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Hybrid Metaheuristic for Virtual Machine Scheduling in Cloud Computing

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Abstract— Cloud Computing is expanding as the next generation platform which would ease the user on pay as you use mode as per requirement. Cloud incorporates a set of virtual machine which comprises equally storage and computational facility. Due to speedy increase in use of Cloud Computing, moving of more and more application on cloud and demand of customers for more services and enhanced results. The fundamental goal of cloud computing is to offer successful access to isolated and geographically circulated resources. Cloud is growing every day and experience many problems such as scheduling. Scheduling means a group of policies to regulate the order of task to be executed by a computer system.VM Scheduling is necessary for efficient operations in distributed environment. This paper combines ant colony optimization and BAT to solve the VM scheduling problem. We discuss and evaluate these techniques in regard of various performance matrices to give an overview of the latest approaches in the field.

Keywords—CloudComputing,Scheduling,BAT,AntColonyOptimization

I. INTRODUCTION

Cloud computing is used in the Internet to consume software or other IT services on demand. Cloud computing is a completely a new technology. With the use of Cloud Computing users are able to share processing power, storage space, bandwidth, memory and software. As if somebody is using Cloud computing then their resources get shred along with that the cost is also getting shared. This helps user to spend only less cost as they have to pay on the basis of usage. The provider of cloud computing solutions delivers a permission to use its software, hardware, platform, or storage providers like services over the internet. There is such kind of disc or hardware available which user can buy to take the cloud services. Recurring fees is charged by the cloud provider on the monthly basis which is based on the usage by the users.

The evolution of Virtualization, Utility computing, Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) all are combined to make a cloud computing. It is also a development of distributed, parallel and grid computing [1]. Over other existing computing techniques the cloud computing is advantageous and it much improve the availability of IT resources. So with the use of cloud computing users are able to use the infrastructure of IT and pay for that only which will save the cost to buy the physical resources that may be vacant when it is not in use. The data, operating systems, applications, storage and processing power will be active on use basis. The cloud is just like a space available on web where computing has been already installed to get advantage of it in different services [2].

A. *Cloud Computing Architecture*

In the field of information there is one well accepted institution name National Institute of Standards and Technology (NIST) who has given different definitions of working. There are three cloud services, five essential characteristics and four models of cloud deployment have been defined by NIST in their architecture of Cloud Computing [3].

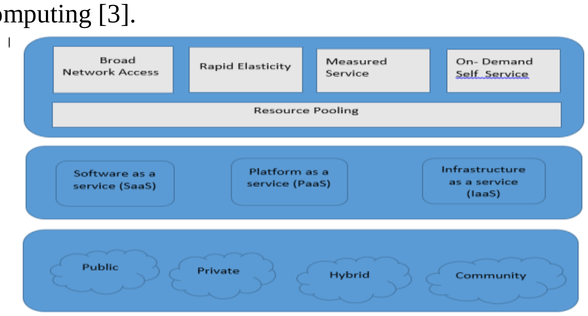

Figure 1. Visual model of NIST Working of Cloud Computing

B. Cloud Service Models

There are 3 Cloud Services model and these 3 fundamental classifications are often referred to as "SPI model" i.e. software, platform or infrastructure as a service.

- Cloud Software as Service: There are different applications running by providers on a cloud that can be used by users by using this service.
- Cloud Platform as Service: In cloud infrastructure there are different tools and programming languages that have been provided by provider. The use of this service allows customers to applications acquired or created by customers.
- Cloud Infrastructure as Service: The fundamental computing resources like storage, network and processing provision can be acquired by customer using this type of cloud service. This acquired resource can be used by customer to deploy and run a different software or applications.

C. Essential Characteristics of Cloud Computing

There are numbers of characteristics of Cloud computing out of them the main characteristics of cloud computing are given below:
On-demand self-service: Without any human interaction with each provider of services a consumer can A consumer can independently have provision of computing capabilities, such as server time and network storage as needed.

Broad network access: The available capabilities over the network are available and can be accessed through the use of standard mechanism. This promotes the use of heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants (PDAs)).

Resource pooling: According to customers demand different virtual and physical resources can be assigned or re assigned using multi-tenant model. These are some cases in which subscriber will only be able to specify the provider location at higher level of abstraction but it unable to known exact location of provided resources. The storage, processing, memory, network bandwidth, and virtual machines are all examples of its resources.

Rapid elasticity: To quickly scale in and scale out the capabilities can be rapidly, elastically and automatically provisioned. At any time and in any quantity the capabilities can be purchased by customers.

Measured Service: In same level of abstraction use of metering capability helps in automatically controlling and optimizing resources that should be appropriate for cloud systems required services. The utilized service customer and provider both resources can be controlled by monitoring it then a transparency report need to provide.

D. Cloud deployment Strategies

There are mainly three strategies which can be deployed in Cloud computing. The basic cloud computing strategies are given below:
Public Cloud: This type of cloud services is always available to clients through a third party internet provider. This is very cheap or almost free to use but still interpret public as free is not always applicable. In public cloud computing vendors provide an access on control mechanism to their users and it does not mean that a user's data is publically visible to others. To deploy number of solutions an elastic, cost effective means is provided by the public clouds.

Private Cloud: A private cloud computing is elastic and service based. These are the two benefits of public cloud which is also offered by private clouds. The public and private cloud is different from each other as data has been managed within the organization for private cloud service without any network bandwidth restrictions. There is also provision of security and all legal requirements has been fulfilled which is absent in case of public cloud services. In addition, a great control of the cloud infrastructure is given to provider and it also improves the security and resiliency because the used network is restricted and designated to access by the users.

Community cloud: The organizations who are sharing same interests in terms of security and mission uses community cloud. The member of cloud community will be able to access the data and applications available on cloud.

Hybrid Cloud: The private and public cloud is combined to get services advantages of both make it Hybrid Cloud. In this case the business critical services are controlled by themselves that is using private cloud and other non business critical information has been outsource and controlled by public cloud.

Rest of the paper is organized as follows, Section II contain the related work of scheduling in cloud computing, Section III contain the methodology of proposed technique, Section IV describes results and discussion and Section V concludes research work with future scope**.**

II. RELATED WORK

Christina Hoffa1 et al. (2008) exploits the basic use of the scientific workflows in cloud. Focuses on the astronomy application montage which is being widely used nowadays. Basically Montage is a workflow that provides short job runtime. This approach is able to provide good compute time performance but the challenge or main problem in that is it can be suffer from the resource scheduling delay and wide areas communication. Previously the cloud was under developed that won't be able to provide solution to flexible, on demand computing infrastructure to various applications [4]. In cloud computing there are a number of virtual servers which work collaboratively by internet and they can be dynamically managed, maintained and monitor..

Er-Dun, Zhao et al. (2012) proposed a data placement strategy according to the storage capacity of the datacentre. Data placement is an NP hard problem but some effort made to reduce the data movement among the data centre. Existing techniques used the k-means clustering. The k-means clustering focused only on few data centres only which effect the data placement strategy. Genetic algorithm has been used to select the optimal solution [5]. Heuristic algorithm has been proposed for data placement as well as maintains the load balancing of data centres.

Cong Wan et al. (2012) discuss about the investigation of scientific workflow scheduling schema which is done under cloud computing environment .the result for experiment through simulation demonstrated the scheduling algorithm which decreases the processing time and cost .cost is reducing with response time limitation and processing with budget limitation in scientific workflow [6]. The future work in this paper is solving some problem like algorithm for time complexity is rather high. It will be cost quite a while given more sorts of example. Such Issue will be resolved with the help of heuristic calculation.

Amal Ganesh, et.al, (2014), have recommended that one of the key challenge in cloud computing is getting the continuous reliability and resources availability. So, to achieve that a robust fault tolerant (FT) systems need to use in cloud environment. In this paper [7], a fault tolerance basic concept has been highlighted by authors for that they have considered different Reactive FT policy and Proactive FT policy. Here are large numbers of different faults for that author has used various FT techniques that are associated to it. They have given a review on different existing methods for fault tolerant along with their frameworks and algorithms. It has become a key topic for different researchers who are working on it and this paper will help them to propose a new FT technique in Cloud. In this paper the authors have did comparison on limited number of FT models.

Deepak Poola, Saurabh Kumar Garg (2014) presents three resource allotment policies with cost, robustness and makespan as its objective. For making the schedule robust by considering the budget and deadline constraint, the resource allotment policies adds slack time to it. Author test these policies with two failure models for five scientific workflows with two metrics for robustness. Results show that these policies are being robust against doubts like performance variations and task failures of virtual machine. With the proposed strategies introduced, the RTC arrangement demonstrates the maximum robustness and in the meantime reduces make span of the workflows. The RTC strategy contributes a robust schedule with expenses hardly higher than the reference algorithm investigated [8].

Keng-Mao Cho, et.al. (2014) proposed an ACOPS approach for VM scheduling with load balancing. To further reduce the computing time and improve the scheduling result, [9] this paper added a PSO operator into the ACO procedure. By consulting the personal best and global best solutions, the search results will converge quickly and achieve a higher quality. Experimental results show that ACOPS is faster than traditional ACO and, in most cases, is superior in balancing the system compared to other approaches. Future study include continue improving the performance of the proposed algorithm.

Puya Ghazizadeh, et.al, (2015), have introduced a new concept name it vehicular cloud. The computational resources unpredictable availability, distributed ownership and its consequences makes vehicular cloud different from conventional one. In this paper [10], a job assignment strategy is used to propose a fault tolerance system which is based on redundancy. In vehicular cloud is proves to be efficient in reducing the resource volatility effects. The theoretical analysis of mean time to failure of this strategy is given in this paper. Then comparative analysis results show that this method is accurate in terms of theoretical prediction. The proposed strategy is not very effective in all type of environment.

Jianbing Dinga, Zhenjie Zhangc (2015) talks about Abacus. It is auction based resource assignment framework which is for cloud computing. It gives effectual service difference with several budgets and priorities for jobs. They develop a auction mechanism which is very effective. Abacus as of now just handles independent calculation resources in the framework. So there can be the future work in which the dependent resources can be handled. Hence, another theme for future study is to analyze the convergence speed theoretically [11]. It will be difficult to sketch mechanism of resource allocation for complex cloud applications.

Bashir Mohammed, et.al, (2016), have critically analyzed the IVFS model and concludes that it is not able to tolerate faults that reduce each computing node reliability. In this paper [12], a new model has been proposed by authors that will be able to remove the drawback of existing model based on computing or virtual machine reliability. The proposed model has been testing by performing simulation on it that shows it is better as compared to existing one. A diverse software tool has been used for forward or backward recovery that results in improves pass rates. A critical analysis experiment results shows that this model is prove to be efficient to use in fully fault tolerant IaaS cloud environment. There are some drawbacks of this paper such as they didn't work on different challenges of fault tolerance that can affect the performance in terms of checkpoint overhead, recovery time of checkpoint and recomputing time.

Chou LD, et.al (2016) have proposed the vitality protection for green processing is one of the imperative issues while designating assets. To enhance vitality productivity, the dynamic power-sparing asset designation (DPRA) component in view of a particle swarm optimization is proposed. Mechanism DPRA not just considers the vitality utilization of physical machine (PM) what's more, virtual machine (VM) yet additionally recently handles the vitality productivity proportion of forced air system. Additionally, the minimum squares relapse strategy is used to estimate PM's asset usage for apportioning VM and disposing of VM relocations. DPRA a novel asset portion system is proposed to diminish the power utilization and to streamline the electric bill of cloud server farms. The mechanism which is proposed utilizes the minimum squares relapse to gauge the usage of VMs and PMs. At that point, the PSO calculation is used by DPRA to convey VMs into PMs with dynamic asset assignment. The surely understood CloudSim testbed system is utilized to build an information focus condition and to lead recreations [13].

Srimoyee Bhattacherjee et.al, (2017) have concluded that migration policies for VMs could show how efficient resource management strategies could lead to reduction of energy consumption in a cloud computing environment. The proposed PMM policy takes migration decisions based on history data generated from the VMs' behavior in the near past. The proposed PMM policy is a greedy approach that follows the problem solving heuristic to find out the optimum solution for allocation and migration of VMs at each stage. Unlike existing works where VM migrations are initiated as soon as SLA (in terms of availability and Quality of Service) is violated, PMM policy takes such decisions if SLA is violated currently and also in the future, estimated from the predictions, thereby minimizing the number of VM migrations and making an accurate migration. The main contribution of this work is the design of a prediction based VM migration scheme using Markov chain model which reduces total energy consumption of the cloud environment. The methods discussed in this paper [14] to minimize total energy consumption are not optimal. To get the optimal solution this work further extended to minimize the total energy consumption while providing the required Quality of Service and also take exact VM allocation and migration decisions.

III. METHODOLOGY

A. ACO Algorithm:

Ant colony is a class of development calculations established on the activities of an insect settlement. In this algorithm when an ants group tries to look for the food, they use a special kind of chemical to communicate with each other. That chemical is referred to as pheromone. Initially, ants starts search their foods randomly. Once the ants discover a path to food source, they leave pheromone on the path. An ant can pursue the trails of the other ants to the food source by sensing pheromone on the ground. As this process continue, most of the ants attract to choose the shortest path as there have been a huge amount of pheromones accumulated on this path. Minor departure from this methodology is the honey bees calculation that is more similar to the scavenging examples of the bumble bee [15].

Pseudo Code:

1. Initialize τιψ and ηιψ, ∀(ιψ).
2. For each ant k (currently in state ι) do repeat
choose in probability the state to move into
append the selected move to the k-th ant's set tabuk.
until ant k has completed its solution.
end for
3. For each ant move (ιψ) do
compute the fitness function
update the trail matrix.
end for
4. If not (end test) go to step 2

B. BAT Algorithm

Bat algorithm (BA) based on echolocation features of micro bats, is proven to be efficient. Bat algorithm (BA) increases the diversity of the solutions using a frequency-tuning technique in the population. Fitness evaluation function is used to find the weaker individuals from both ACO with Bat algorithm and replaced with stronger individuals from other algorithm Stronger individuals of both ACO with Bat algorithm are combined to enhance optimization process [16].

Pseudo Code:

1. Initialize the bat population xi and vi
2. Define pulse frequency fi at xi
3. Initialize pulse rates ri and the loudness Ai
4. While (t< Max number of iteration)
5. Generate new solutions by adjusting frequency and updating velocities and locations solutions
6. Evaluating those solutions using fitness function
7. if rand >ri
8. Select a solution among the best solutions
9. Generate a local solution around the selected best solution end if
10. Generate a new solution by flying randomly
11. If (rand< Ai & f(Xi)<f(X))*
12. Accept the new solutions
13. Increase ri and reduce Ai
14. end if
*15. Rank the bats and find the current best x**
end while

- **Proposed Technique**
  1.) Initialize the population for both ACO and BAT Algorithm.
  2.) Evaluate the fitness function for the solutions generated from each algorithm.
  3.) Find the best solutions from both the algorithms.
  4.) Combine the best solutions
  5.) Update the solutions
  6.) Evaluate the solutions and optimize again the combined solutions using BAT algorithm.
  7.) Evaluate the performance parameters total execution time, total power consumption, Failure Rate and Resource Utilization.
- **Flowchart for ACOBAT**

Deploy cloud environment with finite number of virtual machine, cloudlets and broker. Initialize the population implies that the solution of ACO and BAT algorithm is to be generated. Evaluate the fitness function is used to find the weaker individuals from both ACO with BAT algorithm and replaced with stronger individuals from other algorithm. ACOBAT finishes it search and output the scheduling result when it reaches the maximum number of iterations. If it terminates, it combines the best solution of ACOBAT to enhance the optimization process and scheduling takes place. If it doesn't, it again evaluates fitness affinity adjustment using ACO and BAT. The solution thus produced gets swapped the best with the worst and vice versa and update the population. Then it again goes to the Fitness evaluation step. If it is yes, then the process stops otherwise it again repeats the whole process.

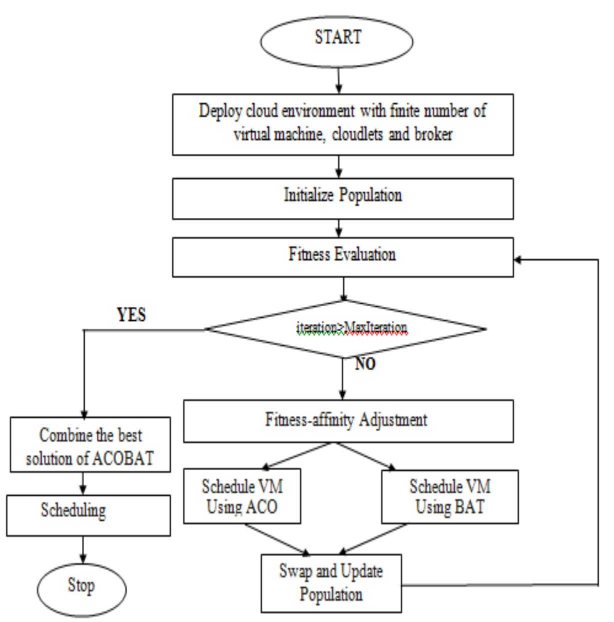

Figure2. Flowchart of Proposed Technique

Although the PSO algorithm is weak for local searches, by combining the ASO algorithm with BAT algorithm is considered powerful in searches addresses this problem. Bat algorithm (BA) based on echolocation features of micro bats, is proven to be efficient. Bat algorithm (BA) increases the diversity of the solutions using a frequency-tuning technique in the population. Fitness evaluation function is used to find the weaker individuals from both ACO with Bat algorithm and replaced with stronger individuals from other algorithm Stronger individuals of both ACO with Bat algorithm are combined to enhance optimization process.

IV. RESULTS AND DISCUSSION

To compare and evaluate the existing and proposed approach based on following parameters:

A. Execution time:

The execution time of the schedule S is denote by ET(S) and is defined as the total of the execution time of all the tasks of the schedule S. If n is the total number of tasks in a schedule, the execution time can be calculate as:

$$ET(S) = \sum_{i=1}^{n} T(i) \quad (1)$$

$$T(i) = \frac{\text{Instruction of the task i}}{\text{MIPS rate of virtual machine on which the task is scheduled}} \quad (2)$$

Table 1: Comparison on basis of total execution time

Datasets[VM, cloudlets]	ACOBAT(Prop ed)ms	ACOPSO (Existing)n
Dataset1[10,20]	96.09	192.34
Dataset2[20,35]	165.47	319.87
Dataset3[30,45]	193.07	399.33
Dataset4[45,55]	232.87	460.24
Dataset5[60,90]	357.03	734.05

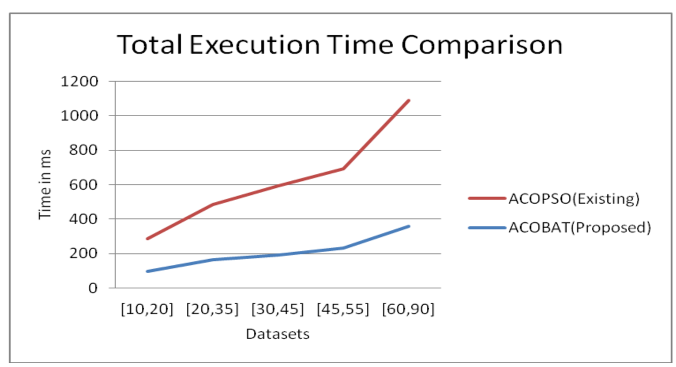

Figure3. Comparison on the basis of total execution time

As in Figure 3, a graph shows the comparison of proposed technique with existing technique on the basis of total execution time. For datasets [10, 20], total execution time for existing technique is 192.34 and by using ACOBAT technique the time is reduced to 96.09. For datasets [20, 35], total execution time for existing technique is 319.87and by using proposed technique the time is reduced to 165.47. As the datasets increases, total execution time for existing technique is more than proposed technique.

B. Energy consumption:

The energy consumed by the proposed algorithm and the existing algorithms is presented in Table 2 and Figure 9 respectively. It shows that the proposed algorithm has significantly reduced the power consumption compared with the existing. ACOBAT can reduce the energy consumption and help achieve the efficient green computing.

$$Kp * maxpower + (1 - kp) * maxpower * utilization \quad (3)$$

Maxpower = maximum power

Kp = probability

Table 2: Comparison on basis of total energy consumption.

Datasets[VM, cloudlets]	ACOBAT(Proposed)kw/h	ACOPSO(Existing) kw/h
Dataset1[10,20]	13	15.91
Dataset2[20,35]	22.74	27.85
Dataset3[30,45]	29.24	35.81
Dataset4[45,55]	35.74	43.77
Dataset5[60,90]	58.49	71.64

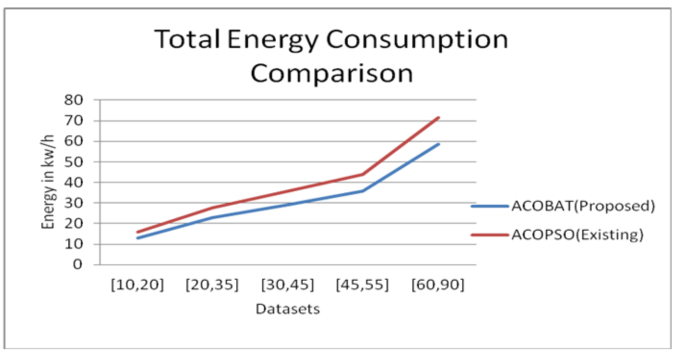

Figure 4. Comparison on the basis of total energy consumption

As in Figure 4, a graph shows the comparison of proposed technique with existing technique on the basis of total energy consumption. For datasets [10, 20], total energy consumption for existing technique is 15.91 and by using ACOBAT technique the energy is reduced to 13. For datasets [20, 35], total energy consumption for existing technique is 27.85 and by using proposed technique the energy is reduced to 22.74. As the datasets increases, total energy consumption for existing technique is more than proposed technique.

C. Failure Rate

VM failure involves failure of any one or many virtual machines (logical component) hosted on an underlying physical component. VM failure can be detected either by a provider or by a customer but correction can be made only by the provider.

$$Failure\ Rate = \frac{Total\ no.of\ failures}{Total\ Execution\ tim} \quad (4)$$

Table 3: Comparison on basis of total failure rate

Datasets[VM, cloudlets]	ACOBAT(Proposed)	ACOPSO(Existing)
Dataset1[10,20]	0.0102	0.0154
Dataset2[20,35]	0.0123	0.0156
Dataset3[30,45]	0.0148	0.0173
Dataset4[45,55]	0.0171	0.0193
Dataset5[60,90]	0.0216	0.0244

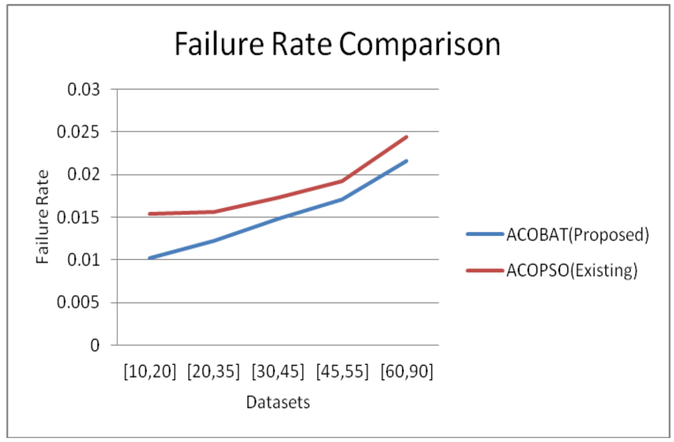

Figure 5.Comparison on the basis of total failure rate

As in Figure 5, a graph shows the comparison of proposed technique with existing technique on the basis of total failure rate. For datasets [10, 20], total failure rate for existing technique is 0.0154 and by using ACOBAT technique the failure rate is reduced to 0.0102. For datasets [20, 35], total failure rate for existing technique is 0.0156 and by using proposed technique the failure rate is reduced to 0.0123. As the datasets increases, total failure rate for existing technique is more than proposed technique.

D. Resource Utilization

The main concern is to discover the best utilization schedule for given resources in terms of profit obtained by utilize that resource, and the number of time slice during which the resource will be utilized.

$$RU = \frac{\sum_{i=1}^{n} Total\frac{exe}{}}{no\ of\ host} \quad (5)$$

Table 4: Comparison on basis of total resource utilization

Datasets[VM, cloudlets]	ACOBAT(Proposed)	ACOPSO(Existing)
Dataset1[10,20]	100.04	200.15
Dataset2[20,35]	153.69	307
Dataset3[30,45]	203.32	407.19
Dataset4[45,55]	218.32	437.8
Dataset5[60,90]	373.99	828.6

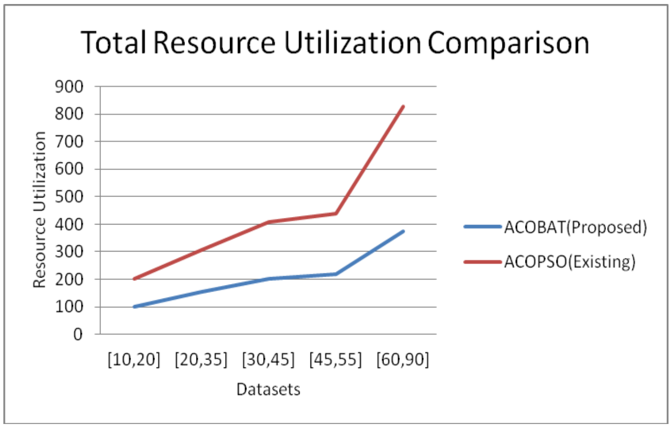

Figure6. Comparison on the basis of total resource utilization

As in Figure 6, a graph shows the comparison of proposed technique with existing technique on the basis of total resource utilization. For datasets [10, 20], total resource utilization for existing technique is 200.15 and by using ACOBAT technique the resource utilization is reduced to 100.04. For datasets [20, 35], total resource utilization for existing technique is 307 and by using proposed technique the resource utilization is reduced to 153.69. As the datasets increases, total resource utilization for existing technique is more than proposed technique.

V. Conclusion and Future Scope

In the existing paper, VM scheduling is done using ACOPS algorithm. ACOPS suffers from the partial optimization, which causes the less exact at the regulation of its speed and the direction. In the proposed work, ACO algorithm is combined with BAT algorithm in the way to eliminate the worst solution and to combine the best solutions to more optimize the solution.Proposed technique ACO with BAT is compared with ACO with PSO technique. Results of the proposed technique are evaluated on the basis of various parameters. Experimental results show that ACOBAT is faster than existing ACOPS and, in most cases, is superior in balancing the system compared to other approaches. In future we can do multi optimization and we can increase the parameter for QOS of Virtual machine.

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