AN IMPROVED RESOURCE SCHEDULING BY DYNAMIC RESOURCE AWARE LIVE MIGRATION TECHNIQUE

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Abstract: The main objective of this method is to improve the resource scheduling with the consideration of the available resource capacity and the load level of resources. It is done in the infrastructure as a service in the cloud computing with the concern of both physical and network characteristics that includes parameters like CPU, memory, storage, bandwidth and so on. The proposed methodologies in this work are named as Balanced Workload based Resource Scheduling (BWRS) and Dynamic Resource aware Live Migration (DRLM). BWRS attempts to schedule the tasks in the resources by considering the factors like CPU, memory, storage, network link capacity, bandwidth and disk capacity including the workload level that are submitted by the users. DRLM attempts to migrate the tasks in the resource in case of increased load level. The proposed methodologies examines the prospect to place the Virtual Machines in a flexible mode to improve the speed of discovery the best allocation on the premise of permitting the maximum utilization of resources and reducing the energy consumption. Experimental results show that proposed algorithms efficiently utilise the resources in cloud data centres, and the multi constraints for resources contain good balanced utilizations, which signify their promising energy saving capability. The performance comparison is done under the parameters called the makespan, computation cost and the processing overhead.
Keywords: Infrastructure as a Service (IaaS), virtual machines (VMs), physical machines (PMs), Live Migration and Resource Scheduling.

I. INTRODUCTION

Cloud computing has emerged as one of the most promising compute platforms for the future [1], [2], [3]. Clouds have a distinct benefit over conventional data centres in offering elasticity and acquiring increased resource utilization. Elasticity from a customer's viewpoint is the capacity to maximize or minimize the amount of resources which is needs to reserve for it. Elasticity from a providers' viewpoint is the capability to faultlessly move resources from one customer to another in reaction to demand variation, consequently permitting the cloud to perform at high resource utilization. Virtualization is one of the technology which is used to enables both elasticity and high resource utilization. To obtain the double objectives, clouds host diverse applications as virtual machines on a shared physical server to attain increased resource utilization. Additional, the resources allocated to any set of applications hosted on the cloud can shrink/expand according to the workload intensity. The virtualization layer offers the necessary isolation layer between applications running on the same physical server. Lower server utilization causes an enormous waste of electricity, the data collected from more than 5000 production servers over a six month period have shown that even if servers typically are not inactive, the utilization infrequently schemes 100% [4]. Usually servers perform at 10%-50% of their full capability, important to additional operating cost on over-provisioning and extra Total Cost of Acquisition (TCA) [4]. Furthermore, power consumption gives high cost in ancillary cooling facilities, which will unquestionably increase the cost of operation. Thus, it is a vital requirement to determine new solutions to minimize the energy consumption in data centres. Now, most of physical servers in cloud data centre use virtualization technology, which runs multiple virtual servers on the same PM so as to increase resource utilization and minimize the power consumption. In addition, virtualization also assists cloud providers to obtain more flexible and well effective management. For public cloud with virtualization, one of its most important services is IaaS, such as Amazon EC2 [1]. Tenants pay to rent VM resources, according to the service level agreements (SLAs), cloud providers take benefits of VM's bendable placement on PM to attain better the resources allocation in order to reach the tenants demands. In view of the fact that various resource utilization is reasoned by several mappings between VMs and PMs, so in favour of cloud providers, the important problem should be how to place multiple VMs demanded by tenants onto physical servers in order to reduce the number of active physical resources and minimize the power consumption, and in the same way, operation and management costs will be reduced. At the present time, VM scheduling is becoming a hot subject. At present, the first issue for VM scheduling problem is how to optimize the power consumption of both PMs and network elements such that switches, routers, links, etc. There are generally two examine types based on different resources optimization: one is to combine VMs to get better PM utilization [5-8]. However these researches ignore the impact of network topology and communication traffic parameter. In fact, as the limited resources in data centre, network resources have a direct impact on application performance [9]. The other type uses VM scheduling approach to get better network traffic [10, 11], but these systems basically believe that adequate resources are offered while placing VM to PM, and doesn't analyze the issue on how to optimize PM's CPU, memory, storage etc. The second challenge is how to design a two-stage VM scheduling in static placement and dynamic migration [6]. Dynamic migration refers to VMs demand to be re-correct while VMs do not correspond with PMs in the initial computation, in particular when VMs meet workload fluctuations in running in order that VMs will migrate dynamically [12]. Static placement distress the objective function accuracy, at the same time as dynamic migration mainly concerns how to reduce the migration cost. As a result, different VM scheduling should be taken in these two stages.

II. RELATED WORKS

There are two interests on VM scheduling issue. One of the issues is how to place VM based on the physical servers [5-8]. Verma et al. [5] dynamically re-correct server's location and analyze the migration cost and energy consumption; it illustrates that dynamic migration approach comprehends low energy cost. Bobroff et al. [6] supports prediction approaches when reducing the number of active PMs, and present mechanism for dynamic migration of VMs based on a workload forecast. Dong et al. [7] propose a static VM placement technique to minimize both the numbers of PMs and network elements in a data centre which is used for minimizes the power consumption, although, this technique doesn't analyze the dynamic VM migration. Wang et al. [8] analyze the combining of both bandwidth of VM and PM as a random packing NP-hard problem (SBP). However, these algorithms only analyze the PM optimization, and pay no attention to the optimization of other resources.

M. Wang, X. Meng and L. Zhang [8] provide the VM bandwidth demand by random variables subsequent probabilistic distributions. This system believe the consolidation of VM bandwidth with PM bandwidth as a random packing NP-hard trouble, it shows certain size of VM is loaded onto a PM with a probability distribution and the main aim of optimization is reducing the number of PMs. However this technique ignores the impact of network topology and VM network traffic. It only supports PM optimization, and doesn't consider the optimization of other resources.

Srikantaiah S, Kansal A, Zhao Feng [13] demonstrates numerous of the difficulties in performing consolidation for power optimization, and introduces probable research directions to overcome the issues. Primary step for enabling energy efficient consolidation, this works the inter-relationships between power consumption, resource utilization, and performance of consolidated workloads. The system discloses the energy performance trade-offs for consolidation and illustrates that optimal operating points exist.

Beloglazov A, Abawajy J, Buyya [14] demonstrates another benchmark VM selection technique that is a VM migration aware approach is also known as Single Threshold (ST). It is founded on the design of setting the upper utilization threshold for hosts and placing VMs, while keeping the total utilization of CPU below this threshold. Here every time frame all VMs are reallocated using the MBFD (Modified Best Fit Decreasing) with additional condition of keeping the upper utilization threshold not despoiled. The results illustrated that with the growth of the utilization threshold power consumption reduces, while the percentage of SLA violations increases. Given that a higher utilization threshold provides more aggressive consolidation of VMs by the cost of the increased risk of SLA abuses.

Jiankang D.et.al [15] presents a VM scheduling scheme which is considering conditions of multiple resources such as the physical server size (CPU, memory, storage, bandwidth, etc.) and network link capacity. These considerations are used to minimize both the numbers of active PMs and network elements in order to finally reduce power consumption of the system. Because VM scheduling issue is defined as a mixture of bin packing problem and quadratic assignment problem. This VM scheduling problem is also called as a classic combinatorial optimization and NP-hard problem. Consequently, a balanced workload for PMs should be a major problem concern and live migration does not maintain the size change of VMs in running.

Wood et al. [16] proposed few migration approaches. One of the approaches was to compute a value to choose which physical server to place VM. The value was attained by average utilization of CPU, memory and network bandwidth. Tian et al. [17] proposed a dynamic and integrated resource scheduling approach for cloud data centres. This technique used a variance to point out load imbalance level comparing utilization of CPU, memory and network bandwidth of a single server. Even though these techniques support the multiple resources while scheduling the resources, they treated the resources as one abstract capacity and did not analyze the power consumption in cloud data centres.

III. REVIEW OF OUR PREVIOUS STUDY

This work proposes an optimal VM scheduling scheme on the basis of multiple resources constraints by cross-optimizing VMs placed on PMs to minimize the numbers of activated PMs and network elements, thereby reducing the energy costs in data centre. Based on this, here propose a two-stage scheduling strategy:

- In static VM placement, the optimization of the PM resources is abstracted as a multi-dimensional Bin Packing Problem (BPP) to reduce the number of activated PMs; while for the optimization of network resources, the network topology and the current network traffic is abstracted as the quadratic assignment problem (QAP) so as to put the large traffic between VMs into the same PM or the same network switch. Once network communication cost is small, the number of required network elements will be reduced. As is well known, BPP and QAP is NP- hard problem, thus here take a new greedy algorithm to solve.

- In dynamic VM migration, the number of migrated VMs is taken as migration costs. In a given number of VM migrations, here attempt to optimize the network performance and energy consumption, and apply a new heuristic algorithm to solve.

In this VM scheduling scheme, here consider multi-resource constraints of PM and network bandwidth and attempt to save energy consumption. Here propose to optimize both PM resources energy and network resources energy. This work abstracts VM placement problem as a combination of multi-constraint BPP and QAP. After analyzing the advantages and disadvantages of the selected algorithm, here propose a new two-stage heuristic algorithm to solve such problem. The main aim in this work is to reduce the quantity of physical resources to save energy consumption in data centre, but there are still some potential problems. On the one hand, if on the same PM increasingly VMs are placed then overload of physical resources will happen. Due to this physical resources overload may have influence on VM resource expansion. On the other hand, if more network traffic aggregates on the same network link, network link utilization will be improved, but it will also bring network congestion.

IV. PROPOSED RESOURCE SCHEDULING SCHEME

In IaaS, cloud providers rent resources for tenants, and tenants sign SLAs with cloud providers to guarantee the service performance. Our proposed resource scheduling scheme is mainly for cloud providers without violating SLAs as possible, that is, on the premise of ensuring the performance. The main concern for cloud providers should be how to design resource scheduling scheme to improve the physical resource utilization in the resource pool and reduce the numbers of active PMs and network elements, so our scheme will finally reduce the operation cost in data centre by means of reducing the hardware investment and energy consumption. Our main contributes is how to reduce number of PMs used while different sizes of VMs are mapped to PMs with different sizes. Meanwhile, some resource constraints such as CPU, memory, storage, network link capacity, bandwidth and disk capacity should be considered. When an application arrives, the cloud data centre rents a VM to the application.

4.1 Balanced Workload based Resource Scheduling (BWRS) algorithm

The BWRS algorithm shows where to place the VM to get a better balance utilization of resource components among a physical server considering resource consumption. Algorithm BWRS includes three basic steps: 1) calculate each component capability of every physical sever; 2) get each component capability of the VM; 3) get the smallest value of Imbalance Utilization Value , and allocate the VM to that sever. Imbalance Utilization Value is used to match the VM and the server to get the best balanced utilizations between multi-dimensional resources.

IUVi is defined as the Imbalance Utilization Value (IUVi) among multi-dimensional resources of physical server i. Here we assume that the new VM is placed on the physical server i. And the current average CPU utilization, average memory utilization, average network bandwidth utilization are CPU_i^U, MEM_i^U and NET_i^U. The imbalanced utilization value (IUVi) of sever i is define as

$$\text{IUVi} = \frac{(CPU_i^U - IR_i^U)^2 + (MEM_i^U - IR_i^U)^2 + (NET_i^U - IR_i^U)^2}{3} \quad \text{----> (1)}$$

Where, $IR_i^U = \frac{CPU_i^U + MEM_i^U + NET_i^U}{3}$

IUVi is used to match the VM and the server to get the best balanced utilizations between multi-dimensional resources.

Algorithm 1: Balanced Workload based Resource Scheduling (BWRS) algorithm

Input: A new VM v_j and a set N of n active physical servers in a cloud data centre
Output: A VM-sever match
{
1) Let $n* = 1$ and $IUV_* = 1$;
2) for $\forall\ n_i \in N$
3) Compute $r^c_{n_iR}$, $r^m_{n_iR}$, and $r^n_{n_iR}$ of the n_i –th physical server;
4) Get the results of r_c, r_m, and r_n of the VM v_j according to Computing Capability Matrix (CCM), Memory Capability Matrix (MCM) and Network Capability Matrix (NCM).;
5) Calculate IUV_i ;
6) if ($IUV_i < IUV_*$)
7) Let $n* = n_i$;
8) $IUV_* = IUV_i$;
9) end if
10) end for
11) if (IUV_* == 1)
12) Calculate traffic between VMs on PMm and VMs not yet placed
13) Choose VMs with the largest communication flows
14) If the capacity of VMs less than capacity of PMm, Calculate and Activate PMnew
15) pm++
16) PMm ← PMnew
17) else
18) If VMs cannot meets the capacity of network bandwidth, Calculate and Activate PMnew
19) pm++
20) PMm ← PMnew
21) Endif
22) Endif
23) Place VMs onto PMm
24) else
25) Assign v_j to $n*$;
26) end if
}

Our scheme looks for one of VMs with largest communication flow which has been placed on PMs, and then places this VM on same PM. If the current capacity of PM cannot meet the demands of the VM, activate another PM which keeps the shortest distance with the current PM. Meanwhile, according to the routing algorithm, our scheme looks for one of VMs with largest communication flow which has been placed on PMs, and then places this VM on same PM. If the flows of VM to be placed cannot meet the network link bandwidth capacity, repeat the second step and re-activate a new PM.

This BWRS algorithm is only the first part of VM allocation. The algorithm deals with the admission of new applications for VM provisioning and places the VM on the server. In order to use all the provided resources in cloud data centres, heterogeneous workloads should be consolidated to the minimum number of physical machines. Thus, idle servers can be switched to the sleep mode to reduce energy consumption. And the second parts of VM allocation are the optimization of the current VM allocation and dealing with where to migrate VMs.

4.2 Dynamic Resource aware Live Migration (DRLM) algorithm

DRLM algorithm is the next part of VM allocation. The algorithm DRLM is the optimization of the current VM allocation. It is carried out in three phase. At the first phase, the algorithm DRLM chooses the VMs which are needed to be migrated. To determine which VMs should be migrated, resource utilization threshold value is introduced. If the utilization of CPU, memory, storage, network link capacity, bandwidth and disk capacity of a single physical machine is below the given node utilization threshold, all the VMs on the physical machine have to be migrated to other physical machines.

Algorithm 2: Dynamic Resource aware Live Migration (DRLM) algorithm

Input: A set N of n active physical machines in a cloud data centre and node utilization threshold vector <cpu$T$, mem$T$, net$T$>, X, tp (network topology), A (Communication traffic matrix), B (Communication cost matrix), tv (migration costs)
Output: X`, N_{mig}
{
1) for $\forall\ n_i \in N$
2) Compute $CPU_{n_i}^{U}$, $MEM_{n_i}^{U}$ and $NET_{n_i}^{U}$ of the n_i physical server;
3) if ($CPU_{n_i}^{U}$ < cpu$T$ and $MEM_{n_i}^{U}$ < mem$T$ and $NET_{n_i}^{U}$ < net$T$)
4) X^{target} = BWRS(A,tp)
5) C=Diff(X^{target},X)
6) If C.size<=tv:
7) X`= X^{target}
8) Return X`, N_{mig}
9) Else:
10) X^{tmp}=X
11) P=get_performance(X, A, tp)
12) For i <nMax
13) N_{mig} =0
14) tmp=i
15) While(N_{mig} <tv):
16) Move_vm(X^{tmp}, X^{target}, C[tmp])
17) N_{mig} ++
18) Next=vm_on_target_pm(X^{target},C[tmp])
19) Erase(C, tmp)
20) If next==NULL:
21) tmp=0
22) Else:
23) tmp=next
24) End if
25) End while
26) P`= get_performance (X^{tmp}, A, tp)
27) If P` better_than P:
28) P=P`
29) X`= X^{tmp}
30) end if
31) end for
32) Return X`, N_{mig}
}

Second phase the reconfiguration schemes considered for dynamic VM resizing. Recent hyper visors tolerate reasonably low overhead implicit and explicit VM resizing. A VM is described with a min and max and a share.

In this work, min is defined as the minimum resource reservation, max is defined as a maximum capacity allowed and also share is used to capture its priority for shared resources. The range between the min and max gives implicit VM resizing in a hyper visor. While a VM is inoperative, its allocation is tending to any other VM that may need resources which is within its max. This allows the PM to give resource to any VM that sees enhance in workload on condition that the server has spare ability. For each VM, by varying the entitlements such that min or max or both min and max, the explicit VM resizing is executed.

Final phase, the chosen VMs are allocated to other physical machines using the BWRS algorithm. After all the VMs migrated to other machines, the physical machine has to be switched to the sleep mode to reduce power consumption.

V. EXPERIMENTAL RESULTS

In this section, we are comparing the performance of the proposed system such as BWRS algorithm and DRLM algorithm in terms of makespan, computation cost and overhead. To assess efficiency, we measured these comparison parameters of system. From the end of this experimentation section, we can say that the proposed system has higher efficiency than the existing system.

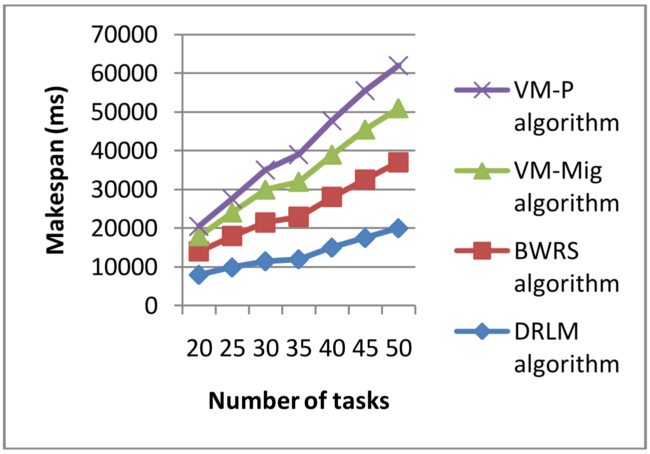

Figure 1. Makespan comparison

In the figure 1, we are comparing the proposed system such as BWRS algorithm and DRLM algorithm in terms of Makespan. In this graph, x axis will be the number of tasks and y axis will be Makespan in milli seconds. When the task is increased, Makespan also increased according to the number of tasks. In that graph we can see that, Makespan of the system is reduced somewhat in proposed system than the existing system. In other words, we can say that the Makespan of proposed system is reduced which will be the best one. Thus the proposed system is well effective in Makespan comparatively.

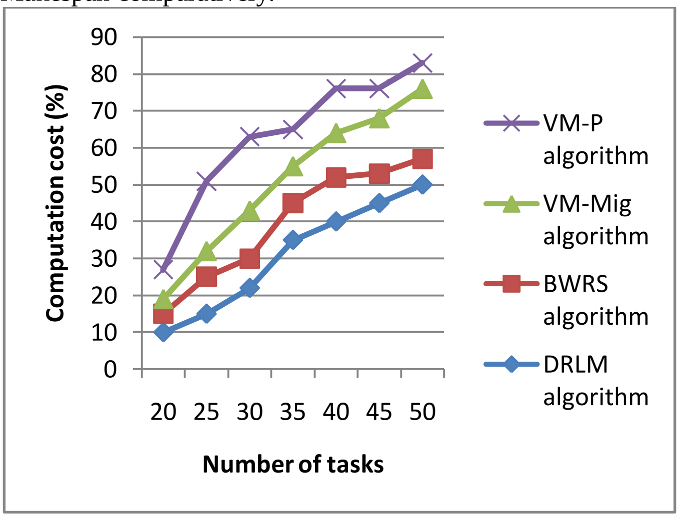

Figure 2. Computation cost comparison

In the figure 2, we are comparing the proposed system such as BWRS algorithm and DRLM algorithm in terms of Computation cost. In this graph, x axis will be the number of tasks and y axis will be Computation cost in %. When the task is increased, Computation cost also increased according to the number of tasks. From that graph we can see that, Computation cost of the system is reduced somewhat in proposed system than the existing system. In other words, we can say that the Computation cost of proposed system is reduced which will be the best one. Thus the proposed system is well effective in Computation cost comparatively.

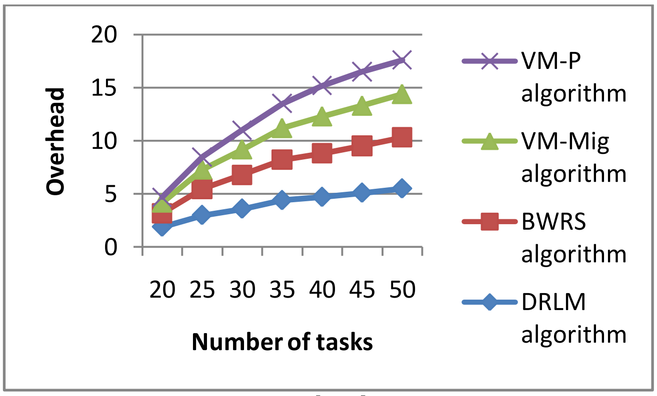

Figure 3. Overhead comparison

In the figure 3, we are comparing the proposed system such as BWRS algorithm and DRLM algorithm in terms of Overhead. In this graph, x axis will be the number of tasks and y axis will be Overhead. When the task is increased, overhead also increased according to the number of tasks. From that graph we can see that, Overhead of the system is reduced somewhat in proposed system than the existing system. In other words, we can say that the Overhead of proposed system is reduced which will be the best one. Thus the proposed system is well effective in Overhead comparatively.

VI. CONCLUSION

In this proposed system, we are proposing two novel algorithms called the Balanced Workload based Resource Scheduling (BWRS) and Dynamic Resource aware Live Migration (DRLM). This proposed scheduling algorithm is balanced workload for PMs and also investigate the problem of consolidating various workloads. These two proposed algorithms are used for managing cloud data centres to make full use of the resources. The optimal allocation of VMs by the two algorithms results in higher utilization of resources. Therefore, our proposed system is well effective than the existing system. Experimental results show that proposed algorithms efficiently utilise the resources in cloud data centres, and the multi constraints for resources contain good balanced utilizations, additionally provide better makespan, low overhead, computation cost is well reduced in our proposed system.

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