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Analysis on SLA in Virtual Machine Migration Algorithms of Cloud Computing

T. Lavanya Suja and B. Booba

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T. Lavanya Suja[1], Dr. B. Booba[2]

[1]Research Scholar, [2] Professor, Dept. Of CSE

VISTAS, Vel's University, Chennai

{lavanyasujat, boobarajashekar}@gmail.com

Abstract. Cloud Computing is a transforming field which has grown into multidimensions because of contributions from academia and industry in research and development. The cloud services provide the flexibility to achieve the operational excellence of the modern applications in all domains. Moving all legacy applications into cloud utilize the advantage of advance features in cloud infrastructure like security, reliability and scalabity. As storage and computation are not done in physical machines, they are termed as Virtual Machines (VM). Virtual Machine migration is inevitable in all the services, so there are various VM migration algorithms in the market. All algorithms need Load Balancing component and adhere to the Service Level Agreement (SLA) signed between the Cloud Provider and Cloud Consumer. SLA's importance for the provider and consumer in terms of profit and benefits respectively is analyzed in detail.

Keywords: Cloud Computing, VM, Migration algorithms, Load Balancing, SLA, Uptime, Downtime.

1 Introduction

A cloud refers to a distinct Information Technology (IT) environment that is designed for the purpose of remotely provisioning scalable and measured IT resources. Cloud computing is the delivery of computing services – servers, storage, databases, networking, software, analytics, intelligence etc. over the internet to offer faster innovation, flexible resources and economies of scale in a pay per use basis [20].

Nearly every business is using some form of cloud computing or storage service. Cloud computing has transformed so many businesses throughout the past decade with its scalability, versatility, and reliability [21].

In cloud business the provider and the consumer are bonded by the Service Level Agreement (SLA) an agreement between them on the list of services called Quality of Services (QoS). As the consumer pay on the basis of his usage the quality standards are followed to the core. Any violation in QoS will cost the provider so the factors listed in it plays a key role in the business lifetime.

Cloud providers invest a lot of time and energy in devising an algorithm for their own requirements so there are numerous algorithms in the market. In the previous work [22] an elaborate survey on VM migration algorithms was done. The next step in the work is to analyze the monetary benefits and losses for the cloud consumer and cloud consumer so as to throw light on the importance of SLA

The rest of the paper is organized like this. Section 2 talks about the related work notably done for developing a VM migration algorithm and inclusion of factors in SLA and its importance. Section 3 registers the implications from the wide literature review, then the findings are projected as graphs in section 4 and finally section 5 gives the conclusion and future work of this study,

2 Related Work

A pre-emptive scheduling algorithm [1] which improves the efficiency and makes the job done before their deadline is met. A better option than traditional scheduling and other similar approach algorithms.

The CloudSim tool kit provides a platform to test the working of algorithms in cloud environment and analyze the performance metrics. Without plunging into the cloud directly we are able to simulate the results of the performance of the IaaS algorithms and also the applications in SaaS. This paves way for improvement in our development and also a cost reduction factor in the SDLC [2].

Load Balancing is an important concept in VM migration algorithms. There are various approaches which are classified under Static and Dynamic. The metrics include Throughput, Fault Tolerance, Response time, Migration time and Scalability. Many algorithms for Load Balancing [3] also have inspired by nature like Ant Colony and Bees Foraging behavior just like Migration algorithms. Here we find a similarity in the metrics and inspiration for algorithms between Migration and Load Balancing Algorithms.

An improved Round Robin [4] was proposed to improve the overall task completion time and number of VM migrations both in space shared and time-shared scenario. The other parameters measured are Idle time of tasks, number of million instructions re-executed and number of delayed tasks. In all the parameters the improved Round Robin algorithm performed well which showed dynamic load balancing and knowing the length of the task are very essential. Hence those parameters are considered.

Chien et al. proposes an efficient virtual migration algorithm [5] with a smaller number of migrations. The authors also bring the advantage of better SLA compliant during the VM migration. Apart from the fact they propose the experimental results shows that the total migration has increased, time to select VM needed to migrate has increased and so is the percent time of SLA violations.

SLA's importance and need for detection and cost of violation are discussed in this paper [6]. The authors throw light on formulation of SLA, burden laid on consumer to detect and report SLA violations so as to claim the benefits like money refund within the stipulated time. They also appreciate cloud providers like Verizon for automatic credit done to the Consumer account in case of SLA violation. Azure is stringent

claimed by the authors as it asks the consumers to report SLA violation within 5 days compared to 30 days by other cloud providers.

Saravanan et. al. portrays the trade-off between the minimization of migration time and consumption of energy in Artificial Bee Colony algorithm [7]. Hence, they propose SALMonADA model which includes a system for monitoring the SLA violations and report immediately. They say that it relieves the burden of the cloud consumer from monitoring and reporting to the cloud provider and thereby reaping the benefits of payment credit. This stresses the importance of SLA and its monitoring both by the cloud provider and consumer.

SLA monitoring has got very much importance as it costs much for the cloud provider and the cloud consumer. As cloud providers lay this responsibility of reporting SLA violation within 30 days of the next payment cycle, it becomes mandatory for the cloud consumer to be vigilant on this. Accuracy and fast detection are the main characteristics of this SLA monitoring. Apart from this inclusion of SLA factors play a major role. In [8] the author emphasize on the frequency of times and the interval between each checking is done.

Analyzing the guarantee terms and identifying the test requirements done in a proactive and a reactive way [9] brings out a Testing suite for SLA violations. This may serve as a benchmark for measuring the performance and helps the cloud provider in avoiding the SLA penalty amount. On the other hand, it helps the business up and running for the cloud user thereby their service in uninterrupted.

The work [10] have reviewed five different SLA based architecture and brought out their merits and demerits. CloudWatch is taken as an example to analyze the SLA parameters and studied for their usage in finding out the SLA violations.

In an attempt on a comprehensive study on architecture of SLA [11] the authors have given a detailed explanation on its Lifecycle, pricing and parameter. There are roughly 12 parameters to be considered for SLA in IaaS which is the maximum number of parameters compared to SaaS and PaaS.

They have also compared the performance metrics of five different providers and has brought in light to the penalty cost incurred by the cloud providers because of SLA violations. As less than 30 minutes of downtime cost a 10% of credits to a maximum of 100% thereafter. This clearly shows that the credits given by the cloud provider is certainly a loss in his profit and good will.

Hussain et al provides a detailed review of SLA requirements and the SLA violation penalty paid by the cloud providers. The situation of a small and medium cloud provider is mentioned of importance as their resources should be thoroughly utilized. They propose Optimized Personalized Viable SLA [12] to generate a viable SLA and predict the violation before happening thereby avoiding the violation and penalty.

GIPL ‘s SLA document clearly gives the percentage of uptime as 99.721% and a decrease in 0.5% of it cost a penalty of 1% of its Quarterly payment [13]. The overall penalty cap is 15% of quarterly payment and it increase by 5% for every SLA violation. When it reaches the 20% of quarterly payment the consumer has the right to terminate the contract between them. Such is the situation and importance of SLA terms laid down in the agreement. This gives a clear picture of money gained as profit by SLA compliance and loss incurred because of SLA violation.

In a detailed literature survey [14] the findings clearly say that there are five different groups of cloud computing service composition and the most attention needed

research objectives are algorithm improvement and user requirement satisfaction which call for new and improved algorithms including SLA parameters are need of the hour.

The authors [15] propose that the cloud application needs some time for e.g. 5 minutes to get steady and thereafter the net utility of the provider becomes constant. They have proposed a model CASVid and an algorithm for monitoring SLA violation at application level. They were successful in doing so foe a single application and has to extend it for heterogenous applications too as cloud provider has more than one application for service.

A detailed taxonomy of Load Balancing algorithms is presented in [16] by categorizing into two viz. Static and Dynamic Type. The authors agree that Load Balancing is a NP complete problem and is of much importance as it saves in terms of cost and time. Among the approaches discussed the simulation results show that Minimum Compilation Time (MCT) gives an optimal solution. This finding gives a clue that compilation time should be given more importance than execution time.

A conventional approach of dynamic load balancing [17] is claimed to be 30% more average research utilization rate and 225% less makespan than First Come First Serve, Shortest Job First algorithms. In order to achieve this, more migration of tasks from one VM to another VM takes place which specifies VM migration not only improves performance but also inevitable. This gives a clear indication that VM migration plays a major role in any algorithm and approach.

In this soft computing based Stochastic Hill Climbing approach [18] the authors claim it to be a better load balancing algorithm than FCFS and RR algorithms. The overall Response Time is 30% less than the existing approaches. Cloud Analyst is the simulation tool used to measure the performance metrics.

This [18] is a centralized approach in contrary to the many decentralized approaches [19] many in the market. While it has advantages like minimum time to take a decision, there are disadvantages too like crashing of the central node shuts down the service itself.

3 Implications

Going through the literature review reveals the fact that factors included in SLA plays a crucial role in deciding the profit of the cloud provider and increase the business of the cloud user. Every minute of uptime is counted and every hour of downtime is monitored. After including the factors in SLA, it should be strictly adhered and violation of it cost money for the cloud provider and loses the goodwill of the cloud user. Data from various sources were compiled in the form of graph for clear picture and better understanding to bring out the loss of profit in dollars. The loss of cloud provider turns into a bonus income for cloud user as it is paid in percentage of Quarterly Payment (QP).

4 Findings

Average downtime and uptime of major cloud providers like AWS, Google Cloud, Microsoft and IBM in hours/year is projected in the below graph [23], [24]. The graphs have been plotted on data acquired from 2007- 2013.

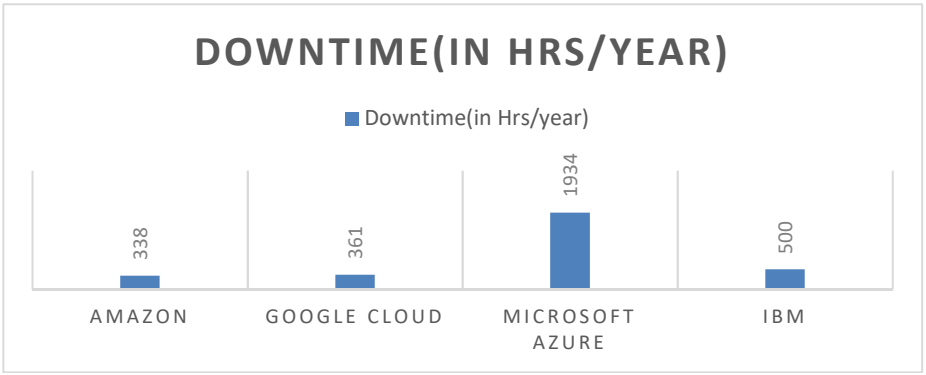

Fig. 1. Average downtime in hours/year of 4 major cloud providers.

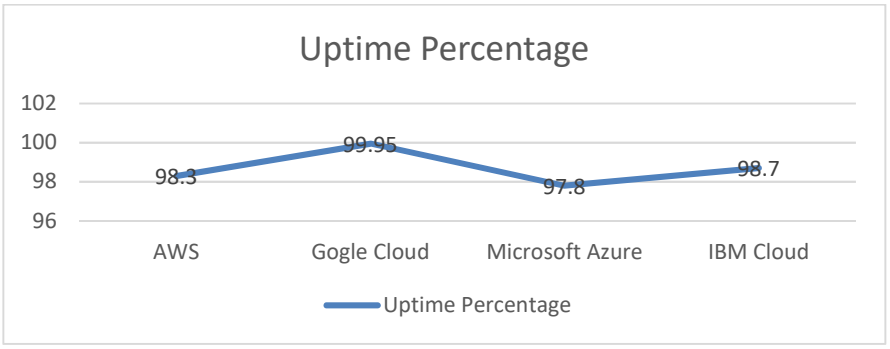

Fig. 2. Average uptime percentage of 4 major cloud providers.

4.1 Cost benefits in terms of repayment for the cloud consumer

When a factor in SLA like uptime percentage is not met then the cloud provider pays the cloud consumer 0.5 to 5% of Quarterly Payment (QP) [13] and is shown in the graph below. Here the SLA include 99% of uptime so the minimum loss of 0.5% starts when uptime goes in the range of 98.5-98.99% and thereafter it increases by 0.5%.

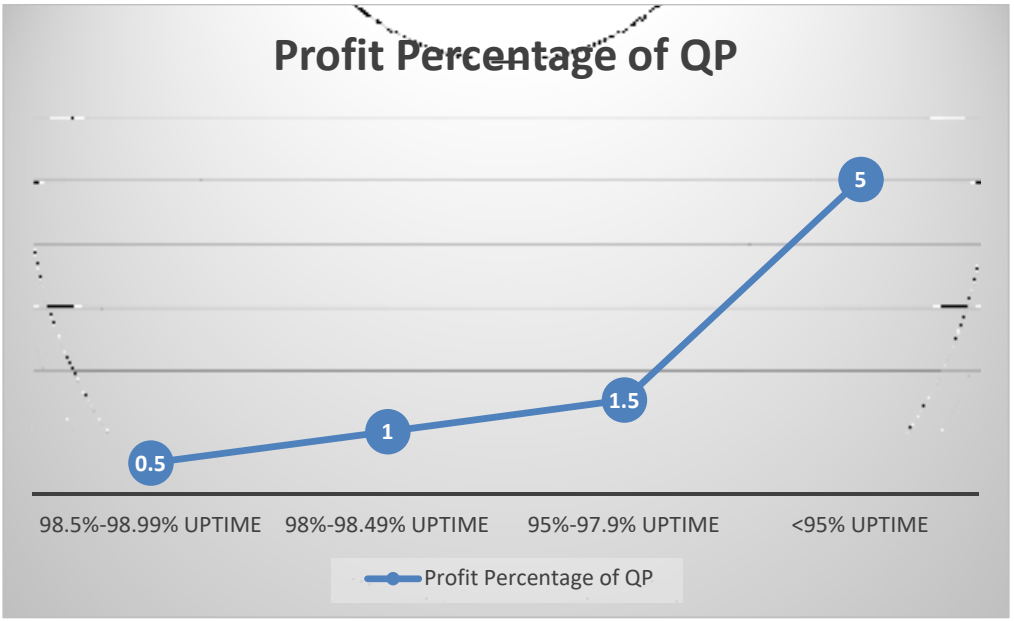

Fig. 3. Profit percentage of a Cloud Consumer.

4.2 Incurred loss for the cloud provider

The below graph plots the lost money in million USD for the major 4 cloud providers in the duration years 2007-2013 due to unavailability of service and SLA breach [24], [25].

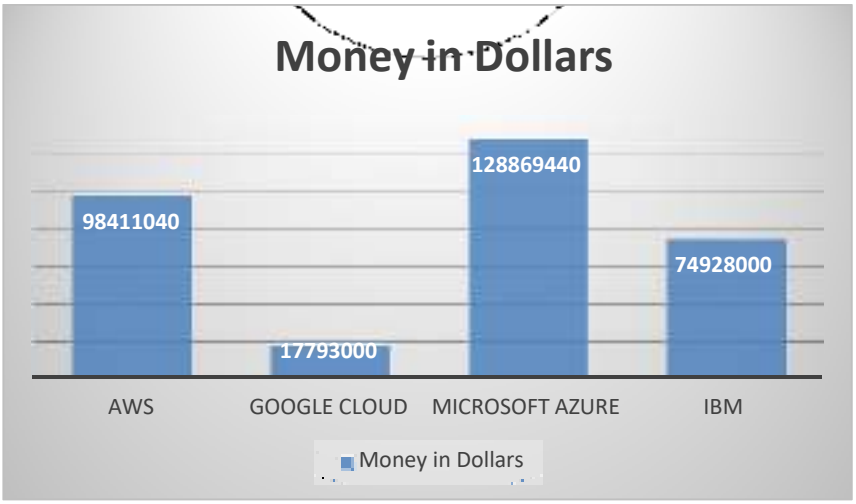

Fig. 4. Average Loss incurred by Cloud Provider for SLA breach.

5 Conclusion and Future work

Having analyzed the key components of VM migration algorithm reveals the fact that load balancing, energy efficiency, complying to SLA are the most important. Though SLA are followed to 95-98% on an average the rest of the 5-2% breached time incurs a lot of money loss for the Cloud providers. On the other hand, even though the cloud consumers get a monetary benefit by the 5-2% SLA breach, their business and goodwill get affected is a great concern especially for cloud start-ups. In the next work it is planned to propose a detailed review on performance and profit of cloud start-up companies in terms of SLA

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