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ABC FOR OPTIMAL ENERGY-AWARE ALLOCATION OF DATA CENTRE RESOURCES

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ABSTRACT

Cloud computing provides workable solutions for long-term medical image archiving systems. A huge problem in present research is the effective dividing of resources present in hand. In this study, allocation protocols for efficient management of energy resources in cloud computing environments are detailed. The proposed energy-aware allocation technique divides Data Centres (DC) resources among client applications in such a way that improves energy efficiency of DCs as well as provides desired Quality of Service (QoS) for every client. Heuristic protocols are used for optimizing the division of resources such that energy efficiency of DC is improved. In the current paper, energy aware resources allotment technique is implemented in clouds via Genetic Algorithm (GA), Artificial Bee Colony (ABC), Best Fit Decreasing (BFD) as well as the suggested ABC with crossover and mutation of onlooker bees with employed bees technique. ABC possesses the benefits of few variables as well as rapid convergence speeds. Outcomes are obtained for energy consumption, quantity of Virtual Machines (VM) migration as well as make span.

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INTRODUCTION

Cloud computing is an evolution of several technologies that are brought together for altering organizations' approach to building information technological architecture. It is not an entirely innovative notion, however several already present technologies are put together to form cloud computing, making it accessible to the public. Recently, software as well as hardware have undergone intensive development and the benefit of approach is that resources which were in isolation previously may now be used in such a manner so that their advantages may now be enjoyed through one virtualized unit.

Several definitions are present for explaining cloud computing, though there is no one definition which is recognized as official. The several definitions may be summed up thus: "Pools of virtual resources which are useful as well as accessible and may be utilized as resources on demand with or without nominal fee". Cloud computing is understood as the idea of provision of computing as a service like how electricity has been provided as a shared pool with on-demand service. With advances in cloud computing, load balancing between virtual machines as well as preservation of energy are important challenges.

The fundamental premise of cloud computing is that users data is not stored locally, rather it is stored in DCs of the Internet. Organizations that offer cloud computing services are the ones who take care of the management as well as maintenance of DC. The users are capable of accessing the stored data at any point through usage of Application Programming Interface (API) offered by cloud providers via any terminal equipment linked to the Internet. Although clouds have highly simplified the procedure of dividing capacities, it presents various new problems in the domain of managing quality of service. QoS represents the levels of performance, dependability, as well as availability provided by applications as well as by platforms or architecture which hosts them. Quality of Service is basic for cloud users who have the expectation that provider will deliver the stated quality, as well as for cloud providers, who are required to discover the correct trade-off between quality of service levels as well as operation cost. But, discovering optimum trade-off is a hard decision issue, frequently worsened by SLA particularly mentioning QoS target as well as economical penalty related to SLA violation [1].

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Virtualization offers effective solutions to the aims of cloud computing paradigms through facilitation of generation of VM over basic physical servers resulting in enhanced resources usage as well as abstraction. Virtualization implies the creation of virtual variant of devices or resources like servers, storage devices, networks or even operating systems wherein the method partitions resources into one or more implementation environments. Device, application, as well as end user interact with virtual resources as if they were one real logical resource. Factors which cloud providers ought to take into consideration are elasticity, scalability, live migration of VM as well as performance isolation. Live migration of virtual machines, the procedure of dynamic transfer of VMs over various servers on the fly, has confirmed to indicate a novel chance for enabling agile as well as dynamic resources management in modern DC. This is particularly important as DC networks are fraught with scalability as well as efficacy problems that are concerns for users as well as scholars. Resources allotment protocols take resources needs of VMs into consideration and change allotted resources, thereby ensuring it an on-demand elastic cloud. VM placement as well as migration are a crucial component of resources allotment in cloud DC.

Resources allotment is a huge problem in cloud computing environments. Resources allotment has several levels of problems such as scheduling tasks, computational performances, re-allocations, response times as well as costs efficacy. Accomplishing tasks with least cost is the most significant challenge in cloud computing. Resources allotment refers to the procedure of provision of services as well as storage space to certain tasks requested by users. Resources allocation is the primary technology of cloud computing that uses computational resources in the network for facilitating the implementation of complex jobs which need huge-scale computations. Resources allotment requires the consideration of several factors like load balancing, make span as well as power usage. Choosing desirable resource nodes for executing tasks in cloud computing is to be taken into consideration, and they are to be correctly chosen as per characteristics of the job. Particularly, cloud resources are needed to be allotted not only for satisfying QoS requisites mentioned by users through SLA but also for decreasing power usage.

Virtualization technologies permit cloud providers to handle the issue of energy inefficacy through creation of several VM instances on physical servers, thereby enhancing usage of resources as well as improving Return on Investment (ROI). The decrease in power usage may be attained through switch of idle nodes off, thereby decreasing idle energy usage. Furthermore, through usage of live migrations, VMs may be consolidated in a dynamic manner on minimum number of physical nodes as per their current resource requisites. But, effective resources management in clouds is important because modern service applications frequently experience extremely varying workloads leading to dynamic resource utilization pattern. Hence, aggressive consolidation of VM leads to performance decrease when applications encounter rising demands leading to increase in resources utilization. Guaranteeing dependable quality of service defined through SLA is crucial in cloud computing environment, and so, cloud providers face energy-performance tradeoff.

Scheduling refers to the procedure of allotment of jobs to available resources based on jobs' qualities as well as needs. The primary aim of scheduling is improved usage of resources with no adverse impact on services offered by clouds. There are two kinds of scheduling, which are resources as well as task scheduling. Given below are few requirements of scheduling in cloud computing: **Fair resource allocation** – Scheduling is performed such that allotment of resources is carried out fairly. **QOS** – Resources as well as tasks are scheduled so that quality of service is attained. **Resource utilization** – This refers to the level to which system resources are used. Excellent scheduling protocol offers maximal resource usage. **Energy consumption** – This refers to the level to which system resources are utilized. Excellent scheduling protocol conserves power usage [2].

Scheduling procedure in clouds are split into three phases which are: **Resource discovering and filtering**- DC Broker finds the resources available in the network system and gathers status data regarding the resources. **Resource selection** - Target resources are chosen on the basis of particular requisites of tasks as well as resources. This is the decision phase. **Task allocation** –Tasks are allotted to the chosen resources.

The issue of optimization is the most critical issue currently and lot of research has been carried out for solving it. Earlier, work was carried out on GA, ABC as well as hybrids of several EAs. Some works are present that compare their performance evaluations as well as suggest the optimal method for particular issues. ABC is the most recent protocol suggested by Dervis Karaboga in 2005, which simulates the intelligent activity of honey bees. It is similar to Particle Swarm Optimization (PSO) as well as Differential Evolution (DE) protocols and

utilizes solely common control variables like colony size as well as maximal cycle number. ANC as an optimization protocol offers a population-based search process wherein food positions are altered by the bees with time with the aim of the bees being to find the food position with greatest nectar quantity.

In this work, an energy-aware resources allocation is carried out through the BFD method along with optimization methods like GA as well as ABC and proposed the ABC with crossover and mutation of onlooker bee with employed bee. Section 2 provides an account of studies related to the field, section 3 discusses the methods and materials utilized, section 4 presents the outcomes obtained while section 5 provides the conclusion.

RELATED WORK

Raju et al., [3] suggested an Energy-Aware Multi objective Chiropteran Algorithm (EAMOCA) by combining echolocation as well as hibernation characteristics for scheduling resources and for conservation of energy. Promoting energy conservation in cloud environments was attained in a deep manner. Through usage of performance measures like total energy utilized by physical resources, Service Level Agreement (SLA) violations (CPU performance) as well as VM migrations, the study modified the method via real time execution by initializing private clouds utilizing VMware.

Zhang et al., [4] studied the scheduling process for cooperative implementation in mobile cloud computing. Mobile applications were denoted by sequences of fine-grained jobs developing a linear topology, and all of them were implemented either on mobile devices or offloaded on cloud sites for implementation. Design aim was the minimization of power utilized by mobile devices, while fulfilling time deadline. The authors formulate the minimal-energy job scheduling issue as a restricted shortest route issue on directed acrylic graphs and adapted canonical "Lagrange Relaxation based Aggregated Cost (LARAC)" protocol for resolving the issue approximately.

Zhang et al., [5] offered a theoretical model of energy-optimal mobile cloud computing under stochastic wireless channels. The aim was the conservation of energy for mobile devices, through optimal execution of mobile applications in mobile devices or offloading onto clouds. Moreover, for energy-optimal implementation scheme of applications with minimal output data, the study derived a threshold policy that states that data consumption rates, defined as ratio between data size (L) as well as delay constraint (T), was contrasted to a threshold that relies on both power usage as well as wireless channel models. In the end, numerical outcomes propose that a considerable quantity of power could be conserved for the mobile device through optimal offloading of mobile applications to clouds in certain situations.

Kliazovich et al., [6] suggested a scheduling solution, called e-STAB, that considers account traffic requisites of cloud applications offering energy effective task allotment as well as traffic load balancing in DC network. Efficient distribution of network traffic enhances QoS of running cloud applications through reduction of transmission-related delay as well as congestion-related packet loss. Evaluations on Green Cloud simulators, highlight advantages as well as efficacy of the suggested scheduling method.

Jiang et al., [7] suggested a resilient routing protocol for reaching greater network energy efficacy that has its basis in optimization problems. The authors attained extremely effective routing in energy-effective networks for cloud computing, the links of lesser usage were switched to sleep state for saving network energy. Simultaneously, the lesser link traffic was gathered to links with higher usage for enhancing link usage as well as to sleep maximal number of links. The study suggested an optimized link sleeping technique for maximizing quantity of sleeping links. Through targeting of network resilience, a weight-adaptive scheme was introduced for reducing link congestions as well as enhancing resilience of networks. Simulations indicated that the protocol was efficient as well as viable for achieving energy-effective networks for cloud computing.

Hosseinimotlagh et al., [8] suggested an optimum usage level of hosts to implement a particular set of instructions for minimizing power usage of hosts. The investigators suggested CM scheduling protocol on the basis of unsurpassed usage level for coming up with optimum power usage while fulfilling desired quality of service. Otherwise put, the suggested protocol performs regulation of allotted computational resources of VM on hosts that lead to achieving optimum energy levels in the hosts. Simulations prove that the suggested technique not only decreases overall energy usage of clouds by 60%, but also impacts turn-around time of real-time jobs by 94%. It

also improves acceptance rates of arrival jobs by 96%. Furthermore, it has a significant part in the acceptance of long jobs that have shorter deadlines.

Lin et al., [9] suggested a new protocol that begins from minimum-delay scheduling solutions and consequently carries out energy reductions through migration of jobs from local core as well as cloud and through application of dynamic voltage as well as frequency scaling method. Linear-time re-scheduling protocol was suggested for tasks migrations. Simulations demonstrated considerable energy reductions with application completion time restriction fulfilled.

Cheng et al., [10] suggested a power-saving job scheduling protocol on the basis of vacation queuing model for cloud computing system. Firstly, the authors utilize vacation queuing model with exhaustive services for modelling tasks scheduling of heterogeneous cloud computing systems. Then, on the basis of busy period as well as busy cycle under steady states, the investigators analysed expectation of task sojourn times as well as power utilization of computing nodes in the heterogeneous cloud computing systems. Consequently, the authors suggested a task scheduling protocol on the basis of similar jobs for reducing power usage. Simulations prove that the suggested protocol decreased power usage of cloud computing systems efficiently while fulfilling task performance.

Singh & Chana [11] suggested fuzzy-logic based power-aware autonomic resources scheduling model for clouds for energy effective scheduling of cloud computing resources in DC. The investigators tested the suggested model in CloudSim based simulation environments as well as real cloud environment. Outcomes of experiments prove that the suggested model outperforms with regard to resources usage as well as power utilization along with other quality of service variables.

Hung et al., [12] suggested a GA that is power-aware in scheduling of resources allotment (GAPA) which resolved the Static Virtual Machine Allocation Problem (SVMAP). Because of restricted resources like memory for implementing simulations, the authors generated workloads which contain samples of one-day timetable of lab hours in the university. The study evaluates GAPA as well as a base scheduling protocol (BFD) that ranks lists of VM in start time and utilizing BFD protocol, for resolving SVMAP. This leads to GAPA obtaining lesser overall energy usage than the base protocol in simulations.

Beloglazov & Buyya [13] suggested an effective resources management policy for virtualized cloud DC. The goal was the continuous consolidation of VMs leveraging live migrations as well as switching off idle nodes for minimal energy usage, while offering needed quality of service. The investigators presented outcomes of evaluations proving that dynamic re-allotment of VM brings about considerable power conservation, thereby proving this approach worth of further study.

MATERIALS AND METHOD

Here, energy aware allocations of DC resources, BFD, GA as well as ABC with crossover and mutation of onlooker bees with employed bees are detailed. BFD finds optimal solutions while First Fit Decreasing (FFD) provides sub-optimal solutions. Benefits of GA [14] include the fact that it is able to resolve every optimization problem which might be described with chromosomes encoding; it is able to resolve issues with various solutions and is able to solve multidimensional, non-differential, non-continuous and non-parametrical problems. Genetic Algorithm needs minimal expertise to handle it and can be carried over easily to other models. The benefit of ABC rests in its simplicity, flexibility and resilience, utilization of less control parameters in contrast to other search techniques, simple hybridization with other optimization frameworks; able to handle objective cost stochastically and simple implementation with basic mathematical or logical operations.

ENERGY-AWARE ALLOCATION OF DATA CENTRE RESOURCES

DC is home to several varied applications with varied resource needs as well as performance goals. Generally, cloud applications may be decomposed into 1 or more jobs implemented in 1 or more VMs. During runtime, schedulers handle the assignment of jobs to machines. These days, production DCs like Google's Cloud Back-end frequently implements huge quantities of jobs every day. Very huge-scale workloads hosted by DC not only uses considerable storage as well as computational power, but also large quantities of energy. Practically, operational cost on energy is not solely through the running of physical machines, but also from the cooling of all DCs. It is noted that power consumption makes up around 12% of the monthly operational cost for generic DCs. For huge organizations such as Google, 3% decrease in energy costs might convert to more than a million dollars in savings. Governmental organizations attempt the implementation of standards as well as regulations for promoting energy-effective (that is, Green) computing.

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Current advances in virtualization have led to its distribution across data centres. Through supporting the movement of virtual machine between physical nodes, it permits dynamic migration of virtual machines as per performance requisites. If virtual machines do not utilize every resource which is provided, they may be logically resized as well as consolidated to minimal quantity of physical nodes, whereas idle nodes may be turned to sleep mode for eliminating idle power utilization as well as decrease overall energy utilization by DCs [15].

At present, resources allocation in Cloud DCs aim at the provision of high performance while also fulfilling SLA, with no focus on allotment of virtual machines to decrease power utilization. For exploring both performance as well as energy efficacy, three critical problems are to be handled: Firstly, excessive power cycling of servers can decrease dependability. Secondly, switching resources off in dynamic environments is problematic from the viewpoint of quality of service. Because of the diversity of workload as well as aggressive consolidation, few virtual machines might not get the needed resources at peak loads and thereby fail in meeting the required quality of service. Thirdly, guaranteeing SLA introduces problems into accurate application performance management in virtualized environments. Every issue requires efficient consolidation policies which can decrease power usage with no compromise to user-specified quality of service requisites.

BEST FIT DECREASING (BFD)

Conventional BFD protocols rank incoming jobs in descending order on the basis of CPU requisites. After the ranking, job at the top of the list is chosen and placed on already utilized server with minimal CPU capacity. In the event of non-availability of resources on utilized servers, job is placed on new server which has minimal CPU capacity [16].

BFD protocols are famous for online bin packet, and are regarded as excellent for VMs placement in cloud environments. BFD protocols are regarded better compared to next fit, and first fit protocols with regard to worst case as well as average uniform case. Furthermore, BFD protocols may also be improved for managing multi-criteria optimizations as done. At present, there is no in-depth work present which tests BFD on the basis of various scenarios. Hence, a comparison is carried out for evaluating BFD methods on the basis of workload as well as migration methods.

GENETIC ALGORITHM (GA)

Genetic Algorithms are search heuristics which mimic the procedure of natural evolution. The heuristics are routinely utilized for generating helpful solutions to optimization as well as search issues. Genetic Algorithms are part of the bigger class of Evolutionary Algorithms (EA) that create solutions to optimization issues through usage of methods which owe their inspiration to natural evolution, like inheritance, mutations, selections, as well as crossover. But, the adequate representation of possible solutions is critical for ensuring that the mutations of pairs of individuals (that is, chromosomes) results in novel, valid as well as meaningful individuals for the problems. Output schedules of jobs are array lists of populations (known as chromosomes or genotypes of the genome) that encode potential solutions to optimization issues, evolve towards better solutions. The major terms utilized in Genetic Algorithm include:

Initial Population: This refers to the set of every individual which is utilized in Genetic Algorithm for finding out the optimum solutions. All solutions in the population are known as individuals. All individuals are denoted as chromosomes for making them adequate for genetic operations. From initial population, individuals are chosen and few operations are employed for forming the subsequent generations. The mating chromosomes are chosen on the basis of certain conditions [17].

Fitness Function: Fitness functions are utilized for measuring quality of individuals in the population as per certain optimization goal. Fitness functions may be different for various cases. In certain cases, fitness functions may have their basis in deadlines, whereas it other cases, it may have their basis in budgetary restrictions.

Selection: It utilizes the proportion selection operator for determining the probability of several individuals genetic to the subsequent generation in the population. Proportional selection operators imply the probability that is chosen as well as genetic to subsequent generation groups is proportional to size of individual fitness.

Crossover: It utilizes single-point crossover operators. Here, solely one intersection was initialized in individual code, at that point, some of the pair of the individual chromosome is interchanged.

Mutation: Mutations imply that the value of some gene locus in the chromosome coding series was substituted by another gene value for generating a novel individual. Mutations are that which negate the values at mutated points with respect to binary coded individuals.

Genetic Algorithm functions thus:

1. *Start*

2. *Set population with arbitrary potential solutions*

3. *Test all candidates*

4. *Iterate till* (*ter* min *ating criterion is fulfilled*)

   a. Choose parents

   b. Re *combine pairs of parents*

   c. Mutate the resul tan *t offsprings*

   d. Test new candidates

   e. Choose individuals for the subsequent generation;

5. *End*

PROPOSED ABC WITH CROSSOVER AND MUTATION OF ONLOOKER BEE WITH EMPLOYED BEE

In the suggested technique, two extra steps are included to generic ABC – which are crossover as well as mutation operators. The initial step of ABC is the generation of population. The populations created are utilized by employed bees. After this, crossover is employed. If crossover or probability fulfils, then 2 parents are chosen arbitrarily for performing crossover operation on them. Novel offspring is created after this. With best created offspring, substitution of the worst offspring is done if it is better than the worst parent with regard to fitness values. Here, crossover operator is employed on 2 randomized chosen parents from current population [18].

2 offspring created from crossover, one replaces worst parent, and the other parent is the same. Now, mutation is carried out on scout bee phase of ABC. Through usage of mutation operator, there is a possibility of altering local best position and the protocol might not rely on local solution. On the other hand, particles might make use of the other's benefit through sharing of information method. In the suggested technique, mutation is performed on the probabilistic way in every food searching operation for every iteration in the lifecycle of ABC.

Choosing of food source is carried out in an arbitrary manner. Food sources are chosen arbitrarily from food size and then mutation is carried out. In mutations, created offspring substitutes for older offspring. Mutations utilized here are uniform mutations. When carrying out mutations, they arbitrarily choose a food source and substitute one of the dimension values through arbitrary numbers created between upper as well as lower bounds of the food source. Suggested protocol is detailed below

ABC with Crossover and Mutation Operator Algorithm:

Step 1: Initialization
For i=0 to maximum number of food sources do
For d=0 to dimension size do
Arbitrarily set food source positions Xij
End for d
Calculate fitness values of all food sources
End for i
Iterate
Step 2: Employed Bee Stage
For i=0 to maximum number of employed bees do
For d=0 to dimension size do
Yield novel potential solutions
End for d
Compute fitness values of all individuals
If fitness values of novel solutions are better than older ones, substitute the older ones with the new ones
End for i
For i=0 to maximum number of food sources do
Compute probability for all food sources
End for i
Step 3: Crossover stage
If crossover condition fulfils
For i=0 to maximum number of food sources
Choose 2 arbitrary individuals from current population for crossover
Employ crossover
Novel offspring created from parents because of crossover. Substitute worst parents with best novel offspring if it is better.
End of i
Step 4: Onlooker Bee Stage
For i=0 to maximum number of onlooker bees do
Based on probability Pi, select food source

For d=0 to dimension do
Yield novel potential solutions for
Food source positions Xij
End for d
Calculate fitness values of individual food sources
If fitness values of novel potential solution is better than already present solution, substitute the older one
End for i
Step 5: Scout bees Stage
If any food source is depleted, substitute it with novel arbitrary position created by scout bees
Step 6: Mutation stage
If mutation conditions are fulfilled then
Choose arbitrary particle from current population for mutation
Employ mutation for generating novel individuals novel offspring created because of mutations
Novel set of sequence is yielded for offspring
Calculate cost for the offspring
Calculate fitness value for updated individual
Memorize best food source as of yet
Till (terminating conditions are fulfilled)

RESULTS

In this section, the energy consumption KWh-ABC and ABC with crossover and mutation of onlooker bee with employed bee are evaluated. An energy consumption, number of VM migration and makespan as shown in **[Table- 1 to 3]** and **[Figure- 1 to 3]**.

Table: 1. Energy Consumption

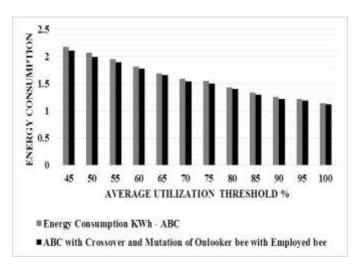| Average Utilization Threshold %	Energy Consumption KWh - ABC	ABC with Crossover and Mutation of Onlooker bee with Employed bee
45	2.18	2.11
50	2.07	1.99
55	1.95	1.89
60	1.81	1.77
65	1.69	1.66
70	1.59	1.54
75	1.55	1.5
80	1.43	1.4
85	1.33	1.29
90	1.26	1.22
95	1.22	1.19
100	1.14	1.12

Fig: 1. Energy Consumption

From the **[Figure- 1]**, it can be observed that the ABC with crossover and mutation of onlooker bee with employed bee has lower energy consumption by 3.26% for 45 average utilization threshold, by 1.79% for 65 average utilization threshold, by 3.05% for 85 average utilization threshold and by 1.76% for 100 average utilization threshold when compared with energy consumption KWh - ABC.

Table: 2. Number of VM migrations

Average Utilization Threshold %	Energy Consumption KWh - ABC	ABC with Crossover and Mutation of Onlooker bee with Employed bee
45	3231	3134
50	3126	3056
55	3006	2908
60	2901	2799
65	2911	2821
70	2751	2690
75	2670	2601
80	2647	2551
85	2599	2527
90	2514	2428
95	2424	2354
100	2347	2264

Fig: 2. Number of VM migrations

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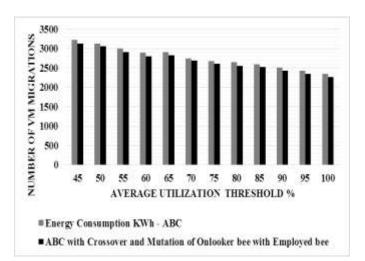
From the **[Figure- 2]**, it can be observed that the ABC with crossover and mutation of onlooker bee with employed bee has lower number of VM migrations by 3.04% for 45 average utilization threshold, by 3.14% for 65 average utilization threshold, by 2.8% for 85 average utilization threshold and by 3.6% for 100 average utilization threshold when compared with energy consumption KWh - ABC.

Table: 3. Makespan

Number of jobs	Energy Consumption KWh - ABC	ABC with Crossover and Mutation of Onlooker bee with Employed bee
50	463	449
100	832	815
150	1312	1272
200	1687	1620
250	2202	2125
300	2689	2600

Fig: 3. Makespan

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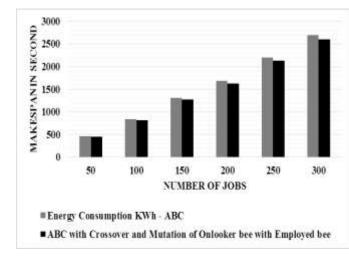
From the **[Figure- 3]**, it can be observed that the ABC with crossover and mutation of onlooker bee with employed bee has lower makespan by 2.01% for 100 number of jobs, by 4.05% for 200 number of jobs and by 3.36% for 300 number of jobs when compared with energy consumption KWh - ABC.

CONCLUSION

Virtual DS facilitates the sharing of resources between computational services as well as hosted appliances. Cloud provider ought to execute energy effective resources management methods for maximizing their returns as well as for improving their efficacy. In the current study, energy aware scheduling was included utilizing ABC, GA as well as BFD. Read coded crossover as well as mutation operators are employed after employed bee phase as well as scout bee phase of ABC. With usage of crossover, new offspring is created from initial population and it replaces the worst parent with best offspring and with mutation operator, a food source is arbitrarily chosen and one of its dimension values are replaced by an arbitrary number generated within lower as well as upper bounds of the food source. Outcomes probe that ABC with crossover as well as mutation of onlooker bees with employed bees leads to lesser makespan by 2.01% for 100 tasks, by 4.05% for 200 tasks as well as by 3.36% for 300 tasks in comparison to power consumption KWh - ABC.

CONFLICT OF INTEREST
The authors declare no conflict of interests.

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The authors report no financial interests or potential conflicts of interest.

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