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Energy Efficiency in Virtualized Data Centers

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Abstract: The objective of this paper is to present a survey of virtualized data centers, the challenges of virtualization in data centers and the possible solutions for those challenges specially energy efficiency. Virtualization is used to minimize the challenges of resource management, dependability on the services and sometimes deployment. Although virtualization is very helpful to minimize the problems of energy efficiency but it comes with many other issues as well.

Introduction:

Now a day's data centers and big data are demanding more than ever. Big Data plays a vital role in industrial and information technology organizations. But as the data is growing fast, the challenges for data centers are also crucial more than it were ever.

Data centers have to face many challenges regarding security and energy efficiency and a lot of research is being done on the challenges faced and upcoming challenges of Big Data and also the possible solutions to meet these challenges. Our main concern is about the challenges regarding the energy efficiency. Many techniques and algorithms for energy efficiency have been introduced in last 10 years. Many researchers follow the techniques and algorithms of job scheduling, CPU scheduling and job distribution between computer servers. In [1] the idea to add the network awareness with energy efficiency was introduced to check and balance the energy usage in data centers. For this purpose a method named as DENS was used, which focus on how the job is performed individually and what are the demands of traffic. In order to lessen the number of computer server used it is a deal between job fortification and distribution of traffic patterns. To save energy two major techniques are used one is Dynamic Voltage and Frequency Scaling (DVFS) and second is Dynamic Power Management (DPM). DENS were used to minimize the hot spots in data centers by lessening the amount of computer networks [1].

Some other methods are also used to minimize the challenges of big data. Most important virtualization is used to minimize the challenges of resource management, dependability on the services and sometimes deployment. Server virtualization is also used to mitigate the challenges of efficiency. Those Data centers which used the technology of server virtualization by using Virtual machine with it is called virtualized data center. [2] Although virtualization is very helpful to minimize the problems of energy efficiency but it comes with many other issues as well.

Researcher is going to discuss the challenges of Virtualized Data Centers and their possible solutions. In Virtualized Data Centers the problem related to the management of resources and scheduling of tasks arises. As the nature of Virtual Machines is loosely coupled with the networks and other hardware resources so it becomes difficult to measure preciously that how much a resource is being used the parameters of running hardware. And that is the main reason of complexity in scheduling of tasks and the fair management of resources. In [3] task scheduling issue is discussed. The major goal is to improve the throughput, response delay should be low. Availability is the major part. The previous researches that were done on scheduling in Virtualized Data centers mainly consider the infrastructure layer but they totally ignore the service layer that is specified by SLAs. To meet this issue in [2] a multiclass model is introduced with the fuzzy prediction method and a dynamic scheduling algorithm of task is also introduced. Previously another algorithm was introduced for scheduling of job to maintain the energy consumption. That was cyber physical, spatio-temporal, thermal aware job scheduling algorithm [3]. That was useful to lessen the usage of energy in data centers and not affecting the performance. That was basically used for both physically efficiency and also the performance of internal working.

Resource management should be done effectively by considering the power consumption. To minimize the usage of electric power and to make good services the resizing of virtual machine is done with the compactness of server. The compactness of servers that is based on virtualization helps in improving the power efficiency. Another important aspect for virtualized data centers is to give a good quality of services (QoS) that a customer demands and that should be done in accordance with Service Level Agreement (SLA). For that purpose an integrity management solution [4] is was proposed in which the resizing of virtual machine is done

with the compactness of server with the novelty of integrated linear programming, ant colony optimization and control theory techniques [4]. The result of these algorithms shows that it achieves the low power usage in data centers and the performance will not be compromised.

Related work:

In recent years most work has been done for the power management in virtualized environment. Many researchers suggest the solution in server consolidation and many follow the technique of placing the Virtual Machine in data center platform. Now in [1] the work has been done by proposing a dynamic approach for managing and minimizing the power consumption in the clusters of virtualized servers. This strategy also considered the efficiency of power by focusing on the cost of servers when they are turn off or on. On the other hand in [2] an approach is presented to loosely couple and for the management of virtualization and for power co ordination to get the better results of placement of virtual machine and runtime analysis to achieve better saving in power consumption with the improvement in terms of SLAs.

[3] suggest the strategy in which VDCs are managed where the virtual machine is place in data center nodes to increase the benefits of the provider and this\ strategy also extends the result of [4,5] in which basic scheduling policy of virtualization was proposed. [6] Proposed a multi- tiered web-applications' scheduling in heterogeneous systems in virtualized environment. That is used to lessen the consumption of energy and performance is also achieved. Here a multidimensional packing problem is proposed to handle multiple resources optimization and used as solution for the consolidation of work load.

Whereas in [7] another algorithm is proposed that is not dependent on the workload type and is good in the environment of generis cloud. In [8] researchers have defined the placement of Virtual Machines in a power efficient way in heterogeneous virtualized environment. They have leveraged "min", "max" and "shares" parameters of VMM that represent minimum, maximum and proportion of CPU allocated to VMs sharing the same resources. Whereas in [8] a new approach is proposed where the power consumption is minimized and performance is maximized by optimizing the placement of Virtual Machines. The proposed algorithm is a heuristic for bin packing problem with different size and different costs but the information about the calculation of cost is not provided.

Several strategies are being proposed for the management of energy in servers, they mainly consider the techniques for energy optimization that are related to microprocessor environment for example in [9] it is stated that the problems in hardware and the rate of violation of SLAs can be increased by Dynamic Voltage/Frequency Scaling (DVFS) on if the servers are turned off. Then they solved it by introducing new compact policies for scheduling which will turn off the idle servers dynamically that will minimize the energy and power consumption.

Many techniques and algorithms for energy efficiency have been introduced in last 10 years. Many researchers follow the techniques and algorithms of job scheduling, CPU scheduling and job distribution between computer servers.

In [10] the idea to add the network awareness with energy efficiency was introduced to check and balance the energy usage in data centers. For this purpose a method named as DENS was used, which focus on how the job is performed individually and what are the demands of traffic. In order to lessen the number of computer server used it is a deal between job fortification and distribution of traffic patterns. To save energy two major techniques are used one is Dynamic Voltage and Frequency Scaling (DVFS) and second is Dynamic Power Management (DPM). DENS were used to minimize the hot spots in data centers by lessening the amount of computer networks [10].

In Virtualized Data Centers the problem related to the management of resources and scheduling of tasks arises. As the nature of Virtual Machines is loosely coupled with the networks and other hardware resources so it becomes difficult to measure preciously that how much a resource is being used the parameters of running hardware. And that is the main reason of complexity in scheduling of tasks and the fair management of resources. In [12] task scheduling issue is discussed. The major goal is to improve the throughput, response delay should be low. Availability is the major part. The previous researches that were done on scheduling in Virtualized Data centers mainly consider the infrastructure layer but they totally ignore the service layer that is specified by SLAs. To meet this issue in [11] a multiclass model is introduced with the fuzzy prediction method and a dynamic scheduling algorithm of task is also introduced. Availability is the main issue that a scheduling algorithm should consider. An efficient task scheduling scheme for virtualized data centers was introduced that was a good tradeoff between availability and performance. First a fuzzy prediction method was introduced to model the uncertain workload in virtualized servers and after that an online dynamic task scheduling algorithm was introduced, called as SALAF (Scheduling Algorithm based on Load-balance and Availability Fuzzy prediction). It maintains the better performance and improves the total availability.

Previously another algorithm was introduced for scheduling of job to maintain the energy consumption. That was cyber physical, spatio-temporal, thermal aware job scheduling algorithm [12]. That was useful to lessen the usage of energy in data centers and not affecting the performance. That was basically used for both physically efficiency and also the performance of internal working.

Most recently in [14] an algorithm is used that make the virtual machines compact so that the physical node in the environment with the similar server can be minimized. The ACO algorithm proposed in [16] is slightly different from the above algorithm because it can be applied in both heterogeneous and homogenous environments.

Resource management should be done effectively by considering the power consumption. To minimize the usage of electric power and to make good services the resizing of virtual machine is done with the compactness of server. The compactness of servers that is based on virtualization helps in improving the power efficiency. Another important aspect for virtualized data centers is to give a good quality of services (QoS) that a customer demands and that should be done in accordance with Service Level Agreement (SLA). For that purpose an integrity management solution [13] is was proposed in which the resizing of virtual machine is done with the compactness of server with the novelty of integrated linear programming, ant colony optimization and control theory techniques [13] The proposed ant algorithm is mainly related to the following elements: (1) heuristic information; (2) pheromone trail; (3) selection probability; (4) pheromone updating rule; (5) local search. Specific implementation of these elements results in distinct ant algorithms with varying degrees of success. The result of these algorithms shows that it achieves the low power usage in data centers and the performance will not be compromised [13].

In order to allocate the resources dynamically and for power management prediction based approaches were used then an algorithm was introduced that works as to make queue of information that is available and this queuing of information will help in making better decisions online and it also use Lyapunov Optimization technique for the allocation of resources [17].

Another approach for virtualized data center is used in [18] which consider many different angles of data center nodes while placing the Virtual Machines which eventually help in increasing the profit of provider. This algorithm applies a simple algorithm for optimization. This approach blends many factors like the overhead generated by virtualization, software requirements and power efficiency [18].

Performance evaluation:

To decide that which Virtual Machine should be combined in a single physical server and how it is to be done. Migration of Virtual Machine that is used in server consolidation has an immediate effect on the response time of service. It is been experimented that if migration of Virtual Machine is minimized to a certain amount then it will reduce the number of migration as well as the penalty on the physical servers is also reduced. For that an algorithm was designed that is

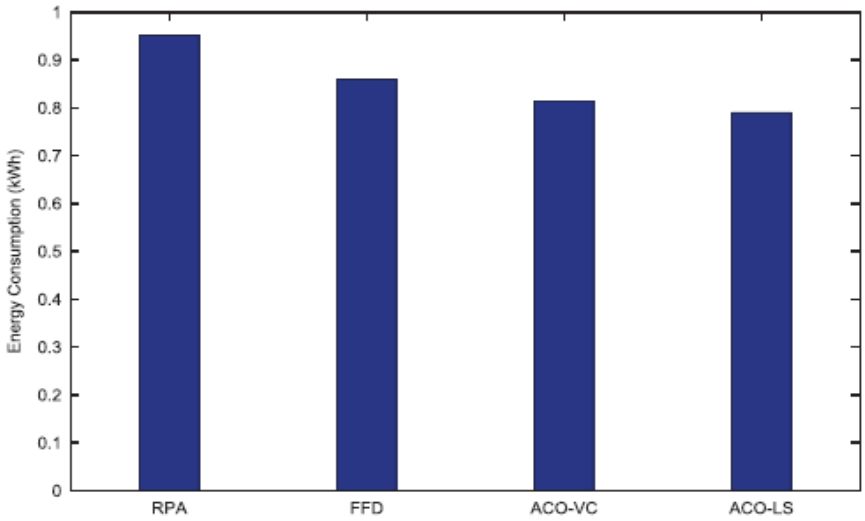
Dynamic consolidation with migration control, the main contribution of this algorithm is a LP formulation and heuristics to control VM migration which prioritize the virtual machine with steady capacity.

To achieve energy efficiency with the quality of service another algorithm is propose that uses the server consolidation along with the advantage of resizing of virtual machine. That algorithm is known as integrated management solution. The novelty in this solution is to integrate linear programming, ant colony optimization, and control theory techniques [1]. The results of this algorithm show that this approach can save about 41.3% of power as compared to those systems that are uncontrolled. The Ant Colony Optimization (ACO) algorithm is validated in Xen virtualized environment for energy optimization and performance control. To check the efficiency of ACO we will compare it three other algorithms that is first fit decreasing algorithm (FFD), an ACO

Comparison results of ACO-LS and three competing algorithms.

Problem	Algorithm	*N*	Power (W)
70 × 100	RPA	67.9	20,166
	FFD	64.8	18,066
	ACO-VC	60.9	17,286
	ACO-LS	58.5	16,793
140 × 200	RPA	134.7	39,736
	FFD	127.8	35,245
	ACO-VC	120.1	33,674
	ACO-LS	115	32,595
210 × 300	RPA	201.3	60,189
	FFD	192.1	54,537
	ACO-VC	177.7	51,513
	ACO-LS	170.2	49,894
280 × 400	RPA	264.1	78,702
	FFD	248.3	70,913
	ACO-VC	228.4	66,674
	ACO-LS	218.3	64,403
350 × 500	RPA	331.0	98,969
	FFD	311.3	88,554
	ACO-VC	285.8	83,046
	ACO-LS	273.4	80,140

algorithm without local search strategy (ACO-VC) and a random placement algorithm (RPA). The proposed algorithm is (ACO-LS). It is a random placement algorithm that starts its execution with the placement of all VMs and the servers' lists in a random order [2]. The following table and graph shows the comparison of above four algorithms [2].



Energy consumption for four algorithms [2]

Availability is the main issue that a scheduling algorithm should consider. An efficient task scheduling scheme for virtualized data centers was introduced that was a good tradeoff between availability and performance. First a fuzzy prediction method was introduced to model the uncertain workload in virtualized servers and after that an online dynamic task scheduling algorithm was introduced, called as SALAF (Scheduling Algorithm based on Load-balance and Availability Fuzzy prediction). It maintains the better performance and improves the total availability. The experimental results show that the proposed algorithm could efficiently improve the total availability of VDCs while maintaining good responsiveness performance.

The system that is used for energy accounting in shred virtualized environment is based on performance monitor counter (PMC). Its shows that PMC based models still can be used for virtualized environments secondly it proves that Dynamic Voltage and Frequency Scheduling (DVFS) will not affect the accuracy and another new method is introduced for the accounting of optimal energy consumption in virtualized environment. The total results for an Intel Core 2 Duo show errors in energy estimations <5%. This estimation can be used to generate more accurate chargeback models, since, as we have shown, VMs machines executed during the same amount of time, presented more than 20% variations in energy consumption. [3].

Conclusion:

Virtualization is used to minimize the challenges of resource management, dependability on the services and sometimes deployment. Although virtualization is very helpful to minimize the problems of energy efficiency but it comes with many other issues as well. In this paper we have done a survey on virtualized data centers and the main challenges of virtualized data centers and got some solutions in form of different algorithms and methodologies and check their performance. Many methods are included related to energy efficiency, task scheduling and quality of service.

REFRERENCES:

[1]. V. Petrucci, O. Loques, D. Mossé, A dynamic configuration model for power efficient virtualized server clusters, in: Proceedings of the 11th Brazillian Workshop on Real-Time and Embedded Systems, WTR 2009, Recife, Brazil, May 25, 2009.

[2]. Quality of service aware power management for virtualized data centers Yongqiang Gao a, Haibing Guan, Zhengwei Qi a, Bin Wanga, Liang Liu b a Shanghai Key Laboratory of Scalable Computing and Systems, Department of Computer Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China IBM Research – China, Beijing 100193, China

[3]. S. Kumar, V. Talwar, V. Kumar, P. Ranganathan, K. Schwan, vManage: loosely coupled platform and virtualization management in data centers, in: Proceedings of the 6th International Conference on Autonomic Computing, ACM, 2009, pp. 127–136.

[4]. Í. Goiri, F. Julià, R. Nou, J. Berral, J. Guitart, J. Torres, Energy-aware scheduling in virtualized datacenters, in: Proceedings of the 12th IEEE International Conference on Cluster Computing, Cluster 2010, Heraklion, Crete, Greece, September 20–24, 2010, pp. 58–67.
[5]. resource management for dealing with heterogeneous workloads in virtualized data centers, in: Proceedings of the 11th ACM/IEEE International Conference on Grid Computing, Grid 2010, Brussels, Belgium, October 25–29, 2010, pp. 25–32.
[6]. S. Srikantaiah, A. Kansal, and F. Zhao, "Energy aware consolidation for cloud computing," Cluster Computing, vol. 12, pp. 1–15, 2009.
[7]. Energy Efficient Resource Management in Virtualized Cloud Data Centers Anton Beloglazov* and Rajkumar Buyya
[8]. Cloud Computing and Distributed Systems (CLOUDS) Laboratory Department of Computer Science and Software Engineering The University of Melbourne, Australia
[9]. M. Cardosa, M. Korupolu, and A. Singh, "Shares and utilities based power consolidation in virtualized server environments," in Proceedings of IFIP/IEEE Integrated Network Management (IM), 2009.
[10]. Verma, P. Ahuja, and A. Neogi, "pMapper: power and migration cost aware application placement in virtualized systems," in Proceedings of the 9th ACM/IFIP/USENIX International Conference on Middleware. Springer-Verlag NewYork, Inc., 2008, pp. 243–264.
[11]. Chun, G. Iannaccone, R. Katz, G. Lee, L. Niccolini, An energy case for hybrid datacenters, ACM SIGOPS Operating Systems Review 44 (1) (2010) 76–80.
[12]. 2010 IEEE/ACM International Conference on Green Computing and Communications & 2010 IEEE/ACM International Conference on Cyber, Physical and Social Computing, DENS: Data Center Energy-Efficient Network-Aware Scheduling Dzmitry Kliazovich and Pascal Bouvry University of Luxembourg.
[13]. Energy accounting for shared virtualized environments under DVFS using PMC-based power model Ramon Bertran a,∗, Yolanda Becerra a,b, David Carrera a,b, Vicenç Beltran a, Marc Gonzàlez a,b,Xavier Martorell a, Nacho Navarro a,b, Jordi Torres a, Eduard Ayguadéa.
[14]. Efficient dynamic task scheduling in virtualized data centers with fuzzy prediction Xiangzhen Kong a,n, ChuangLin a, YixinJiang a, WeiYan a, XiaowenChu b a Department ofComputerScienceandTechnology,TsinghuaUniversity,Beijing100084,PRChina b Department of Computer Science, Hong Kong Baptist University, Hong Kong, PR China
[15]. Quality of service aware power management for virtualized data centers Yongqiang Gao a, Haibing Guan a,⇑, Zhengwei Qi a, Bin Wanga, Liang Liu b a Shanghai Key Laboratory of Scalable Computing and Systems, Department of Computer Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China b IBM Research –China, Beijing 100193, China
[16]. H. Mi, H. Wang, G. Yin, Y. Zhou, D. Shi, L. Yuan, Online self-reconfiguration with performance guarantee for energy-efficient large-scale cloud computing data centers, in: Proceedings of 2010 IEEE International Conference on Services Computing, IEEE, pp. 514–521.
[17]. E. Feller, L. Rilling, C. Morin, Energy-aware ant colony based workload placement in clouds, in: Proceedings of the 2011 IEEE/ACM 12th International Conference on Grid Computing, IEEE Computer Society, pp. 26–33.
[18]. Dynamic Resource Allocation and PowerManagement in Virtualized Data Centers Rahul Urgaonkar, Ulas C. Kozat, Ken Igarashi, Michael J.
[19]. Energy-efficient and multifaceted resource management for profit-driven virtualized data centers Íñigo Goiri ∗, Josep Ll. Berral, J. Oriol Fitó, Ferran Julià, Ramon Nou, Jordi Guitart, Ricard Gavaldà, Jordi Torres Universitat Politècnica de Catalunya and Barcelona Supercomputing Center, Jordi Girona 31, 08034 Barcelona, Spain.
[20]. Energy Efficient Resource Management in Virtualized Cloud Data Centers Anton Beloglazov* and Rajkumar Buyya Cloud Computing and Distributed Systems (CLOUDS) Laboratory Department of Computer Science and Software Engineering The University of Melbourne, Australia.
[21]. Y. Ajiro, A. Tanaka, Improving packing algorithms for server consolidation, in: Proceedings of the International Conference for the Computer Measurement Group (CMG), pp. 399–406.
[22]. E. Feller, L. Rilling, C. Morin, Energy-aware ant colony based workload placement in clouds, in: Proceedings of the 2011 IEEE/ACM 12th International Conference on Grid Computing, IEEE Computer Society, pp. 26–
[23]. D. Kusic, J. Kephart, J. Hanson, N. Kandasamy, G. Jiang, Power and performance management of virtualized computing environments via lookahead control, Cluster Computing 12 (2009) 1–15.