18] 2015 addressed a discrete event CLOUD simulator, namely CLOURAM (CLOUD Risk Assessor and Manager) to estimate the risk indices in large CLOUD computing environments, comparing favorably with the intractably theoretical Markov solutions or hand calculations that are limited in scope. The goal is to optimize the quality of a CLOUD operation and what countermeasures to take to minimize threats to the service quality by reserve planning of reserve crew members.

Mohammad Mehedi Hassan et al. [19] 2015 proposed an automatic method, based on Multi-Objective Particle Swarm Optimization, for the identification of power models of enterprise servers in Cloud data centers. The average consumption of a single data center is equivalent to the energy consumption of 25.000 households. Modeling the power consumption for these infrastructures is crucial to anticipate the effects of aggressive optimization policies, but accurate and fast power modeling is a complex challenge for high-end servers not yet satisfied by analytical approaches.

VI. CONCLUSION

Efficient placement of the VM can improved the overall performance of the system. Virtual machine placement is a technique which maps the VM to the appropriate PM. Since the size of the data center is large in the cloud computing environment, so selecting a proper host for placing the VM is a very challenging task during the virtual machine migration. In this paper number of VM placement approach are explained with their anomalies. Each placement algorithm performs well under some specific conditions. So it is a critical task to choose a technique that is suitable for both the cloud user and cloud provider.

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