Effective Virtual Machine Configuration for Cloud Environment

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Abstract **Cloud computing is most widely increasing platform for task execution. On the other hands, virtual machine configuration plays as a critical role in the cloud computing performance. It is responsible to select the best suitable configuration for task execution by taking into consideration some static and dynamic factors of tasks. The aim of this paper is to study the effective of homogeneity and heterogeneity of the virtual machine configuration for assigning the tasks and satisfying the optimum time and cost. Our study has been evaluated over CloudSim toolkit under VM scheduling policies on virtual machine configuration.**

Keywords: Cloud Computing, Cost, Virtual Machine Configuration, CloudSim, Cloudlet.

I. INTRODUCTION

Cloud computing allows users to use computational resources and services of data centers (i.e., machines, network, storage, operating systems, application development environments, application programs) over the network to deploy and develop their applications [1]. The main feature of cloud computing is providing self-service provisioning, which allows the users to deploy their own sets of computing resources [2].

Cloud computing relies on virtualization to partition and multiplex physical machine infrastructure [3]. The virtual machine configuration controls the sharing of physical resources allocated to virtual machines (VMs). The problem of optimizing the performance of the virtualized applications (i.e., the applications that run on VMs) is considered to be critical to the success of cloud computing, and the VM configuration affects application performance [2, 4].

Although, the main goals of a cloud provider are reducing the cost, maximizing the profit, and utilizing the resources, the cloud provider faces challenge for achieving users' demands. So, the VM configuration mechanisms to virtualize cloud environments play an important role to reduce the difficulty of this challenge.

In addition, the cloud providers face a challenge of resource allocation to meet the users' **Q**uality **o**f **S**ervice (QoS) constraints according to the **S**ervice **L**evel **A**greements (SLAs) to serve different users' workloads requirements. Furthermore, the providers have to solve all these challenges using the available resources for maximizing their total profit by maximizing their resource utilization [5, 6]. For all that, the optimal VM configuration for the shared resource in the cloud infrastructure is considered a complicated task.

In this paper, a study has been to evaluate the effects of homogeneous and heterogeneous VM configuration on the cloud performance with respect to some factors such as VM specification, VM price ($/h), number of cloudlets, user preferences (e.g., time, cost, budget). Through this work, VM configuration and VM capacity are used interchangeability.

The rest of this paper is organized as follows; related work is presented in Section II. Section III discusses and studies different virtual machine configuration. Section IV describes the key idea of virtual machine configuration estimator. An experimental evaluation is presented in Section V. Finally, conclusions and future work are presented in Section VI.

II. RELATED WORK

Lot of research addressed the cost-effective in cloud environment. Gaurav Raj *et al.* [7] has proposed an effective communication framework between the broker and the virtual machine for assigning the task and fetched the results in optimum time and cost. Some authors have addressed other technical aspects such as the impact of network latency, bandwidth constraints, data confidentiality and security, as well as, economic aspects such as sunk costs and price uncertainty to minimize the cost of running a partition of the total workload in the cloud environment [8].

Moreover, the scheduling strategies are studied which consider the use of resources from the "Cloud", to understand how these strategies achieve a balance between the performance and the usage cost, and how much they improve the requests' response times [9]. Also, the process of scheduling some intensive data or computing an intensive application in the cloud needs to optimize the processing time [10]. According to the work in [10], a model for the task scheduling has been formulated to minimize the cost of the cloud applications.

The work of this paper focuses on the studying the effect of homogeneous and heterogeneous of virtual machine configuration for assigning the tasks in the cloud environment.

III. STUDY OF DIFFERENT VIRTUAL MACHINE CONFIGURATION

The aim of this work is to study the effects of variation of VMs configuration on the cloud performance with respect to the cost and time. The cloud application requirements, as well as, VMs configuration would effect on the cloud performance. A cloud simulator (i.e., CloudSim) will be used to study and investigate the effect of the VMs configuration on the cloud performance.

CloudSim is an extensible simulation framework enables smooth modeling of cloud, run simulations, and experiment with ease to analyze the cloud computing infrastructures and application services. The CloudSim helps the software developers and industry-based developers to focus on the design issues of the specific system under investigation without getting caught up in low level Cloud-based infrastructures and services [11].

On the other hands, Cloud Coordinator is one of the main components in the CloudSim toolkit. It is instantiated by each cloud in the system whose responsibility is to discover the cloud services, keep track of load on the cloud resources and monitor the application execution. Furthermore cloud coordinator is responsible for communicating with other data centers and end-users in the simulation environment [12]. Cloud Coordinator divides the requests (jobs) into equal sized cloudlets (tasks). Then, it maps cloudlets to VMs on implemented host in datacenter. Due to the default policy, the time consuming costs insensitive and inefficient. So, an appropriate VMs capacity is needed to achieve set of goals such as minimizing cost and time.

Studying the effect of VMs capacity variation in the cloud performance involves many factors (e.g., VM specification, VM price ($/h), number of cloudlets, user preferences, etc…). So, we need to balance between these factors and to find the most suitable VMs configuration in terms of reducing the cost and execution time. According this work, some of factors has been studied such as VM specification, VM price ($/h), number of cloudlets, user preferences (e.g., time, cost, budget).

Figure 1 illustrates the steps of the proposed VMs configuration estimator to decide the best VMs configuration according to the set of specific factors. Initially, the possible VMs configurations are generated using variation of the VM parameters like RAM and number of processors. Then, these VMs configurations are estimated according to the VM specification, VM price, the number of cloudlets and cloudlets lengths. A decision will be considered according to the user preferences in terms of cost and time. Once the best configuration is chosen, the cloudlets are scheduled to VMs. The VMs configuration estimator will be explained in details in the next section.

IV. VIRTUAL MACHINE CONFIGURATION ESTIMATOR

This section describes the VM configuration estimator as depicted in Figure 1 (i.e. estimate the cost of the reserved VMs). The VMs configuration is considered as an important issue in the cloud performance. Also, it effects the cloud resource utilization directly. Therefore, the cloud providers always prefer to ensure that the resources are utilized efficiently within their best capacity. We demonstrate how to estimate the cost of VMs configurations in the next subsections.

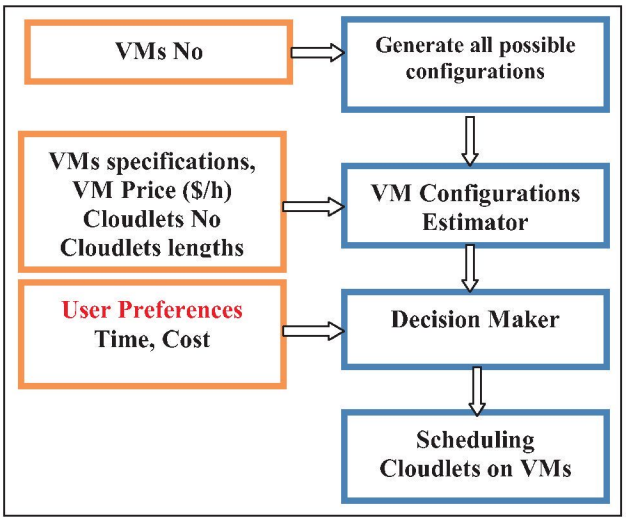

Fig. 1. The workflow for choosing VMs configurations

A. *Time per VM_i*

Again here, the request is divided into a number of cloudlets which will be scheduled in the VMs. So, we need to calculate the number of cloudlets per each VM using Eqn 1. We assume that the reminder cloudlets will be given to the last VM.

$$CloudletsperVM_i = \frac{No.Cloudlets}{No.VMs} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

The needed time for each cloudlet is calculated using the MIPS (expressed in millions of instructions per second) of the processor for the assigned VM. This time is determined according to Eqn.2 [12].

$$TimeperCloudlet = \frac{Cloudlet-length}{MIPS(VM_i)} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

After calculating the number of cloudlets and their execution time for each VM, the needed time for each VM to execute all the assigned cloudlets will be calculated according to Eqn. 3.

$$TimeperVM_i = \frac{TimeperCloudlet * CloudletsperVM_i}{No.CPUs} \quad (3)$$

B. *Cost per VM_i*

Secondly, the cost can be estimated based on the time and price according to Eqn 4. Since the time is expressed in seconds (i.e., using MIPS), so we need to convert it into hours to calculate the cost using price ($/h). Generally, the fraction of minutes will be considered as a new hour.

$$CostperVM_i = Price(VM_i) * TimeperVM_i(Hours) \ldots (4)$$

C. *Time per Configuration*

Because the user request might be served using more than one VM, the finished time equals the execution time of the last cloudlets. So, the time of configuring (i.e., finished time of reserved VMs) is calculated using Eqn. 5.

$$TimeperConfiguration = Max(TimeperVM_1, TimeperVM_2, \ldots, TimeperVM_n) \quad (5)$$

D. *Cost per Configuration*

The total cost of VMs configuration is the overall of estimated cost of each VM. It is calculated as follows:

$$CostperConfiguration = \sum_{i=1}^{No.VMs} CostperVM_i \ldots (6)$$

V. EXPERIMENTS & EVALUA ATTION

The CloudSim toolkit is used to simulate the cloud resources and the communication environment. The CloudSim simulator is used to verify the variation of VM capacity using homogeneous and heterogeneous VM specification.

According to this work, the CloudSim is used to simulate various scenarios to study the performance of the cloud computing. We investigate and analysis the performance of the cloud under different virtual machine capacity by using different VM configuration in terms of the number of processors. The internal memory (i.e., RAM) has been constrained 512 Mb and the number of CPUs are varied from one to twenty. The internal MIPS and the bandwidth are maintained constant at 1000 for each. Cloudlets number is varied from 25 to 150 where 1000,000 is consider the length of each one. One Datacenters is established and three VMs are created. Ten different VMs configurations are generated for these three VMs.

Amazon's EC2 instance type configurations and their prices are used in this work. These instances are classified into two use cases as shown in Table I and Table II.

Table I. Amazon EC2 instance types and price using Use case 1

Instance Type	m1.small	c1.medium	m2.2xlarge
CPU	1	5	13
Price ($/h)	0.085	0.17	1

Table II. Amazon EC2 instance types and price using Use case 2

Instance Type	m1.small	c1.medium	m2.2xlarge
CPU	4	7	20
Price ($/h)	0.34	0.5	0.68

Two experiments are conducted to analysis the performance using the two different simulated environments [13].

A. *Homogeneous VM Configurations*

The homogenous VM configuration means the VMs are belonged to the same instance type. For example, type 1 refers to *m1.small*, type 2 refers to *c1.medium* and type 3 refers to *m2.2xlarge*. Therefore, all three VMs are the same type.

Firstly, the use case (1) will be considered. Figure 2 shows the estimated cost (i.e., price$ / h) for the different cloudlets number under three homogenous VMs configuration. These VMs execute a varied number of cloudlets (from 25 to 100 cloudlets). As noted that the VM configurations (type 2) is the cheapest VM configurations although it is not the slowest one as shown in Figure 3.

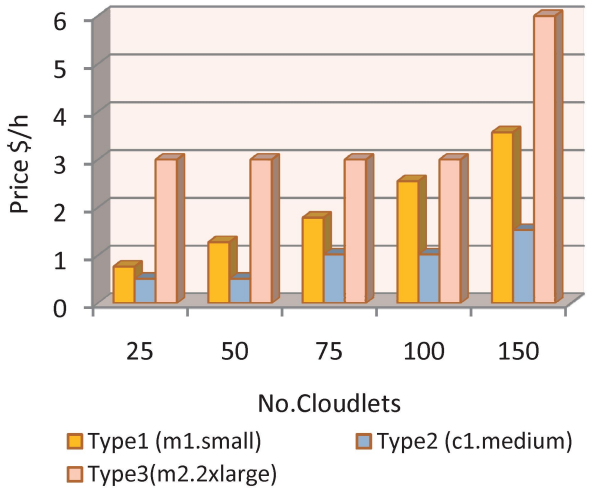

Fig. 2. Cost of Homogeneous VM Configurations for Use Case 1

We observe that the taken time in case of 150 cloudlets under type 3 is two hours which also reflects in the total price (see Figure 2). For all three VMs, with considering one dollar per hour as a price each one, the total price for three VMs is six dollars for two hours. Also, this experiment provides an indication of the strict cost computing which used in some cloud payment model. By considering the case of the execution time is exceeded by at least one minute in new hour, the price will increase and the user will pay for a new full hour (60 minute) although he/she used one minute.

Secondly, the use case 2 is used for 100 cloudlets under three types of VMs configurations. Figure 4 depicts the cost comparison between two use cases for 100 cloudlets. Whereas, Figure 5 shows the time comparison between two use cases. The comparison indicates that the homogeneous VMs configuration is not appropriate in the different use cases. *So, this will motivate us to use heterogeneous VMs configurations to improve cloud performance.*

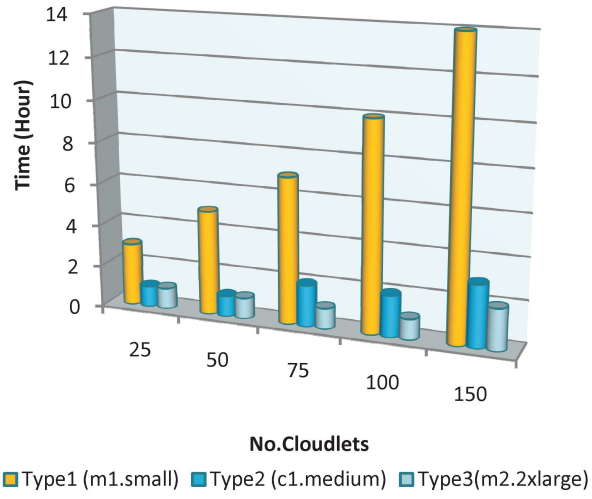

Fig. 3. Time of Homogeneous VM Configurations for Use Case 1

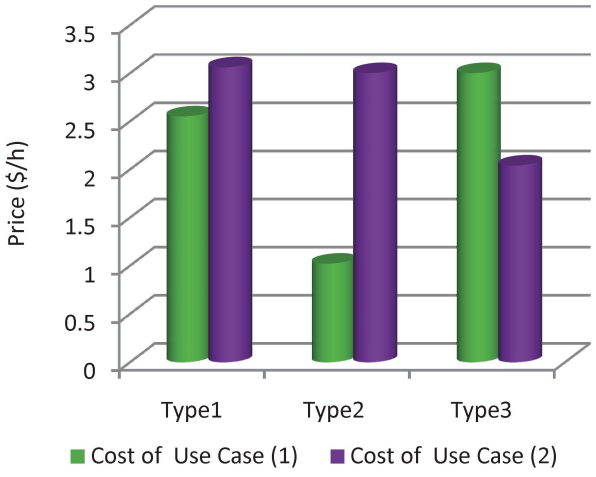

Fig. 4. Cost Comparison between two use cases for 100 cloudlets

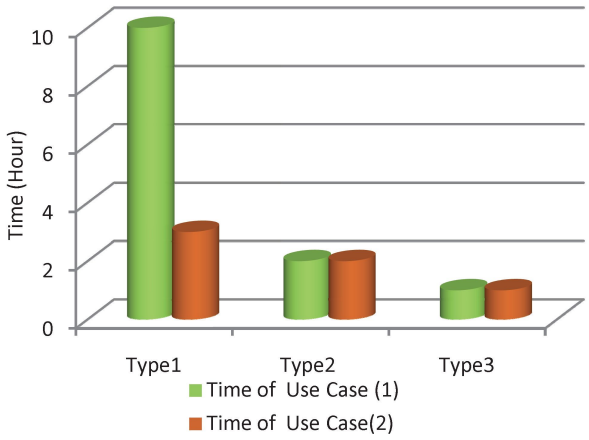

Fig. 5. Time Comparison between two use cases for 100 cloudlets

B. Heterogeneous VM Conffiigurations

Due to the lack of flexibility of the homogeneous VMs configuration, especially with regard to minimize cost and time, we need to generate partially synthetic VMs configuration of different instances type to improve the cloud performance. For this experiment, ten different heterogeneous VMs configurations are generated as described in Table 3. Each configuration represents a combination of three instance types. Thus, some configurations are homogeneous such as the first, seventh and tenth configuration where it consists of three instances of type 1, type 2 and type 3 respectively (see the shadowed rows in Table III). The most features of these heterogeneous VM configurations are shown in Figure 6.

Table III. Ten different VMs configurations

No. Config	Type1 (m1.small)	Type2 (c1.medium)	Type3 (m2.2xlarge)
1	3	0	0
2	2	1	0
3	2	0	1
4	1	2	0
5	1	0	2
6	1	1	1
7	0	3	0
8	0	2	1
9	0	1	2
10	0	0	3

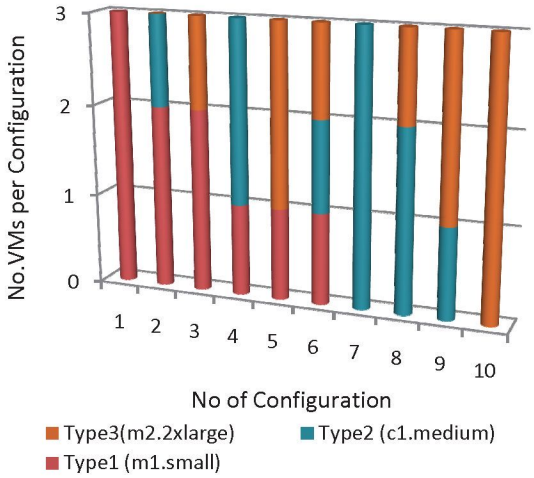

Fig. 6. Heterogeneous VM Configurations

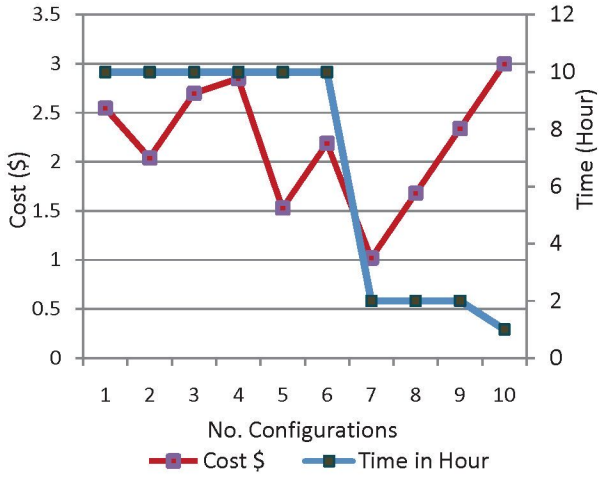

Fig. 7. Cost versus Time in Heterogeneous VM Configurations Use Case 1

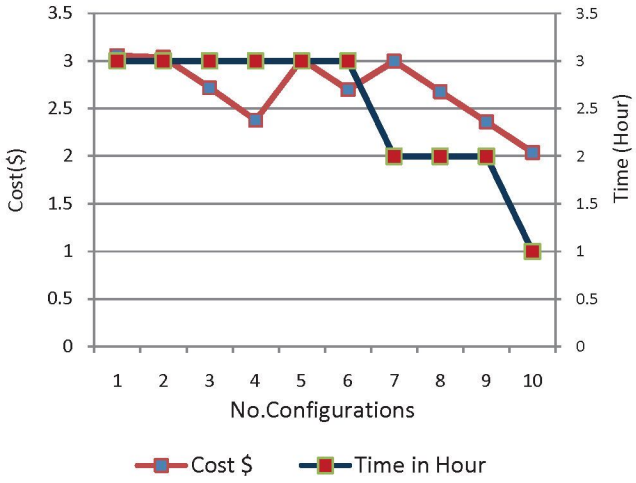

Fig. 8. Cost versus Time in Heterogeneous VM Configurations Use Case 2

Figures 7 and 8 depict the effective of the heterogeneous VM configurations with respect to the cost and time for use case 1 and use case 2 respectively. It is not evident from the results that the composite heterogeneous VM configurations provides better completion time of job comparing to the homogenous configuration. For example, for use case 1, the second, fifth and seventh configurations are considered cheaper than the other configurations. According to Figure 7, it is found that the seventh configuration is the cheapest one although it is a homogeneous configuration, but it has not the shortest time.

For use case 2, the fourth, sixth and tenth configurations are cheaper than the other configurations, but the tenth configuration is the cheapest one although it is a homogeneous configuration.

So, we need a yardstick to measure the effective VM configurations for the cloud performance.

Here, we try to compute a simple elasticity parameter to indicate the tradeoff between the cost and time and vice versa [14]. Elasticity can be estimated for cost and time related to VM configuration. The cost time elasticity (*CT-elasticity*) is the ratio of cost to time for VM configuration. Whereas, the time cost elasticity (*TC- elasticity*) is the ratio of time to cost for VM configuration. Eqn.7 and Eqn.8 are used to calculate *CT- elasticity* and *TC- elasticity* respectively:

$$CT\_Elasticity = \frac{Cost}{Time} \quad \text{.....(7)}$$

$$TC\_Elasticity = \frac{Time}{Cost} \quad \text{.....(8)}$$

Figures 9 and 10 depict the *CT- Elasticity* and *TC-Elasticity* for both two use cases. For use case 1, eighth and ninth VM configurations seem as quite acceptable when the user prefers to pay fewer prices or to accept a little delay in the response time. On the other hand, in use case 2, the first, second and fifth VM configurations seem as quite acceptable.

By analyzing the obtained results, we can conclude that there are many factors and policies would affect the user and provider decisions.

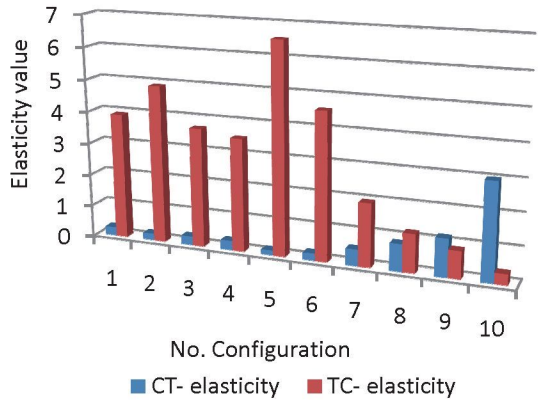

Fig. 9. Elasticity parameter for Use Case 1

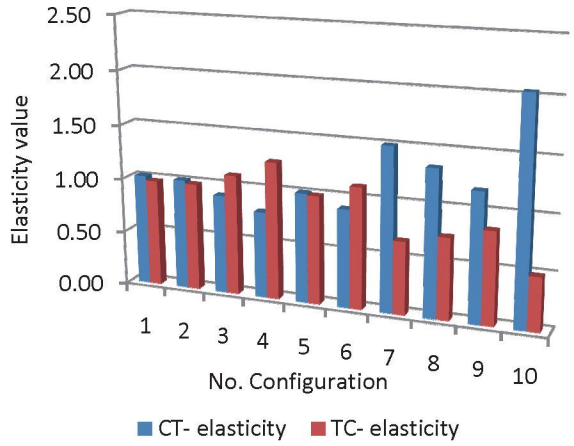

Fig. 10. Elasticity parameter for Use Case 2

VI. CONCLUSIONS AND FUTURE WORK

The Cloud providers face the problem of VM configuration efficiently within different applications. The goal of this paper is to study and analyze cloudlets execution under homogeneous and heterogeneous virtual machine configurations with respect to the cost and time. The results show that the virtual machine configuration is affected by multiple factors to get appropriate preferences for both users and providers. The future work may apply intelligent mechanism to choose the best VM configuration by taking into account proper pricing models to minimize the cost.

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