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A Review of Virtual Machine Placement: Bio-Inspired Based Approaches

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ABSTRACT: *Cloud computing contributes in an admired way to accommodate and demonstrate internet service in Such a way that data centers rapidly host a substantial number of applications such as Ecommerce, web hosting, social networking, etc. Through implementing virtualization and choosing the most suitable host for each Virtual Machine (VM) you can make better use of a data center. VM placement problem optimization is aimed at multiple targets through choosing the maximum effective VM placement algorithm with multiple methods. All these techniques aim at simultaneously reducing power consumption, avoiding traffic congestion and maximizing the use of resources. This review aims to provide an improved way of understanding some of the current techniques and algorithms that warrant placing batter VM with a defined prospect trend in the cloud computing environment.*
KEYWORDS*: Datacenter, Cloud Computing, Energy Efficiency Multi-objective Optimization, VM placement*

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I. INTRODUCTION

Given the increasing complexity of the current Internet application, data size and network requirements in large data centers such as clouds are both internet applications and data size, network resource requirements are gradually becoming complex [1]. This increase in size storage and inefficient resource utilization is causing high energy consumption [2]. Virtualization technology assists in the allocation of numerous physical machine VMs (PMs). The key preoccupation of the evolving cloud computing environment is the virtual machine placement efficiency and elasticity [3]. Virtual machine placement approaches include the host allocation protocol to standardize the number of hosts in the cloud data center. Whereas dynamic restructuring changes the number of active PMs according to their resource needs and increases energy consumption [4]. Eventually enhancing the positioning of VM would improve the energy efficiency. If more VMs can be assigned to fewer resources, the power consumption can be minimized in a data center [5].The problem of virtual machine placement has shown significant gain if it is acceptable Allocation policies used to reduce energy savings and energy consumption, which accounted for a significant proportion of total maintenance costs in the data center. As placement is subject to various constraints arising from multiple domains, such as protection, a VM resource (dynamic or static), availability requirements, etc. [6]. VM placement optimization can be traffic-aware, application-aware, energy-aware, data-aware network topology-conscious or combination of one or more of these [7]. Such methods are therefore either server energy consumption, central processing unit (CPU) or memory without network consideration when network energy consumption is low [8]. Applying an effective strategy with the implementation of new powerful VM placement algorithms to reduce the amount of hardware over-providing. They are different methods of placing VM which differ in purpose. Consolidation and load balancing of the physical servers maximized resource utilization ratio and improved overall data center efficiencyFurthermore, VM positioning has the backup mechanisms (snapshot of each VM) and active VM in case of a disaster recovery in the data center.

II. RELATED WORK

A cloud computing is a type of distributed and parallel network consisting of a series of interconnected and virtualized computers that are supplied dynamically and displayed as one or more computing resources to satisfy customer needs. With the number of researchers working towards energy-aware placement, energy consumption has become one of the biggest challenges in the data center world. One of the conventional ways of saving energy in the cloud data center is to propose VM placement in which virtual machines are host at the minimum number of a physical machine. [9]Research VM positioning and optimization energy efficiency study using efficient VM migration in a cloud data center to reduce energy consumption. The proposed solution can be highly efficient in using the resources of a data center, where it incorporates the availability of multidimensional resources which can provide maximum energy savings by reducing the number of migrations required. [10]Presented a VMP by considering a well-defined set of strategies for optimization, objective function and techniques for solution. The classification criterion cloud will be when the VMP problem is examined online or offline, whether cloud architectures will be considered if the VMP is broker-oriented or provider-oriented, and the type of experimental environment suggested. As cloud computing expands rapidly, cloud providers pay close attention to data center operating costs and efficiency. Customers can now be attracted if the providers provide them with a high quality service at a low cost rate, which can be accomplished by reducing energy consumption to meet customer requirements. Several researchers had thus started to study energy-efficient and resource management in this regard.

EAGLE

The main objective of this algorithm is to minimize total energy consumption inside the datacenter. The algorithm also reduces the amount of resource fragments where their sizes decrease. The model also balances the multi-dimensional use of resources, reducing the number of active hosts leading to lower energy consumption. The algorithm was contrasted with first fit decreases algorithm where it outperforms it with an energy-saving average of about 15 percent [11].

DYNAMIC PROGRAMMING AND LOCAL SEARCH

This algorithm calculates the number of VM copies and positions them inactive servers in the cloud data center in order to minimize the total energy cost. The proposed algorithm also provides a flexible technique for the data center to increase the resource availability and energy efficiency. In this regard, service providers will determine how to handle high-processing VMs by spreading these requests among the hosts in order to minimize energy efficiency. The algorithm reduces the energy cost relative to VM placement strategies by 20 per cent[12].

FIRST FIT DECREASING ALGORITHM

Solving a VM placement problem requires some adjustment that allows the algorithm to suspend the physical host and assess the impact of the VM allocation over the cloud data center's entire energy consumption. With every VM that is currently on the network, where the algorithm allocates less VM than other algorithms such as Energy-Unaware, there are no resources available in a heavily used cloud. In a more practical case, first fit decreasing algorithm performs batter then another sophisticated algorithm for ample allocation of resources to VM. Three proposed algorithm where compared that is (FFD, PABFD, and GPABFD) which indicate less difference but FFD outperform the rest PABFD and GPABFD[5].

AVVMC

The Ant Colony Optimization (ACO) is a meta-heuristic algorithm that is computer techniques influenced by the foraging behavior of some ant species. Such techniques demonstrate the resource utilization of active PMs Whereas when reducing power consumption at all dimensions. The algorithm outperforms the current other algorithms for ant colony optimization[13]

OEMACS Ant Colony

In a cloud environment, energy consumption leads to a significant percentage of the total cost. The explanation behind OEMACS's creation for VM placement is focused on the ACS approach where VM assignment is constructed based on ants ' global search details. To achieve maximum VM deployment, minimum active number hosts have been switched off and the other idle user node has been turned off. The infeasible and local search is undertaken to speed up OEMACS ' global converges, which contributes significantly to the development of the solution. The strong global search presence of ACS results in differentiated problems of different size. The algorithm has a significant advantage compared to heuristic algorithms that experience problems when the cloud expands to a large scale. The algorithm can be extended to various sizes and cloud system characteristics. OEMACS has managed to minimize the number of active hosts, integrate various resources, maximize resource utilization and cloud power consumption [14].

BANKER ALGORITHM

The strategy to optimize the VM positioning is being applied in IaaS clouds. The method shows better use of cloud data center capital and less energy consumption. The banker algorithm optimizes VM placement by means of a complex threshold that minimizes migration with greater energy efficiency compared with existing methods [15].

DRAGONFLY ALGORITHM

The algorithm is to control resource wastage for the data center to give way to better resource utilisation. The algorithm is good in a situation where by a local optima find out, but still can be roll back to get the global optima of the solution. The algorithm is compared with some other bio-inspired algorithm such as ant colony system (ACS), genetic Algorithm (GA), artificial bee colony (ABC) and binary particle swarm optimasation (BPSO) . the algorithm has faster convergence and less placement time then other algorithm compared with. The algorithm has greater coodination and capacity to maintain a good balance between explotation and exploration [16].

EQVPM

Power and networking within the cloud data center are some critical issues due to the enormous demand by application for bandwidth and strict latency it is very important to manage the data center efficiently with the minimum number of resources. A lot of researchers have focused more successfully in the cloud on VM placement for more usable resource and network use. Nonetheless, due to the unbalanced and antagonistic nature of the positioning but still congested ta center network. For the energy-efficiency and QoS-conscious placement system EQVMP is proposed. When considering hop delay, energy consumption, and network latency the algorithm decides successful VM placement. While the energy and delay performance technique is considered second best where it achieves 10 times the efficiency of other energy-conscious and delay-conscious positioning While the energy and delay performance technique is considered second best where it achieves 10 times the output of other energy-conscious and delay-conscious positioning [17]

MODIFIED BEST FIT DECREASING (MBFD)

Because of the growing growth of cloud computing where service providers on the correct host have a major challenge in the placement of virtual machine. The algorithm is for placement of VM which evaluates by two parameters the total number of virtual machine migration and total energy consumption in the cloud environment [18].

JAYA

This is one of the new bio-inspired algorithm with objective to reduce the energy consumption in both homegenous and heterogenous data center. The proposed work reduuce the active servers and service level agreement violiation SLAV. The algorithm is compred with particle swarm optimisation (PSO) and power aware best fit decreasing algorithms to find its effectiviness, but is not good in energy resouce allocation[19]

UNIFIED ANT COLONY ALGORITHM

Unified ant colony-based algorithm (UACS) deals with new inward-bound VM assignment and VM migration for virtual dynamic machine (DVMP) placement. The purpose of the algorithm is to determine minimum energy consumption and VM migration by guaranteeing user satisfaction from a global perspective. UACS used to decrease number of servers while increasing number of the party. The solution has a better positioning with less VM migration, lower energy use while maintaining user satisfaction criteria [20].

UTILITY FUNCTION ALGORITHM

The method is to create self-manage VM placement solutions that dynamically assign VM to host with respect to cloud data center resource utilization. The main objective of the methodology is to raise provider benefit by reducing the source of energy costs and cost differential for SLAVs. The important reason this approach differentiates from heuristics process is that it considers Physical Machine overloaded (PM overloaded) and Physical Machine under loaded (PM under loaded). After evolution, the proposed technique is observed to outperform the current heuristic-based approach for energy saving and minimizing SLAVs in both highly charged and lightly charged cloud data [21].

COOPARETIVE SWITCHING ALGORITHM FOR FORAGING (C-SAF)

The proposed algorithm is very efficient in searhing, homing and exploitation of resource. The algorithm has less aaverage foraging time in search for resource as such an optimal solution is quickily found. The algorithm is compared with some other foraging releted algorithm. The algorithm is bad in term of solving complex shape problem and resource that are close to the bourdaries[22]

PS-ES HEURISTIC

The algorithm is selection method for VM live migration placement, Ps-Es is an improved PSO-based technique. The proposed algorithm makes use of Simulated Annealing dependent twice of an assumption. Ps-Es improve the efficiency and efficacy of Particle Swam Optimization (PSO), and later optimize the entire approach.To obtain and process data, the algorithm utilized probability theory and mathematical statistics. Ps-Es minimizes incremental energy consumption whilst minimizing the number of VM migration failures[23].

NDAP Greedy Heuristic

The suggested aim is to address the network and multi-component device placement issue in a big data center and then identify their optimization issue. The algorithm as a standardized placement of heuristic applications, so it can be used in a variety of multi-tier or composite applications. The NDAP confirmed its effectiveness in reducing overhead coordination in two separate applications for multi-tier and science workflow. Meanwhile the proposed algorithm is flexible enough to be expanded to deal with more special cases in the future [24].

HEURISTIC MIGRATION-BASED VM PLACEMENT ALGORITHM

The suggested algorithm studies the problem of VM placement to minimize the total completion time for online and off-line scenarios within the cloud data centre. The algorithm is compared with other algorithms with a high approximation of the algorithm displaying the optimum solution. They are considered separately by the algorithm as user and service for integration of off-line and on-line placement [25].

MULTI-OBJECTIVE ANT COLONY (VMPACS)

A major research concern has become due to the rise in prevalence of large-scale cloud computing systems and how VM placement can be achieved on available servers. The proposed algorithm is a multi-objective ant colony method for VM problem. The algorithm's goal is to effectively find the collection of non-dominated solutions that simultaneously minimize energy consumption and resource waste in the cloud environment [26].

ADAPTIVE THREE-THRESHOLD ENERGY-AWARE ALGORITHM (ATEA)

Energy consumption is becoming more and more severe due to the development of large-scale cloud data centers. To address the problem of energy reduction and SLA breach, an adaptive three-threshold energy-aware algorithm (ATEA) with strong use of historical data from resource use by VM is proposed. The algorithm breaks down the data center into four groups of small load, high load, heavy load and moderate load hosts. These algorithms generally migrate to small charged hosts and migrate to moderately charged hosts[27].

COMPARISON OF RELATED WORKS TABLE

The table below provides a comparison of the work performed by the aforementioned resource management researcher and the energy usage of the cloud computing virtual machine placement. Table 1 contains six vertical divisions identifying authors/period, title article, methodology applied, methodology achievement, and comparison methodology and limitation of method.

Table : Comparison of Related Works

Authors/Period	**Paper Title**	**Methodology Applied**	**Methodology Achievement**	**Compared Method with**	**Limitation of the Method**
[27]	Virtual Machine Placement Algorithm for Both Energy – Awareness and SLA Violation Reduction in Cloud data	ATEA (Three Threshold Adaptive Power-Aware Algorithm)	Reducing energy use and the Service Level Agreement (SLA)	The algorithm was compared to: KAM-MMS, KAM-LCU, KAM-MPCM, KAIMPOM, and KAI-LCUM	The method is not responsible for energy costs in the data center
[26]	A Multi-Objective Ant Colony System Algorithm for Virtual Machine Placement in	VMPACS multipurpose ant colony	Minimizes overall waste of resources and electricity consumption	Approaches single goal ant colony	Does not apply to SLA

	Cloud Computing				
[25]	Migration-based Virtual Machine Placement in Cloud Systems	Heuristic approach MBVMP	Save Time for Resources and Migration	Best-fit and First-fit heuristic	Energy consumption and SLA
[24]	An Algorithm For Network and Data-Aware Placement of Multi-Tier Application in Cloud Data Centers	NDAP Greedy Heuristic	Resource usage	Linear and line arithmetic	Need more work on Power consumption, Energy cost, and SLA
[23]	A Heuristic Placement Selection of Live Migration for Energy-Saving in Cloud Computing Environment	PS-ES Heuristic	The algorithm aims to reduce power consumption and failure of VM migration events in the cloud data center	DAPSO, PS-ABC Random-Migration	Doesn't consider allocating resources and SLA
[21]	Optimizing virtual machine placement for energy and SLA in clouds using utility functions	Functional utility algorithm	Save energy and reduce SLAVs in both moderately charged and highly powered cloud data centers	Heuristic algorithms	Does not take care of the optimisation of capital
[14]	An Energy-Aware Unified Ant Colony System for Dynamic Virtual Machine Placement in Cloud Computing	Unified Ant Colony Algorithm	Get better placements with less VM migrations and lower energy use while preserving QoS requirements	Heuristic, probabilistic, and other Algorithms based on ACS	Does not consider the number of VMs in lager
[18]	Energy Optimized VM Placement in Cloud Environment	An optimal MBFD algorithm	Total energy consumption and number of computer virtual migrations within the device	Basic Algorithm for MBFD	Usage of the capital has not been considered
[17]	EQVMP: Energy-efficient and QoS-aware Virtual Machine Placement for Software-Defined Datacenter Networks	EQVMP	Consider energy consumption, the hop delay and the entire network	Random, MSSBP, and TVMP	SLA doesn't pay attention
[15]	Energy Efficient VM Placement Supported by Data Analytic Service	Banker algorithm	The approach promotes the use of data center services and decreases energy consumption	LRR and THR algorithms	SLA is not considered
[14]	An Energy-Efficient Ant Colony System for Virtual Machine Placement in Cloud Computing	Ant colony System algorithm	The method which minimizes the number of active servers, improves the use of resources, manages different resources and reduces the power consumption	FDD Algorithm	SLA not considered
[13]	Virtual Machine Consolidation in Cloud Data Centers using ACO Metaheuristic	Metaheuristic algorithm	The approach shows that the resource use of active PMs is reduced in all dimensions with also reducing the power consumption of PMs	Heuristic algorithms	Does not take Virtual machine and SLA into account
[5]	Consolidation of VMs to Improve Energy Efficiency in the Cloud Computing Environments	First fit decreasing algorithm	The algorithm suspends physical hosts and evaluates the impact of a new VM allocation over the energy consumption of the entire data center. They also allocate less	FFD, PABFD and GPABFD	SLA is not consider

			VMs than all other algorithms, including Energy-Unaware, in a heavy-duty cloud, where there are insufficient resources for every virtual machine currently in the system.		
[12]	Energy-Efficient Virtual Machine Replication and Placement in a Cloud Computing System	Dynamic programming and local search	The approach improves the cloud data center's energy efficiency, and increases the availability of resources.	First Fit Decreasing Algorithm	SLA
[11]	Energy-efficient virtual machine placement algorithm with balanced and improved resource utilization in a data center	EAGLE algorithm	The algorithm reduces the number of resource fragments and their size which also reduces the data center's energy consumption	First Fit Decreasing Algorithm	SLA
[22].	A Cooperative Switching Algorithm for Multi-Agent Foraging	Cooparetive Switching Algorithm for Foraging (C-SAF)	The algorithm is good for searching, exploitation and foraging at anverege time	Non-Cooparetive Switching Algorithm, C-Marking and Non cooparetive C-Marking algorithm	Cannot solve complex shape problem and close bourdaries
[19]	Virtual Machine Placement Using JAYA Optimization Algorithm	JAYA	e algorithm minimized energy consumption in both homogenous and heterogenous data center.	The algorithm is compared with PSO and power aware best fit decreasing algorithm	The algorithm is not good in energy resource allocation
[16]	Modified Dragonfly Algorithm for Optimal Virtual Machine Placement in Cloud Computing	Dragonfly Algorithm	The algorithm is for better resource utilization whichleads to reduction resource wastage and improve efficiency in energy of data center	The is compared with ACS, GA.ABC and BPSO	The algorithm does not have dynamic behaviour

III. CONCLUSION

Batter energy efficiency and resource utilization would be possible in various geographically distributed cloud computing environments with a proper placement of VM. Existing VM placement methods take into account different approaches, device expectations, data center features such as power consumption, resource use and SLA, as well as different assessment strategies. Similarly, the location of VM is a wide area of research with clear optimisation and objectives. Some of the approaches, such as are focused solely on one goal.Certain methods, such as try to incorporate multiple targets when making decisions to position VM. It could also see from the above that by always producing a good solution, Ant Colony is the most commonly employed process. Choosing the VM placement technique is extremely important for both cloud users and cloud providers. Comparative analysis becomes rather difficult with the inclusion of several parameters in a standard fashion of such techniques. VM placement algorithm performs well under such unique conditions / objectives whereby the efficacy of the previous algorithms is compared. Some of the metrics that can be used to measure and evaluate algorithm performance are data center resource-based energy consumption, SLA violation percentage, and VM migration number.

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