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Optimal Virtual Machine Allocation and Migration Model Based on PCA-BFD

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Abstract: This paper comprises of two sections, in the first section study the various energy aware best fit decreasing algorithms like BFD, MBFD, PCA-BFD, and EPOBF, and comparison has been done on the basis of past data. Study shows that PCA-BFD is the best algorithm for energy efficiency. In the second part of this paper PCA-BFD is used for migration purpose. First of all load of all host are evaluated and find the overloaded and under loaded server known as hot-spot node. That node whose load is balanced is considered as non hot-spot node. Virtual machines in hot-spot nodes are sorted in descending order so those high power consumption nodes migrate first. Non hot-spot nodes are sorted in ascending order so low power consumption server are firstly filled.

Keywords: energy efficiency, PCA-BFD, migration, allocation, load balancing.

I. Introduction

Cloud computing is a service delivery where resources are provided to the users through internet. It is dynamic scalable technology which is developing to satisfy changing requirement of users. It is a pay per use model. Data center of cloud computing consumes large amount of electrical energy which increases operational cost [1]. Along with increased cost, it's another adverse affect is increased emission of CO_2 gas which leads to green house effect [2].

II. Related Work

Nguyen Quang-Hung et al. [3] has studied the VM allocation problem for the reduction of energy consumption for the fulfillment of QoS that is the resource and performance availability in HPC cloud. The author has presented EPOBF that is the power aware allocation heuristic for the VMs in HPC cloud. In HPC scheduler, performance of VM migration in terms of energy consumption is measured in watts. The experiments have depicted the less energy consumption as compared to existing power aware heuristics. The EPOBF-ST and EPOBF-FT heuristics are considered as novel VM allocation solution in the cloud data centre with multi core PM (physical machine). EPOBF-FT and EPOBF-ST are considered to the better as compared to PABFD and VBP L1/L2/L30 allocation heuristics.

Zoltán Ádám Mann et al. [4] has investigated the performance that guarantees to be rigorously shown for the heuristics. Particularly, the author has established that MM (Minimization of Migrations) is better as compared to number of selected VMs (Virtual machines) for over-utilized host. It has been shown that the outcome of MBFD could be significantly far from the better. In addition, the author has shown that MM as well as MBFD can provided optimal results.

Fahimeh Farahnakian et al. [5] has proposed dynamic VM (virtual machine) consolidation concept for the elimination of the VMM which is not required. The utilized approach has lessened the SLA (Service level agreement) with a utilization prediction model. The proposed approach has migrated few of the VMs from the physical hosts being overloaded or assumed to be overloaded. The proposed approach has assigned the VMs to the host as per the existing and the future needs. As compared to the another VM consolidation algorithms, the proposed work not only lessened the energy consumption but also has reduced the VM migration and number of SLA violation.

Varasteh A et.al. [6] In BF algorithm the PM with least number of resources that are enough to accommodate a targeted VM is selected for placement. The benefit of this technique is minimal residual resources of physical machine Minimal residual resource is the difference between capacity of PM in term of total resources and the utilized resources of the PM including the target VM.

S. Martello et.al. [7] According to author BFD algorithm, VMs is firstly arranged in the descending order according to their resource requirement and then BF algorithm is applied to this sequence one by one. BFD utilizes smaller machines first and keep the larger machines for future use which increase the mean resource utilization ratio. The short coming of BFD algorithm is that it does not focuses on the power efficiency of a machine. The PM with lowest power consumption is not considered first for VM placement.

Beloglazov, A et.al. has developed a algorithm for VMs allocation i.e. MBFD. It is a variant of BFD. In the former, that PM is selected which shows minimum change in energy consumption after the VM placement. The MBFD model calculates energy consumption by the formula as:

$$P_{AP} = k \, . \, P_{max} + (1\text{-}k) \, P_{max} \, . \, u$$

Here k is the power consumed by an unused server i.e. it is minimum power that will be used by the server. It is considered 70% here because an idle server consumes at least this power and u is the CPU utilization. P_{max} is the maximum power consumed when host is completely utilized. P_{AP} is power consumption after placement. Now, after calculation of P_{AP} , P_{diff} is calculated as:

$$P_{diff} = P_{AP} – P_{BP}$$

The machine with minimum P_{diff} value is selected for VM placement.

N. Tziritas et.al. [8] Has proposed a PCA-BFD algorithm, which is a modification of BFD algorithm. In this algorithm, ratio of maximum power consumption (P_{max}) and maximum CPU utilization (CPU $_{max}$) is calculated. The PMs are then arranged in increasing order according to this ratio and the machine with lowest ratio is selected for placement.

$$R = P_{max} / CPU_{max}$$

The lower ratio here shows that a server gives higher CPU utilization at low power consumption.

III. EVALUATION OF PLACEMNET ALGOS:

In this section, evaluation of various placements algorithms is done on CloudSim tool. CloudSim is a java library which is used as a simulator for analysis. In this evaluation BFD, MBFD, PCA-BFD and EPOBF algorithms are compared. To increase the accuracy of analysis, various migration techniques have also been included into the evaluation. These algorithms are evaluated on two workloads: i) Lowest Workload (LL) : when there are 898 VMs executing on 400 servers ii) Maximum Workload (ML): when 1516 VMs are executed on 400 server. The output of evaluation is: Energy Consumption on Lowest Load (ELL) and Energy Consumption on Maximum Load (EML)

Allocation Policies / Migration Policies	BFD	MBFD	PCA-BFD	EPOBF
Maximum Correlation (MC)	ELL 100 EML 125	ELL 110 EML 150	ELL 80 EML 100	ELL 110 EML 160
Minimization of Migration Time (MMT)	ELL 100 EML 124	LL 135 ML 170	ELL 75 EML 95	ELL 140 EML 165
Maximum Utilization (MU)	ELL 120 EML 130	LL 150 ML 175	ELL 75 EML 110	ELL 154 EML 170
Random Selection (RS)	ELL 95 EML 130	LL 125 ML 160	ELL 80 EML 105	ELL 130 EML 160

Figure representing Energy consumption of placement algorithms on migration technique in KW

Fig.1

The first cell of this table shows that when MC algorithm is executed for VM migration and BFD algorithm is used for VM placement then the ELL is 100 KWatts and MLL is 125 KWatts. From the above results, it can be concluded that performance of PCA-BFD in terms of energy consumption is best than other algorithm and the results do not much vary on different migration algorithms also.

IV. DESIGN OF SYSTEM MODEL

Working of PCA-BFD algorithm is almost same to BFD algorithm with the only difference that PCA-BFD arranges the server machines in the increasing order according to ratio of power consumption and CPU utilization which is calculate as under:

$$P_{max} / CPU_{max}$$

To clarify the actual working of given algorithm through illustration. Consider there are five server having different power capacity and CPU capacity as under:

Server 1: P_{max} =7 CPU_{max} =14
Server 2: P_{max} =6 CPU_{max} =8
Server 3: P_{max} =5 CPU_{max} =8
Server 4: P_{max} =5 CPU_{max} =17
Server 5: P_{max} =6 CPU_{max} =14

Initially calculate the P_{max} / CPU_{max} ratio of each server i.e. {0.5, 0.75, 0.625, 0.29, 0.43} respectively. Next rearrange these hosts in growing order according to the calculated ratio. The server 4 is considered as the best server, so in our example PCA-BFD will firstly select Sever-4 to fill, and then it will considered Server-5 and finally Server-2 will considered at last.

Power/ CPU ratio of each machine in increasing order 0.29, 0.43, 0.5, 0.625, 0 .75

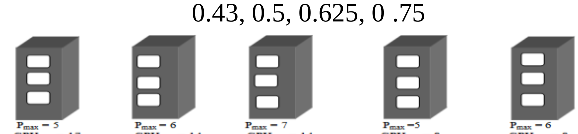

Fig.2

Load monitoring Program: The job of load monitoring program is to monitor the load of PMs continuously. If any under loaded or over loaded PM is found then it is marked as a victim node and it is entered into the queue. Depending upon the load, three queues are maintained.

Queue NPM maintains list of all nodes that has normal load i.e. loaded between lower threshold and upper threshold.

The queue VPM1 is maintained to store nodes that are underutilized. The purpose of this queue is to assign all VMs of the victim nodes of aforementioned queue to another node which will be selected by PCA-BFD algorithm. The freed PMs are then turned off which enhances the energy efficiency in cloud data centers.

Another queue VPM2 is used to maintain list of over-loaded nodes. The VMs of every victim nodes that are present in this list are then sorted in the descending order according to their power utilization. On or more VMs of a PM are selected for migration until load gets balanced. The selected VMs are added to the allocation list and the procedure for all victim nodes.

Proposed algorithm for Enhanced energy efficiency using PCA-BFD

i) Create VMs and add to Allocation_list on user request.
ii) Allocate all VMs of Allocation_list to PM using PCA-BFD policy
iii) Load monitor check PM_i to PM_N
   If PM_i < Lower_util then
      PM_i.add(VPM1)
   Else if PM_i > Upper_util then
      PM_i.add(VPM2)
   Else
      PM_i.add(NPM)
   End if;
iv) For $VPM1_i$ to $VPM1_N$ loop
   Allocation_list.add($VPM1_i$.VMs)
   Switch_off($VPM1_i$)
   End loop;
v) Sort VMs of every PM on VPM2 list in Descending Order according to power utilization
vi) For $VPM2_i$ to $VPM2_N$ loop
   a. Remove top most one or more VMs from the $VPM2_i$ and add to Allocation_list until $VPM2_i$ reaches stable state.
   b. Go to step 2;

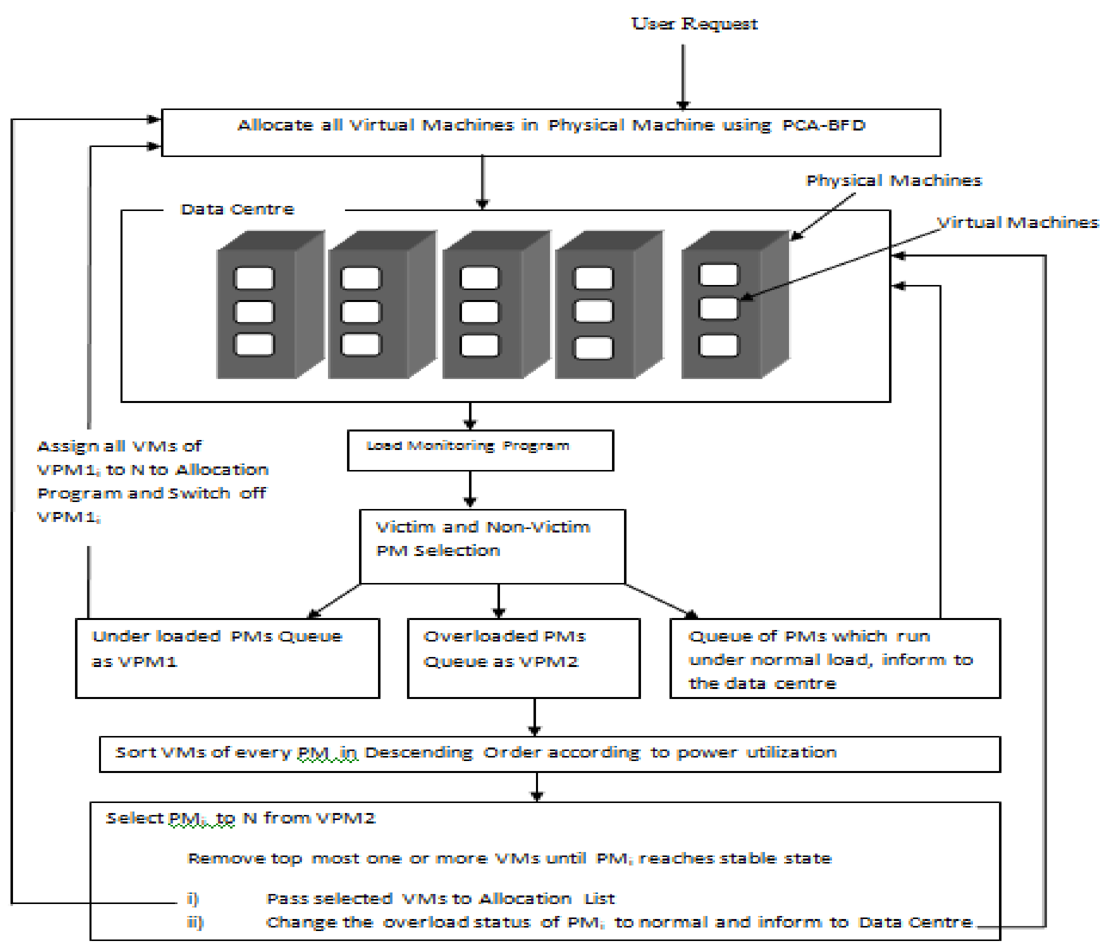

Figure.3 Showing Proposed Framework for Enhanced Energy Efficiency using PCA-BFD algorithm

V. Conclusion and Future Scope

In this paper, the use of PCA-BFD placement algorithm for migration purpose itself can be proved very useful. The load monitoring program checks load of PMs continuously. If under loaded or over loaded nodes are found then some or all VMs are selected and added to the allocation list and further PCA-BFD algorithm is applied on this list to place its VMs on PMs. The proposed algorithm helps data center to achieve better load balancing and it also helps in reduction of migration overheads.

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