Honey Bee Behaviour Inspired Scheduling and Load Balancing of Virtual Machine in Fog Environment

R.S. Mohana
Department of CSE
Kongu Engineering College
Erode, India
mohanaamethesh@gmail.com

B. Krishnakumar
Department of CSE
Kongu Engineering College
Erode, India
krishnakumar@kongu.ac.in

N. Sasipriyaa
Department of CSE
Kongu Engineering College
Erode, India
nsasipriyaa@gmail.com

S. Kalaiselvi
Department of CT-UG
Kongu Engineering College
Erode, India
kalai@kongu.ac.in

***Abstract*— Load balancing is the method which shares the jobs across numerous computing resources in Cloud / Fog environment. The objective of cloud computing is to maximize utilization of all resources such as computing, data storage at low cost in a flexible and secure mode. Cloud computing has many advantages but there are still issues in resource utilization, bandwidth utilization, less throughput etc. To overcome this issue new paradigm of computing is introduced as Fog computing. As fog computing is situated near the end user it is possible to transfer data without delay to remote devices which is distributed. Also fog computing is very useful real time streaming applications and wireless sensor networks. The proposed work uses honeybee galvanizing algorithm aims to schedule tasks to virtual machine when the virtual machine becomes idle. This algorithm provides better resource and bandwidth utilization.**

Keywords— Honey bee Galvanizing Algorithm, Cloud Computing, Fog Computing, Virtual Machine.

I. INTRODUCTION

Cloud computing refers to delivering services such as hardware, software in the data centers over the Internet is the definition given by Armbrust et al. [2]. Cloud computing depends on grids, globally distributed, does not require central infrastructure. It is utility based model so full metering and billing is done. An agreement /assurance is sustained among the provider and consumer is termed as SLA (Service Level Agreement). Autonomic computing is also the basic for Cloud which is dynamically provisioned to the customer.

The important features of cloud computing are no capital investment, On-requirement access, elasticity, effectual distribution of resources, Energy resourcefulness, indefectible utilizion of third-party services.

Based on service models, Cloud computing is assorted as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS).Also cloud computing can be deployed with following models Public, Private, Community and Hybrid. Infrastructure-as-a-Service provides virtual hardware, storage and networking on demand to the user. Platform-as-a-Service delivers runtime environment and hosts application when entailed by the user. Software-as-a-Service offers application and services as needed.

For a given a set of resources allocating a set of client tasks is a hard problem. Many tasks are assigned to a same a resource say virtual machine, remaining resources will be underutilized. To have better resource utilization load balancing strategies can be applied. Load balancing is a technique used to allocate cloudlet/tasks to different resources so that the makespan is reduced [15]. Load balancing is done to improve the both the provider and customer satisfaction. It assigns jobs to various resources like computing, storage and network devices.

Load balancing can be done without large capital investment in both hardware and software. Cloud service providers' deal with various costs which includes maintenance, storage capacity, computing power, software up gradation costs. Even though Cloud computing has many advantages but there are still issues in resource utilization, bandwidth utilization, less throughput etc. To overcome this issues new paradigm of computing is introduced as Fog computing. As fog computing is situated near the end user it is possible to transfer data without delay to remote devices which is distributed [9]. Also fog computing is very useful in live streaming appliances and wireless sensor networks. Areas such as agribusiness, optimization of business procedure, deep sea reconnaissance, health enterprise, etc uses Fog computing.

Figure 1 manifests the edifice of the fog and its components.

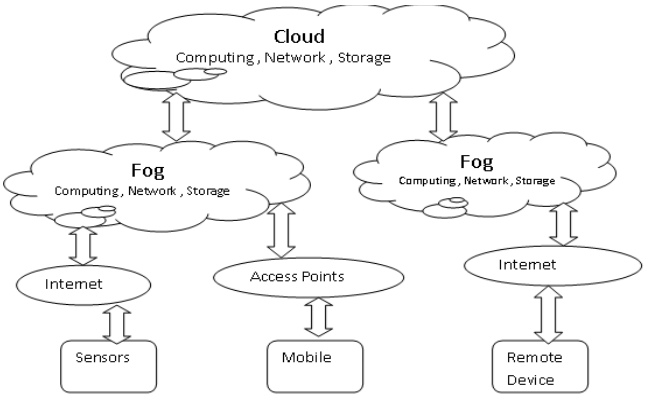

Fig. 1. Architecture of Fog Environment.

II. LOAD BALANCING

Load balancing is the procedure which distributes the amount of work across many computing resources in Cloud / Fog environment. Better consumption of resource is achieved by proper allocation of resources to the client jobs. Load balancing affirms that all the resources/virtual machines are shared with equal workload such that tasks in virtual machine which are over laden are transferred to under laden virtual machine in cloud/fog environment. Many factors are present in real time which makes load balancing as a sensitive problem are fault tolerance, system

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stability, network delay, execution time, overhead, low date transfer delay, scalability, throughput, response time and latency. Various load balancing algorithm such as Min-Min, Min-Max, First Come First Serve (FCFS), and Round Robin (RR) algorithms are employed in cloud to achieve better resource utilization. Load balancing algorithm has to evaluate the total load on computing power, network and storage capacity. The load balancer should be decentralized to avoid single point failure. Also the system must know the resources communicate with each other and the cost involved in the communication.

III. Problem Statement

The main objective of Fog Computing is to offer efficacious right to use to isolated and ecologically distributed resources with the aid of Virtualization in Infrastructure as a Service (IaaS). Cloud providers require proficient resource scheduling/ load balancing algorithm for overseeing vast amount of VM requests. Currently cloudlets/tasks were being allocated in first come first serve fashion after performing Non-dominated sort technique by which the chores are consigned to virtual machine based on their arrival time. But the existing system does not have an efficient load balancing algorithm for handling overloaded virtual machines which is a downside.

A load balancer receives information about the fog components at regular interval and controls the resource utilization. If the load balancing algorithm is centralized if it fails it leads to single point failure. It is better to have distributed procedures for scheduling and load balancing. Many nature inspired algorithms have been developed for scheduling and load balancing in cloud environment which can be extended for Fog environment too.

The proposed work intend to examine the processing time of scheduling algorithms such as first come first serve(FCFS) and round robin scheduling. Also to develop honey bee behavior instigated load balancing algorithm which reduces the load of a virtual machine. It also endeavors to improve the performance of CPU, memory and network operations.

IV. Related Works

Load balancing is the method which shares the workload across multiple computing resources in Cloud / Fog environment. Honey Bee inspired load balancing(HBB-LB) of tasks in cloud computing environments was suggested by Dhinesh Babu and P.Venkata Krishna [6].It aims to increase throughput and balance load in computing resources. A particle Swarm Optimization (PSO) which inspires the behavior of swarm intelligence to use both local and global search techniques is proposed by Ayed salman , Imtiaz Ahmed [3]. In monolithic distributed systems task assignment problem is fathomed using the PSO algorithm. The results prove that it runs with reduced time complexity.

Belabbas Yabougi and Meriem Meddeber [4] introduced a disseminated load balancing model in grid which outperforms than hierarchical method. Erik Cuevas et al [7] advised a Artificial Bee Colony (ABC) algorithm for Block matching for motion estimation. Gbest guided artificial bee Colony algorithm (GABC) was proposed by Guopu.Zha, Sam Kwong [8].This technique was useful for numerical function optimization comprising the information of global best (gbest) solution. Three types of bees such as scout bees, employed bees and onlooker bees are used in GABC algorithm. These bees help to find better solution for any optimization problem.

Pei-Wei Tsai et al [14] planned an Enhanced Artificial Bee Colony Optimization [EABC].In this EABC algorithm the onlooker bee move to identify employed bees based on the fitness value near it .

A hierarchically ever changing tree based model in load balancing strategy for Grid computing is introduced by M.V Panduranga Rao, S.Basavaraj Patil [10]. This model estimates the current workload of a grid based on the data received from its components. Shagufta khan, Niresh Sharma [17] introduces the load balancing of nodes using Ant Colony Optimization (ACO) in Cloud Computing. This algorithm aims to have better resource usage with reduced operating expenses.

V. Proposed Work

A. Honey bee behaviour inspired load balanincg of tasks

The scheduler should perform the scheduling and load balancing process in fog environment practically. Load Balancing is a system to split the amount of work given by a customer that a system has to do across many other resources. The aim of load balancing in fog environment is to utilize them effectively and to reduce the response time. Also virtual machines should not be overloaded or under loaded or idle [13]. A honey bee foraging technique is used for cloudlet/job assignment and load harmonizing is suggested in the proposed work. After assigning tasks to the VMs, current load is measured. When the virtual machine is overloaded the tasks running in this virtual machine will be transferred to the virtual machine with less workload [16].A decentralized load balancing methodology is proposed by Honey Bee foraging technique. This approach improves the system performance and reduces system instability.

B. Bee Foraging Behaviour

Karabogo developed an intelligent foraging behaviour of honey bee swarm namely artificial bee colony algorithm (ABC) for numerical optimization [5].

Initialization process

In the ABC algorithm, initially all the bees are coordinated with some food sources. Then the bees randomly choose some food source and ascertain their nectar quantity. These bees after reaching the hive they dispense this information with other bees through a waggling dance.

Working of Employed bee

The food source information in memory by the Emploued bees and provide this data to its neighbors. This employed bee perform waggle dance in the dancing area where other bees wait to collect information about the food source. Then they move to the formerly inspected food resource and select a new food source with information received from the neighborhood bees. Based on the nectar knowledge shared by the employed bee, the onlooker determines a food source.

Working of Onlooker bee

An onlooker bee collects previous iteration solution data from the employed bees and selects the one better fitness

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value. Waggle dance which are played by the bees tells about the magnitude and features of the solution. Onlooker utilizes this data to prefer a food source.

Working of Scout bee

Random hunt is done by scout bee. Scout bee selects a new food source if the nectar source is forsaken by the bees. Probability of selecting food is directly proportionate to the fitness value of the food source and directly proportionate to total quantity of all food sources.

The employed bee transforms into scout bee if the solution obtained is not satisfied even after a particular number of iterations.

Cloud computing has many advantages but there are still issues in resource utilization, bandwidth utilization, less throughput etc. To overcome this issues new paradigm of computing is introduced as Fog computing. As fog computing is situated near the end user it is possible to transfer data without delay to remote devices which is distributed. Also fog computing is very useful real time streaming applications and wireless sensor networks. The proposed work uses honeybee galvanizing algorithm aims to schedule tasks to virtual machine when the virtual machine becomes idle in fog environment. After assigning tasks to the VMs, current lade is measured. When the virtual machine is overloaded the tasks running in this virtual machine will be transferred to the virtual machine with less workload [16]. A decentralized load balancing methodology is proposed by Honey Bee foraging technique. This approach improves the system performance and reduces system instability.

Honey Bee Algorithm

Step 1: Start
Step 2: Initialize Population of n which is the range of scout bees which are laid haphazardly in VM on Fog computing
Step 3: Repeat till step 10 if Stopping Criterion not met else
Go to Step 11
Step 4: Update the new fitness, assess the fitness of population
Step 5: For each neighborhood, update the new fitness assess the fitness of population
Step 6: Select on look bees ie m sites for neighborhood
Step 7: Recruit scout bees for selected sites (m for best e sites)
Step 8: Select the best fitness bees from batch
Step 9: Assign task to VM
Step 10: Calculate load balance
Step 11: End

VI. Evaluate the fitness of population

$fit_{i,j} = \sum^{n}_{i=1} Cloudletlength_{i,j} / Capacity\ of\ VM_j$ (1)

In a virtual machine VMj, the task i (bee) executes whose fitness is determined using the equation 1. Span of the task that has been rendered in VMj is given by the Cloudletlength. Capacity is Capacity of VMj is estimated using following equation no 2.

Capacity = Number of processing $elements_j$ *processing

$elements\_mips_j$+virtual $machine\_bandwidth_j$ (2)

An employed bee is selected from a patch of scout bees which has best fitness.Fitness values of employed is determined using equation 3

$$Fit_{i,j} = \frac{\sum_{i=1}^{n} cloudletlength_{i,j} + inputfilelength}{Capacity\ of\ VM_j} \quad (3)$$

where inputfilelength is that the length of the job submitted by the client. The employed bee with best fitness is picked from every Batch and task is allocated to virtual machine in fog. Then load balance is evaluated to identify the VMs which are under loaded using variance (SD).

Variance (SD) of the load will be calculated using following equation 4

$$SD = \sqrt{\frac{I}{N}\sum_{j=0}^{n}\left(X_j - \bar{X}\right)^2} \quad (4)$$

In above variance equation, Xj Processing time of VM is determined by equation 5

$$X_j = \frac{\sum_{i=1}^{k} cloudletlength_i}{capacity_i} \quad (5)$$

In above variance equation, Average of all execution times of all tasks in all VMs is determined by equation 6

$$X = \frac{\sum_{j=1}^{n} X_j}{n} \quad (6)$$

If the variance of the loaded VM is less than the Average of all execution time, then the VM is under loaded and the system is said to be stable. If the variance of the loaded VM is more than the Average of all execution time, then the VM is overloaded and the system is in imbalanced state. Some cloudlets in overloaded VM can be migrated to underutilized VM.

VII. Experimental Results

Investigating in real time is practically not viable as it needs too much cost, security etc in real fog environment. IFogsim simulator [20] is used for modelling and simulating fog environment. When IFogsim simulator is used implementation can be done in minimum span of time and testing can be performed with less capital investment. Load balancing using honey bee galvanizing proposed algorithm is compared with existing load balancing algorithms such as FCFS, Round Robin.

A. Makespan

The overarching completion time of the jobs in the VM is defined as Makespan. The objective of any load balancing algorithm in cloud/fog environment is to reduce the makespan. Makespan is calculated in milliseconds. Makespan is given by the following equation 7.

Makespan = $\{CT_{mn} / m \in T, m = 1, 2, \ldots p \text{ and } n \in VM, n = 1, 2, \ldots q\}$ (7)

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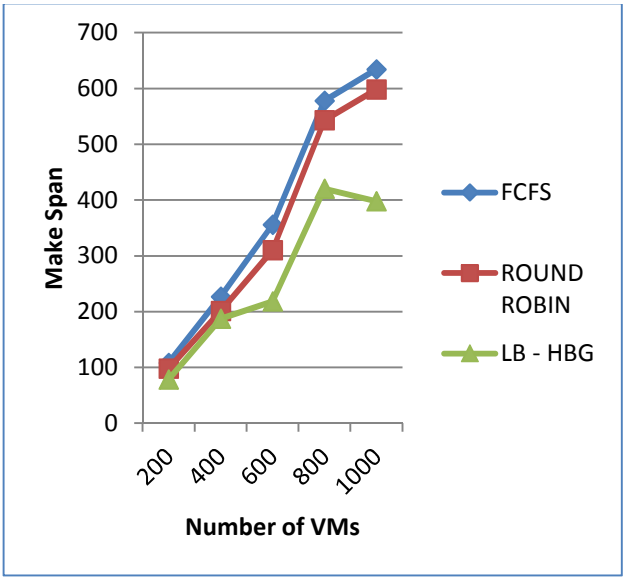

Fig. 2. Comparison of Makespan.

Figure 2 depicts the comparison of makespan with various algorithms such as FCFS, Round Robin and load balancing using honey bee galvanizing algorithm(LB-HBG). When number of tasks increases in fog, the variation in makespan is more. Hence the LB-HBG performs better than FCFS and round robin when makespan is considered.

B. Response Time

The difference between first response from the system and job submission time is calculated as response time. The diminution in awaiting time is utilitarian in improving the receptiveness of the VMs.

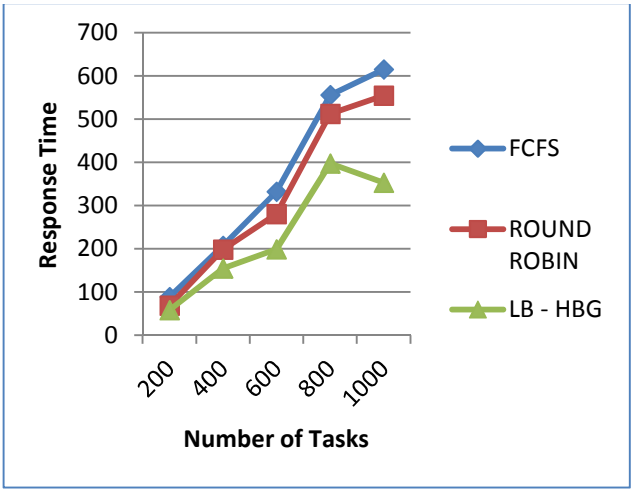

Fig. 3. Comparison of Response Time.

Figure 3 depicts the comparison of response time with various algorithms such as FCFS, Round Robin and load balancing using honey bee galvanizing algorithm(LB-HBG). The X-axis presents number of tasks and Y-axis presents the response time in milliseconds. When number of tasks is near 1000 in fog, the response time is significantly less than existing approaches. Hence the LB-HBG performs better than FCFS and round robin in terms of response time also.

VIII. Conclusion

Fog computing is a new technology term originated by Cisco. It is distributed computing model that widens the services provided by the cloud to the edge of the network. Fog layer acts as intermediate between the end user and cloud. Fog layer is used for proper utilization of bandwidth thus by increasing the efficiency of cloud environment. At the boundary of the cloud the gigantic quantity of information of wireless objects such as sensors and Internet of things in distributed environment has been placed in fog environment. It enables quicker accessing, provides greatest throughput and met other computing necessity of live applications. It is otherwise called as an edge computing. In the proposed load balancing using honey bee galvanizing algorithm (LB-HBG) is designed for fog environment. This LB-HBG is implemented in IFogSim simulation toolkit.

The result gained after instrumenting our proposed framework and algorithm are extremely good. The algorithm has reduced makespan, quick response to the customer request, completing tasks within deadline. It also maintains data constancy along with better resource and bandwidth consumption as compared to the existing algorithms like FCFS, Round robin in fog computing environment.

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