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Research paper



A Novel Energy Efficient Resource Management System in Cloud Computing Environment.

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Abstract

Primary target of cloud provider is to provide the maximum resource utilization and increase the revenue by reducing energy consumption and operative cost. In the service providers point of view, resource allocation, resource sharing, migration of resources on demand, memory management, storage management, load balancing, energy efficient resource usage, computational complexity handling in virtualization are some of the major tasks that has to be dealt with. The major issue focused in this paper is to reduce the energy consumption problem and management of computation capacity utilization. For the same, an energy efficient resource management method is proposed to grip the resource scheduling and to minimize the energy utilized by the cloud datacenters for the computational work. Here a novel resource allocation mechanism is proposed, based on the optimization techniques. Also a novel dynamic virtual machine (VM) allocation method is suggested to help dynamic virtual machine allocation and job rescheduling to improve the consolidation of resources to execute the jobs. Experimental results indicated that proposed strategy outperforms as compared to the existing systems.

Keywords: *Cloud Provider: VM Allocation; Resource Allocation; Resource utilization; Energy consumption*.

1. Introduction

As in cloud computing, pay-per-use services are used which avoids the huge capital investment of deploying the hardware, software and other resources at home. It has some critical issues of being over-charged, privacy leak and intervention of unauthorized service providers [1-3]. In the service providers point of view, resource allocation, resource sharing, migration of resources on demand, memory management, storage management, load balancing, energy efficient resource usage, computational complexity handling in virtualization are some of the major tasks that has to be dealt with [4-8]. Resource allocation refers to the amount of resources and the types of resources that are allocated to compute the user's job. The service providers are intended to schedule and provide the resources to the users based on their needs [9-14]. The major issue focused in this research work is to reduce the energy consumption problem and management of computation capacity utilization [15-16]. It has also been one of the burning topics in the recent years of research. To overcome the above mention issues, a novel energy efficient resource management system is proposed to handle the resource scheduling and for the minimization of the energy utilized by the cloud data centers for the computational work.

The rest of the paper is organized as follows: section II presents the related work. The Contributions are mentioned in section III. Section IV represents proposed system architecture along with algorithms to efficiently handle the system. Section V describes experimental results and discussion & section VI represents the conclusion.

2. Related Work

This section presents different resource allocation and scheduling techniques which helps to present our proposed work. Mehiar Dabbagh et.al [17] proposed a system for overcommitted clouds which is an energy-efficient resource allocation system. System saves enormous energy by minimizing Physical Machine (PM) overload occurrences through monitoring and prediction of VM resource usage and reducing the number of active PMs via efficient VM migration and placement tech. Fei Taoa et.al [18] addressed the optimal scheduling of computing resources (OSCR) problem consisting of energy consumption issue & proposed the energy consumption framework and simplified it to adapt network whose load information is unavailable. Meanwhile, imbalanced load distribution is considered to represent risk on the makespan and used as an effective strategy for both to shorten the makespan and to realize load balance. Tarandeep Kaur [19] proposed Green Cloud Scheduling Model (GCSM). GCSM which is consisting of a scheduler component named as Green Cloud Scheduler for task allocation and scheduling decisions by considering the energy aware capability of heterogeneous Cloud nodes. Jieun Choi et.al [20] proposed job scheduling optimization technique which focuses on the performance & QoS metrics in cluster and cloud environments. As a result, this technique controls the ratio of scheduling distribution for distributed environment with respect to characteristics of application and current workload.

A.V.Karthick et.al [21] proposed Multi Queue Scheduling (MQS) system which gives additional significance to choose task dynamically to accomplish the optimum cloud scheduling problem and therefore it usages unused free space in an economic manner. Vahid Arabnejad et.al [22] presented a new deadline constrained

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scheduling method, called Deadline Constrained Critical Path (DCCP) which achieves the scheduling of workloads on dynamically provisioned by cloud resources. The DCCP works in two stages. First is task prioritization and second is task assignment. This method is based on concept of Constrained Critical Paths to execute a set of tasks on the same instance in order to achieve the goal of decreasing data movement between instances. Zhiming Wang et al. [23] proposed a Particle Swarm Optimization Tabu search Mechanism, aims to improve resource use and clearly taking into account both energy consumption and revenue acquisition in minimizing completion time. The multisource job scheduler is proposed by D Huang [24] to schedule jobs efficiently having multi-resource requirements such as CPU, memory and bandwidth to improve job performance and resource utilization in a virtual machine based on cloud environment. With the growing popularity of cloud computing, it is necessary to examine various methods by which energy consumption in cloud environments can be reduced. Author [25] analyzed the effects of virtual machine allocation on energy consumption using a variety of real-world policies and a realistic testing scenario.
Shahin V et.al. [26] Proposed a platform for workload prediction and VM placement in cloud computing Datacenter. First an estimation module was introduced to predict the incoming load of the DC. Then, schedulers were designed to determine the optimal assignment of VMs to the PMs.

3. Contribution

- A novel resource allocation mechanism is proposed based on the optimization techniques.
- A novel dynamic virtual machine allocation method is proposed, to help dynamic virtual machine allocation and job rescheduling to improve the consolidation of resources to execute the jobs.
- Additionally, a novel virtual machine migration technique is proposed based on the live migration for dynamic reallocation of resources.

4. System Model

Based on the research gap, here we have proposed a system to design and analyze energy efficient resource management method by allocation of various resources to virtual machines for higher utilization of resources and to reduce energy consumption. The proposed work implementation is based on the architecture shown in Fig 1.

4.1 System Workflow

In this work we have taken input parameters from cloudsim and applied federation-> Clustering->job scheduling ->Prioritization.

The system workflow is explained as follows:

1. First of all, create datacenters
2. In next step, create number of cloud brokers
3. Next step create number of Virtual Machines
4. Then creating the number of cloudlets or jobs
5. Next step is perform the resource scheduling
6. Then perform Resource consolidation
7. After performing Resource consolidation, Dynamic Virtual machine allocation is performed for the same following things are required -
   i) Job rescheduling
   ii) Workload monitoring
8. If the workload is overloaded to VM then VM migration is required to perform else the VM should be in stable state or switched off.

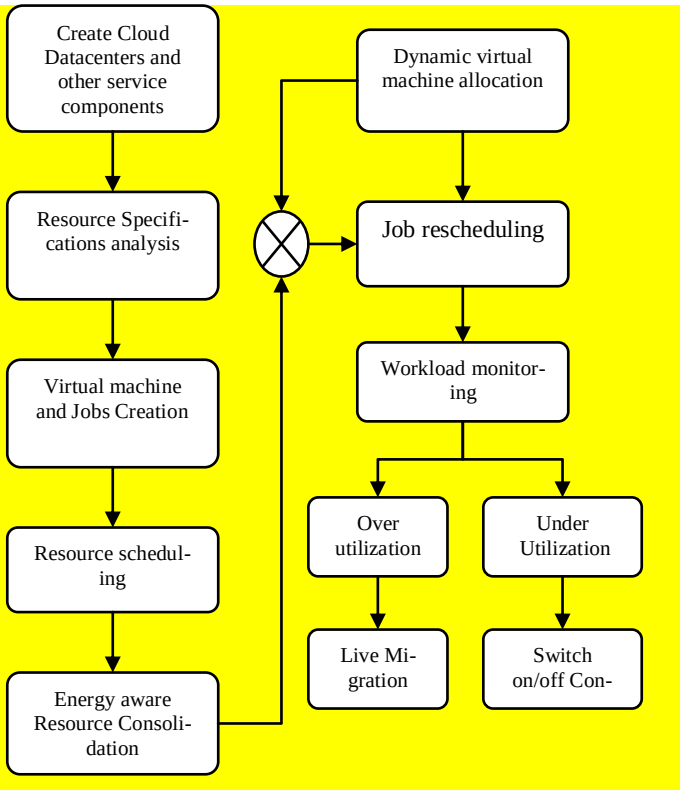


Fig.1. System Workflow

Above steps are further elaborated as follows:

4.1.1 Datacenter Creation:

First steps is to create a set of Datacenters. Datacenters are created with the features like RAM size, bandwidth, and number of host in each datacenter. These are the parameters of datacenters that will affect the end user when he tries to access a cloud service or a web service.

4.1.2 Cloud Broker Creation:

The next step is cloud broker creation, it acts a third-party mediator. And works as a connecting bridge between the user and virtual machine. Broker creation steps includes Broker name, Broker id.

4.1.3 VMs Creation:

The next step is VM creation. Each Datacenter consists of one or more physical machines & each physical machine can hold more than one virtual machines. This Virtual machine are submitted to respective broker. Created VM is having parameter like VM id, Broker id, Datacenter id, CPU, Memory, and Bandwidth etc.

4.1.4 Cloudlet or Job Creation:

The next step is Cloudlet creation. Each cloudlets is having their unique ID and the cloudlet is submitted to respective cloud broker. The features of cloudlets are Cloudlet Length in Million Instruction per Second (MIPS), file size is measure in bytes, and types of cloudlets request for ex. CPU, memory and bandwidth.

4.1.5 Energy Consumption:

The next step is to calculate Energy consumption. For the same first we need to calculate Computing energy comsumption. Computing energy comsumption is calculated as follows:
Cpec= Computing energy comsumption
Ep ← MIPS of one Processing Element (PE) / time
Tp ← MIPS of cloudlet

Din ← cloudlet size
Cpec=Ep+Tp+Din **(1)**

Then second step is Communication energy consumption is calculated as follows:
Cmec ← Communication energy comsumption
Dc ← bandwidth
Din ← cloudlet size
Ec ← Dc/time
Cmec+= (Din/ (Dc/Ec)) **(2)**

Then summation of computing energy comsumption and communication energy consumption is called energy consumption.
Energy consumption = consumption energy + communication energy **(3)**

Energy consumption is used to form the data centers into clusters. Fig.2 shows the computing energy consumption.

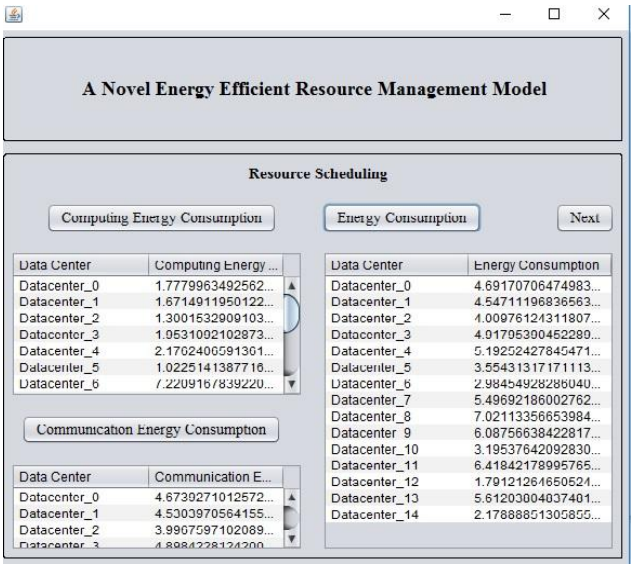
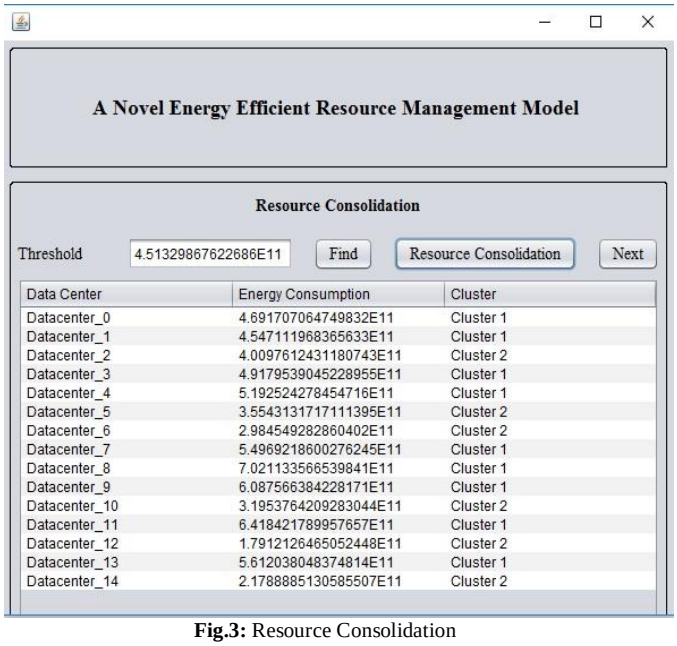


Fig.2: Computing Energy Consumption



Data Center	Energy Consumption	Cluster
Datacenter_0	4.691707064749832E11	Cluster 1
Datacenter_1	4.547111968365633E11	Cluster 1
Datacenter_2	4.0097612431180743E11	Cluster 2
Datacenter_3	4.917953904522895 5E11	Cluster 1
Datacenter_4	5.192524278454716E11	Cluster 1
Datacenter_5	3.554313171711395E11	Cluster 2
Datacenter_6	2.984549282860402E11	Cluster 2
Datacenter_7	5.4969218600276245E11	Cluster 1
Datacenter_8	7.021133566539841E11	Cluster 1
Datacenter_9	6.087566384228171E11	Cluster 1
Datacenter_10	3.1953764209283044E11	Cluster 2
Datacenter_11	6.418421789957657E11	Cluster 1
Datacenter_12	1.7912126465052448E11	Cluster 2
Datacenter_13	5.612038048374814E11	Cluster 1
Datacenter_14	2.1788885130585507E11	Cluster 2

Fig.3: Resource Consolidation

Threshold is the value used to split the data centers into clusters. Threshold is calculated dynamically. Based on the energy consumption of data centers, threshold is calculated automatically.

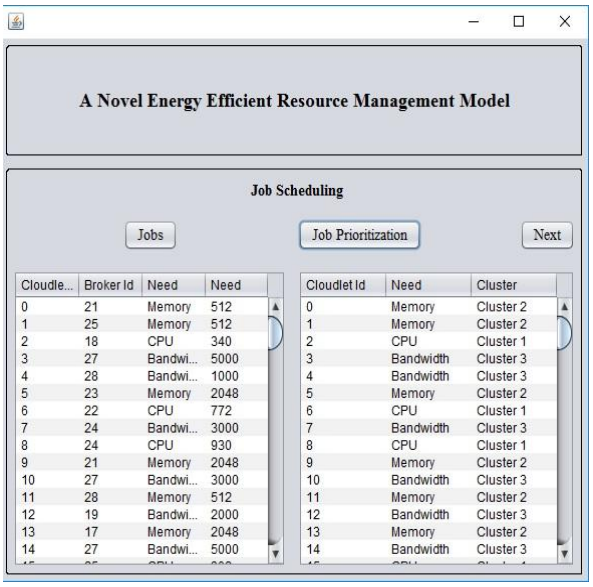
Threshold=total energy consumption / number of data centers **(4)**

If datacenters have high energy consumption than threshold means, they are formed as cluster1. Otherwise declared as cluster2, shown in fig.3.
If energy consumption >threshold
Datacenter=cluster1
Else
Datacenter=cluster2
Workload for the datacenter is predicted for the reallocation of the cloudlets.Cloudlets in over utilized data centers are allocated to under utilized data centers. Workload is calculated as follows:
Workload = Resource Capacity – Needs **(5)**

If workload is greater than zero, then data center is underutilized. Otherwise data center is called as over utilized.

4.1.6 Job Prioritization:

Job Prioritization can be done by applying sequencing algorithm, as shown in Fig.4.In sequencing algorithm jobs with lowest execution is executed first and job with higher execution time is executed subsequently.



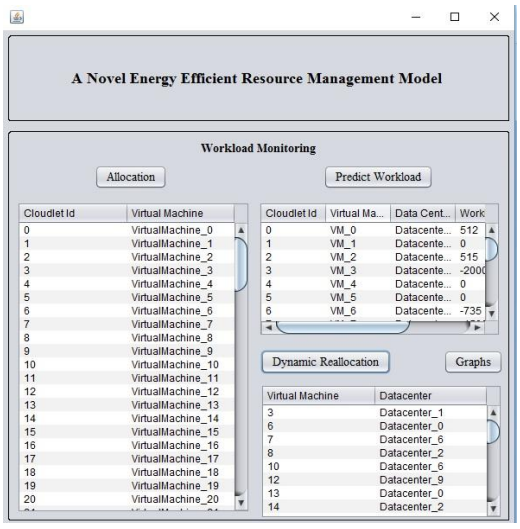
Cloudle...	Broker Id	Need	Need
0	21	Memory	512
1	25	Memory	512
2	18	CPU	340
3	27	Bandwi...	5000
4	28	Bandwi...	1000
5	23	Memory	2048
6	22	CPU	772
7	24	Bandwi...	3000
8	24	CPU	930
9	21	Memory	2048
10	27	Bandwi...	3000
11	28	Memory	512
12	19	Bandwi...	2000
13	17	Memory	2048
14	27	Bandwi...	5000

Cloudlet Id	Need	Cluster
0	Memory	Cluster 2
1	Memory	Cluster 2
2	CPU	Cluster 1
3	Bandwidth	Cluster 3
4	Bandwidth	Cluster 3
5	Memory	Cluster 2
6	CPU	Cluster 1
7	Bandwidth	Cluster 3
8	CPU	Cluster 1
9	Memory	Cluster 2
10	Bandwidth	Cluster 3
11	Memory	Cluster 2
12	Bandwidth	Cluster 3
13	Memory	Cluster 2
14	Bandwidth	Cluster 3

Fig.4: Job prioritization

4.1.7 Job Allocation:

Jobs are allocated on different virtual machines based on VM capacity and cloudlets needs, as shown in Left half of Fig.5.



Cloudlet Id	Virtual Machine
0	VirtualMachine_0
1	VirtualMachine_1
2	VirtualMachine_2
3	VirtualMachine_3
4	VirtualMachine_4
5	VirtualMachine_5
6	VirtualMachine_6
7	VirtualMachine_7
8	VirtualMachine_8
9	VirtualMachine_9
10	VirtualMachine_10
11	VirtualMachine_11
12	VirtualMachine_12
13	VirtualMachine_13
14	VirtualMachine_14
15	VirtualMachine_15
16	VirtualMachine_16
17	VirtualMachine_17
18	VirtualMachine_18
19	VirtualMachine_19
20	VirtualMachine_20

Cloudlet Id	Virtual Ma...	Data Cent...	Work
0	VM_0	Datacente...	512
1	VM_1	Datacente...	0
2	VM_2	Datacente...	515
3	VM_3	Datacente...	-2000
4	VM_4	Datacente...	0
5	VM_5	Datacente...	0
6	VM_6	Datacente...	-735

Virtual Machine	Datacenter
3	Datacenter_1
6	Datacenter_0
7	Datacenter_6
8	Datacenter_2
10	Datacenter_6
12	Datacenter_9
13	Datacenter_0
14	Datacenter_2

Fig.5: Workload Monitoring

4.1.8 Predicting Workload:

Cloudlets are allocated to datacenters. Workload is predicted by VM Capacity – Cloudlet needs. For the VM which is over utilized, datacenters needs the migration. VM's in the over utilized data-centers are migrated to underutilized datacenters.

4.2 Algorithm

Datacenters Creation
Nodc ← *no of data center*
Dc ← *data centers*
For i=*0*: *Nodc* **do**
Dc ← *create_data_center (i)*
End for

Brokers Creation
Nob ← *no of brokers*
B ← *brokers*
For *i=0*: *Nob* **do**
B ← *create_brokers (i)*
End for

Virtual Machines Creation
Novm ← *no of virtual machines*
Vm ← *virtual machines*
For *i=0*: *Novm* **do**
Vm ← *create_virtual_machines (i)*
End for

Cloudlets Creation
Nocl ← *no of cloudlets*
Cl ← *cloudlets*
For *i=0*: *Nocl* **do**
Cl ← *create_cloudlets (i)*
End for

Computing Energy Consumption
Cpec ← *computing energy consumption*
Ep ← *computing energy consumption rate*
Tp ← *computing power of processor*
Din ← *cloudlet size*
For *i=0*: *Nodc* **do**
For *j=0*: *Nocl* **do**
Ep ← *MIPS of one PE/time*
Tp ← *MIPS of cloudlet*
Din ← *cloudlet size*
Cpec+=Ep+Tp+Din
End for
End for

Communication Energy Consumption
Cmec ← *communication energy consumption*
Ec ← *communication energy consumption rate*
Dc ← *bandwidth*
Din ← *cloudlet size*
For *i=0*: *Nodc* **do**
For *j=0*: *Nocl* **do**
Ec ← *Dc/time*
Cmec+= (Din/ (Dc/Ec))
End for
End for

Total Energy Consumption
Enc ← *energy consumption*
For *i=0*: *Nodc* **do**
Enc=Cpec (i) +Cmec (i)
End for

Datacenters Clustering
Th ← *threshold*
To ← *total*
For *i=0*: *Nodc* **do**
To+=Enc (i)
End for
Th ← *To/Nodc*
C ← *cluster*
For *i=0*: *Nodc* **do**
If *Enc (i) > Th* **then**
C=Cluster 1
Else
C=Cluster 2
End if
End for

Jobs Prioritization
C ← *cluster*
For *i=0*: *Nocl* **do**
If *Nocl.Need == "CPU"* **then**
C ← *cluster 1*
Else *Nocl.Need == "Memory"* **then**
C ← *cluster 2*
Else *Nocl.Need == "Bandwidth"* **then**
C ← *cluster 3*
End if
End for

Jobs Allocation
j=0
Alvm ← *allocated virtual machine*
For *i=0*: *Nocl* **do**
If *j == Novm* **then**
j = 0
End if
Alvm = Virtual Machine + j
j++
End for

Predict Workload
Ou ← *over utilization*
Uu ← *under utilization*
For *i=0*: *Nocl* **do**
If *Nocl.Need == "CPU"* **then**
If *Nocl.Need <= Novm.i.capacity* **then**
Uu ← *under utilization*
Else
Ou ← *over utilization*
Else *Nocl.Need == "Memory"* **then**
If *Nocl.Need <= Novm.i.capacity* **then**
Uu ← *under utilization*
Else
Ou ← *over utilization*
Else *Nocl.Need == "Bandwidth"* **then**
If *Nocl.Need <= Novm.i.capacity* **then**
Uu ← *under utilization*
Else
Ou ← *over utilization*
End if
End for

Dynamic Reallocation
Dr ← *Dynamic reallocation*
For *i=0*: *Ou* **do**
Dr = select Uu Datacenter **end for**

5. Performance Analysis

The System executed using cloudsim tool having physical configuration of i3 processor, 4GB RAM and 1TB HDD.
Fig.6 shows the energy consumption graph and it is observed that proposed methodology requires lower energy consumption. The X-axis represents the number of VM whereas Y-axis represents the total number of energy consumed measured in Kilowatt hour.
As shown in graph for 100 VM the total energy consumption by proposed methodology is 11.5kwh, whereas AHDVC-MAD method consumes 14.9 Kwh.

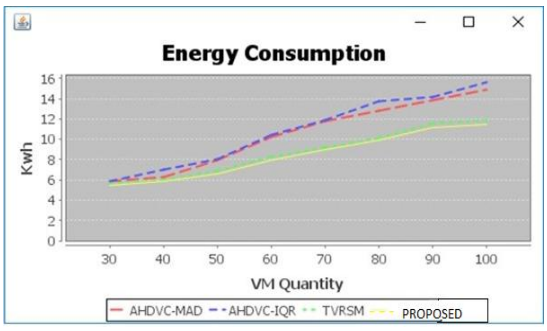


Fig.6: Graph for Energy Consumption

Graph value of fig.6 is summarized in to table 1 and it is observed that proposed methodology consumes energy as compared to all other method is very low.

Table 1: Energy Consumption Vs VM Quantity

Methods / VM Quantity	AHDVC-MAD Energy Consumption in KWH	AHDVC-IQR Energy Consumption in KWH	TVRSM Energy Consumption in KWH	Proposed method-Energy Consumption in KWH
30	5.9	5.9	5.7	5.5
40	6.3	7	6	5.9
50	7.9	8	6.9	6.6
60	10.2	10.4	8.3	7.9
70	11.8	11.9	9.2	9
80	12.8	13.8	10.1	9.9
90	13.9	14.2	11.6	11.2
100	14.9	15.6	11.9	11.5

6. Conclusion

Minimizing the energy consumption is one of the critical stage to reduce the datacenter operating cost. Therefore, an innovative energy efficient resource management method is proposed to handle the resource scheduling and for the minimization of energy utilized by the cloud datacentres for the computational work. In proposed methodology once the energy consumption is calculated, threshold parameter is used to categorize the datacenter in to two clusters, cluster1 is for datacenters having energy consumption greater than threshold & cluster2 is datacenters which are having energy consumption less than the threshold. Then cloudlets are allocated to different VM's of the different datacenters. In next step workload is predicted, if the workload is below zero means the datacenter is over utilized else datacenters are underutilized. VM's in the over utilized datacenters consumes more energy.
Therefore, to save energy dynamic reallocation is performed to migrate VM's in the over utilized datacenters into underutilized datacenters, this can be done by considering the dynamic workload of the datacenters. The experimental results shown that the proposed technique outperforms than the all other techniques for higher resource utilization and to reducing the energy consumption.

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