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ARTICLE

A SURVEY ON CLOUD OPTIMIZATION SYSTEMS

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ABSTRACT

Cloud has become the best revenue generator tool in the business world. The Cloud Service Provider (CSP) gives attention to the enormous data arriving in the cloud. Many techniques are available for solving the problems in cloud. But complete solution is not possible due to the volume, velocity and variety of data arriving in cloud. Modifications in resource utilization, cost pricing, load balancing could be done for the effective utilizations of cloud. The combined optimization of the major factors of the cloud could result in high profit to the CSP. In this paper, an extensive survey of optimization techniques for different factors of cloud is discussed and the results achieved by each factor are tabulated.

KEY WORDS

Deadlock, Virtual Machine Migration, Starvation, Data center cost, cloud service provider, dynamic resource provisioning.

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INTRODUCTION

Cloud has become an essential component in daily life for business organizations, educational institutions, hospitals, Industries for gaming servers, file sharing, billing, web hosting, software applications etc., Because of the resource pool visibility and availability, elasticity, self service and pay per use reasons, the Cloud is always being a vital platform. The Cloud service Providers (CSP) are also increasing due to demand of resources. Having resources in hand, CSP make their own ideas on how to efficiently use them, manage them, protect them and make profit of them [1]. Many investors are also investing in research around cloud computing.

Even though cloud was initially invented in the 1960s, it was introduced for industrial purpose in India in 2006. Once it was started practicing by our business people, many problems arose in the trustworthiness of cloud, legal issues and architectures to follow. Research started in cloud from then till now to achieve best approaches and results. Many cloud applications and models solved most of the basic problems of cloud. But the virtualized cloud storage, heterogeneous underlying hardware, self organizing and self optimizing cloud are still under research. The problems of cloud are easy to solve using one crisp solution due to the fact that the issues are interlinked with one another. Increasing the number of servers may result in best speed and throughput but contradicting in resource utilization. Enhancing the performance with the resources available would be the possible way of solving cloud problems. Minimizing the resources available is nothing but optimization. Certain adaptation in the underlying factors and parameters of cloud would produce efficient utilization.

Optimization is a mathematical model based on decision making. The decision has to taken from the user .The cloud user provides the input data, Control variables and decision constraints for optimization. The sample cloud price data, data center, VM can be taken from Amazon web services, Google trace data, planet lab etc., User provides input data in numerical values and the factors of cloud to be optimized as control variables. The type of service and the number of users are used as decision variables. The resources of cloud like bandwidth, memory, storage, No: of servers, processing speed , latency, power, cost, virtual machine down time, migration time are the control variables. Based on the control variables, the cloud environment can be optimized as maximizing or minimizing function with decision constraints and solved for different input data sets [2].

The Cloud Service Providers have numerous of servers with different memory, storage space, CPU speed, and bandwidth. They expect profit in providing service. They have to make their resources completely utilized for better profit. Optimization techniques are used for effective utilization of cloud resources. This in turn also optimizes the cost for the provider. The arriving load on the provider side has to be monitored and balanced to avoid hacking and over utilization of the resources.

The Optimization technique has many challenges. It needs to deal with the varying loads on the cloud. It needs to scale with the increased number of users at a time [3]. In a short period of time, it Should make fast decisions in service allocation, and deal with additional problems like hackers, over utilization, under utilization, deadlocks, distributed database, replication etc.,

Thus Optimization techniques are broadly extended for 3 factors of cloud: Resource based Optimization, Cost based Optimization and Load based Optimization. Resource based Optimization deals with the user side resource and ways of utilizing them at the maximum profit without deadlock in handling multiple users [4]. Cost based Optimization also deals with the techniques in maximizing the profit using different pricing techniques and cost estimation techniques. Load based Optimization deals with the balancing the resources using parameters to prevent hacking and user to be served at a fair manner. The Existing optimization techniques have been elaborated in the [Table 1].

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This paper is organized as follows. Section II introduces the Resource Optimization methods which contribute to the maximum profit in CSP. Proper resource utilization deals with the correct way of scheduling of resources for varying cloud requests. Section III explains the role of cost maximizing in cloud for profit. It deals with the pricing models, power and energy of cloud resources. Load balancing on the CSP side according to the arriving cloud requests and monitoring their running on cloud resources is elaborated in Section IV. In section V, we conclude this paper.

Table 1: Optimization methods

No.	Methods	Techniques	Author(s), Year	Remarks
1.	Zoutendijk's Feasible direction Method	Karush Kuhn Tucker condition	Bazaara et al., 2013	Properties are difficult to satisfy. Suitable in cases where Objectives don't conflict with each other.
2.	Gradient Projection method	Covergent step size rules are adopted.		
3.	Penalty method	Changing penalty co-efficient in each iteration till convergence.		
4.	Apriori Methods Weighted Global Criteria	Global Criterion F(x) =Sum of the squares of the relative deviations of the individual objective function from the feasible ideal solutions has to be minimized.	Marler and Arora. 2004	Used in cases where user able to specify the constraints, decision variables and goals clearly.
5.	Lexicographic method	Ranking of objectives and constraints is done.	Ching-Lai-Hwang, 2012	
6.	Weighted Min-Max	Backtracking is followed. Solution is obtained by minimizing the function considering the maximal valued parameters in each iteration.	Hazewinkel, Michiel ,2001	
7.	Weighted product	Each parameter is multiplied by weight ratio based on its importance.	Miller,1969	
8.	Goal Programming	Degree of attainment of the goals has to be determined with the available resources. Goals are associated with priority.	MJschienderjans, 1995	
9.	Bounded Objective	The optima of respective objective function exist and coincide by strong duality condition.	Jeffrey,2004	
	A posteriori Methods Genetic Algorithm	Evaluation, Selection, Cross over, mutation as a iteration process.	Fleming ,1993	Used in cases where user not able to explicitly specify the goals and constraints and chooses from the multiple optimal solutions generated.
11.	Normal Boundary Intersection method	Multi-objective optimization is reduced in to beta problem and then solved as weighted single optimization problem	Dennis J.E,1998	
12.	Normal Constraint method	Pareto filter is used for finding the best optimal points resulting in trade off between the given constraints.	Messac.A,2003	
13.	Multi-Objective Particle Swarm optimization	Parameters are taken as particles and position and velocity associated with them are iteratively changed to reach the desired solution	Muller-gritschneder,2009	
14.	Interactive Methods Zionts-Wallenius method	Interactive method where the iteration proceeds with the choice of feasible solution or desire of change in iteration.	Zionts&Wallenious,1976	Used in the cases where user has no specifications in start and interact as the algorithm runs and finds solution.
15.	Satisfying trade-off Method	Min Max approach is minimized by a local approach using simulated	Nakayama,1984	

16.	NIMBUS method	Aspiration levels, upper bounds and weighting co-efficient are formulated and new alternatives are found in each iteration and most preferred one is selected for next iteration till user is	Miettinen,2006	

MATERIALS AND METHODS

Resource optimization methods

Resource Allocation plays an important role in achieving profit for CSP. It is the process where CSP allocates the existing resources to the requested cloud users over the internet. The process deals with the proper utilization of resources at the provider side and also avoids starvation at the user side [5]. Resource Optimization solves the difficulty by helping the CSP to manage their resources before and during allocation.

Resource Optimization is making the resource allocation easier by setting values for the user requirements before allocation. This makes sure that the resource at the CSP side remains safe and optimal. The cloud request mentions the amount of resource and their duration to the CSP. The CSP has to run their Resource Optimization algorithm to find out the sequence of cloud requests to be served so that starvation and under utilization is not encountered [6]. Resource Optimization should avoid certain situations in Resource Allocation. They are

i) Resource conflict evolves when two or more users make access to the same amount and type of resource at the same time

ii) Insufficiency of resources may occur when there are inadequate resources and also when resources not allocated in proper manner.

iii) Resource splinter situation evolves when the resources are separate in remote servers and not able to allocate together immediately at the time to the cloud request.

iv) Over provisioning is the process of user being allocated resources in excess to the requested one. This in turn also called over utilization of resources at the CSP point of view.

v) Under-provisioning is the process of user being allocated resources in smaller amount than his demand. It is called the under utilization of resources at the CSP side.

In the paper "Deadlock detection for resource allocation in Heterogeneous Distributed platform", Ha Huy Cuong et al., presented Parallel Deadlock Detection Algorithm (PDDA) using Resource Allocation Graph (RAG) for IAAS heterogeneity cloud. It avoided starvation of resources using RAG. The time and space complexity of the algorithm held good for the cloud scenario. It was implemented in cloud sim and outperformed better than the optimal time algorithm [7].

In the paper "Decentralized and optimal resource cooperation in geo-distributed mobile cloud computing", Rong Yu et al., suggested coalition based game model for achieving profit at the provider side by utilizing the resources at the maximum. The Profit and Utility factor was measured to be good than the normal schemes on checking it with Normal schemes data [8].

In the paper," An Online Auction Frame work for Dynamic Resource provisioning in cloud computing", Weijie Shi suggested VM auction algorithm for dynamic resource provisioning at the provider side. It resulted in better profit when checked using Google-cluster data with different no of cloud users, different no: of data centers and no: of rounds. The Trace driven simulation was run for 3 data centers and 6 types of VM [9].

In the paper, "Utility Max-Min: An Application oriented Bandwidth Allocation Scheme", Zhiruo cao and Ellen. W.Zegura suggested utility based switch algorithm for effective bandwidth utilization in achieving profit. It resulted in providing better fairness index and Quality of service when checked for different bandwidth in java code. The algorithm outperformed the standard bandwidth allocation schemes but it needs utility function of the arriving functions for its processing [10].

In the paper," A Power Efficient Genetic Algorithm for Resource Allocation in Cloud computing data centers", Giseppe Portaluri et al., presented genetic algorithm for server scheduling resulting in less power consumption of servers. The algorithm was run in Intel 17 with 8 Gb RAM, Ubuntu OS in IJ Metal frame work. The results showed power efficiency with the arriving tasks and completion time. It can be extended to consider the internal communication cost, electricity cost, data center load cost etc., for better efficiency [11].

The Cloud request differs in each type of cloud service. Some request resources in duration for rent. Some users rent resources in storage. In Static resource allocation, the resources are fixed and rented to the users on cost. In dynamic scheduling, the resources are allocated on demand and they are charged based on usage of each resource per hour [12]. The Resource Optimization strategy must assure a deadlock free environment with better speed, bandwidth, throughput, and response time, completion time, profit, VM provisioning and less power consumption. Thus managing and allocating resources in cloud is crucial.

COST OPTIMIZATION METHODS

CSP put a lot of investment based on the type of cloud service they provide. They aim at serving the users demand at minimal cost and expect profit in return. Profit at the CSP side can also be achieved by minimizing cost. This can be implemented by using proper pricing models, scheduling based on geographical location of servers, virtual machine migration scheme saving energy [13]etc.,

The pricing models have to done in an efficient manner to satisfy the user demands. The pricing methodology changes for each type of CSP [14]. The static cost provisioning makes the cost fixed for users. Dynamic pricing methodology changes the cost at various hours based on user demand. The scheduling or resources between users plays a major role in achieving profit. The instances of resources to be allocated for better profit have to pre determined. The server selection has to be done considering their geographical location so that speed, transfer rate and thereby throughput can be maximized. Energy saving comes as the next major factor in achieving profit [15]. The cost of electricity, working and cooling power for servers has to be minimized for saving energy [16]. Different cooling and power saving techniques are being adopted to achieve it. The brief overview of the above discussed parameters in cost optimization techniques have been detailed in the [Table 2].

Table 2: Cost based Optimization models Summary

Paper ID	Addressed Issues	Algorithm and Datasets	Performance Metrics	Implementation	Result and Remarks
[17]	Task scheduling , Resource allocation and Profit	Multi-Objective Optimization • Ant colony Optimization • Resource Cost Model • Make span and budget Cost as constraints Data sets: 100 hosts, 10 Virtual Machines Compared with • Original colony algorithm • Heuristic Algorithm • Min-Min Algorithm • FCFS Algorithm	• Make span • Cost • Dead Violation rate • Resource Utilization	Cloud Sim 3.0 Amazon cloud service data [18].	Outperformed the Min-Min Algorithm even at worst case Better Effectiveness than FCFS algorithm
[19]	Energy consumption Congestion or Hot Spots	Data center Energy Efficient Network Scheduling Algorithm (DENS) • Dynamic Voltage and Frequency Scaling(DVFS) Data sets: Three Tier Data center topology With • 1536 servers • 32 racks • 48 servers//rack • 1 GE internal Link • 10 GE topology Link • Propagation Delay 10 ns	• Power consumption • Uplink traffic load	Green Cloud Simulator	Outperforms the Round robin scheduler and green scheduler in reduced power consumption. Suitable for three tier architecture and Should be checked for other data center architectures.
[20]	Electricity Cost of Data centers in cloud	Energy efficient Algorithm Data sets: Internet traffic Archive, CLARKNET-HTTP, NASA –HTTP, UC BERKELEY IP.	• Normalized cost • Maintenance cost • Electricity cost	Simulation of 1024 servers by hybrid cooling with 2.6 GB service rate. G/G/M model for response time calculation	Outperforms the traditional cooling technique.
[21]	Cost Optimization	Reserved Instances Optimizer with Hill climbing Algorithm based Profit Function Compared with the theoretical values of the inventory model. Data sets: Industrial data	Demand trace and profit function	Nord Cloud	Outperforms the Heuristic methods, machine learning techniques. Risk analysis has to be checked.

[22]	Energy Reduction and Maximizing profit	Profit Driven Online Resource Allocation framework Data sets: Google data traces.	• Profit • Average CPU utilization • Cluster energy	Run on Google Cloud cluster Microsoft cloud computation service data used for pricing values	Evaluated results in Google traces for heuristic Max, Min and Random values. Only CPU utilization is concentrated. Other resources Memory, Bandwidth also to be incorporated.
[23]	Cost Efficiency	Co-Efficient and Reliable Resource Allocation algorithm(CERR) Data sets: Amazon EC2 Instances	• Cost • Reliability • CERR rate	Matlab simulation	Outperforms the MAX-MIN algorithm, MIN_MIN algorithm and FCFS Algorithm

The parameters of the cost optimization can be prioritized based on its importance in achieving profit. Each parameter contributes in achieving profit in its own way depending on the cloud service [24]. The cloud service provider concentrates on optimizing the parameter based on their network topology and architecture. The literature survey analysis of cost parameters in cloud is depicted via pie chart in [Fig.1].

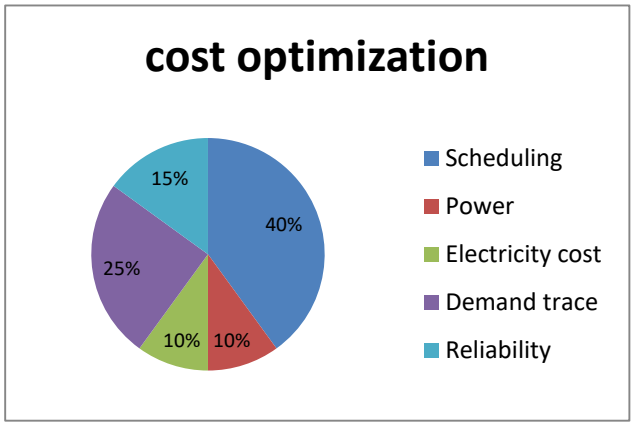

Fig.1: Cost optimization priority factors.

LOAD OPTIMIZATION METHODS

Load balancing has to be concentrated by CSP for its efficient run. If not done, it leads to resource over utilization and deadlock. In cloud, the arriving requests are enormous and vary from time to time. Hence some load balancing technique has to be adopted. Virtualization solves these issues and becomes the powerhouse of cloud computing [25]. It is the process of isolating resources, balancing load and system maintenance in order to serve big data applications. Virtual machine migration is the process of transferring OS instances from the existing physical server to the needed server. It is done to balance the incoming enormous load on cloud.

In virtual machine migration scheme, resources are consumed on both host and guest side causing a migration overhead [26]. The distance between them has also to be considered. By Making effective use of virtual machine migration, profit and optimization gets achieved in Cloud, while handling large data [27]. The different virtual machine migration based load balancing technique is discussed in [Table 3].

Even in small load cases, the resources have to be balanced and monitored properly to avoid deadlock and hacking. Many Load balancing techniques have been developed based on the CSP. In 2016, Lei Yu et al., discussed about stochastic load balancing with hot spot migration of virtual machines in his paper [28].The stochastic algorithm outperforms other virtual migration schemes in three tier architecture. The algorithm had run well on Cloud Sim with the VM utilization trace from planed Lab and Google trace data. But the migration schemes have to be checked for all kind of probability distribution and network topology in cloud.

In 2013, Jai Ganesh and Vincent Antony Kumar designed a Fuzzy logic model for Data Center Load Efficiency (DCLE) Monitoring. It was a model for monitoring CPU, Bandwidth, and Memory. It was implemented for physical machine with limited users. The DCLE meter has to be validated for different virtual machine scenario handling big data in cloud [29].

The CSP may serve software applications, Operating systems, Servers etc., Load balancing also becomes an important issue in security point of view. The hackers try to utilize maximum of a particular resource to hack the system. Hence resource utilization has to be monitored to avoid complete system crack. CSP must concentrate on this factor for efficient running of their service.

Table 3: Load based optimization techniques

No.	Strategies	Algorithm	Author(s)	Year	Remarks
[30],[31]	Virtual Migration Techniques	Pre-Copy approach	C. Christopher et., all	2005	Pre-Copy Migration Technique is used with less down time but more migration time
		Delta compression	P. Svard, J. Tordsson, B. Hudzia, and E. Elmroth	2011	
		Adaptive Rate Limiting	H. Jin, L. Deng, S. Wu, X. H. Shi, and X. D. Pan	2009	
		Time Series Prediction Technique	B.Hu, Z. Lei, Y. Lei, D. Xu and J. Li	2011	
		Recovering System and CPU Scheduling	L. Weining and F. Tao.	2009	Post copy Migration Technique is used with less down and migration time. But its performance depends on the amount of data to be transferred.
		Check pointing/Recovery and Trace/Replay Approach	L. Haikun, J. Hai, L. Xiaofei, H. Liting, and Y. Chen	2009	
		Memory Re-using mechanism for VM consolidation	Soramichi Akiyama	2012	
		Post –copy Approach	R. H. Michael, D. Umesh, and G. Kartik	2009.	

The profit can be achieved by using Multi objective optimization of resource, cost and load using different parameters for each factor. It can be inferred that the combined Optimization of all the three factors will result in better throughput. Depending upon the type of the cloud service, the number of users and the network topology each factor and its parameters plays its role in providing profit.

RESULTS AND CONCLUSION

The Optimization technique is the most thriving one in cloud optimization. Many types of optimization techniques have been developed so far. With respect to the Cloud environment, Resource, Cost and Load based optimization techniques have been developed. The resource optimization helps the cloud provider in effective utilization of resources by considering the type of scheduling and the nature of service. The resources can be protected before allocation by putting certain constraints to avoid over and under provisioning and deadlock of resources and requests in case of heterogeneous databases. This leads to the better profit in providers. Cost can be optimized by introducing pricing models and prior estimation of resource allocation factor leading to profit. The load at the provider side has to be balanced by using Virtual migration techniques reducing the down time and the migration time considering the network topology. This way of effective utilization of incoming load leads to the balanced cloud system avoiding hackers and earning high profit. Thus optimization techniques can be evaluated by various factors like profit, resource utilization factor, traffic load speed, transfer rate, down time, deadlock violation rate etc.,

CONFLICT OF INTEREST
No conflict of interest to declare

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