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Effective Cloud Load-Balancing Policy Based on Golden Eagle Optimization Algorithm

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Abstract: *Several researchers developed many load balancing and work scheduling techniques in cloud computing, but system performance and load are still inefficient and imbalanced. As a result, in this study, we suggest a load-balancing algorithm derived from natural phenomena to enhance performance. In this research, the Golden Eagle optimization algorithm was added to the current load balancing algorithms such as round robin, throttled, and ant-colony load balancing algorithms and compared with them using three scenarios of the service broker, which are the closest data centre, optimize response time and reconfigure dynamically in cloud analyst simulator. It was concluded that the response time and processing time of data centres are close to some algorithms and better than others. The overall response time in the case of the closest data centre is 82.98. The data centre processing time is 33.19, and in the case of optimizing the response time server broker, the response time is 83.32, and the data centre processing time is 33.42. In the case of reconfiguring dynamically, server broker where the response time is 100.06 and the data centre processing time is 50.27, the larger response time values for the dynamic performance policy are clearly shown so that the policy is adopted on the current load-facing the data centre*
.

Keywords: *Cloud computing; load balancing; load balancing algorithms; golden eagle's optimization algorithm*

1. INTRODUCTION

Cloud Computing (CC) is the supply of computing services over the internet, including servers, databases, storage, networking, and software, cloud computing enables faster innovation, more flexible resources, and lower costs. A typical cloud computing environment consists of the front and back sides. The front side is on the user's side and is accessible via an internet connection, while the back end is concerned with the cloud service model. Cloud computing services can be accessed from various and widely distributed resources. On-demand services are provided by distributed computers [1].

Services include software as a Service (SaaS), physical resources Platform as a Service (PaaS), and hardware/ infrastructure Amazon EC2(Amazon Elastic Cloud) [2] Also, three types of clouds (Public clouds, Private clouds, and Hybrid clouds) are employed depending on the domain or environment in which they are used (combination of both private and public clouds) [3] The main benefits of cloud computing: are reduced cost, improved performance, unlimited storage capacity, and so on, and the component of cloud computing creating of Client computers allow end-users to interact with the cloud. Distributed Servers are servers dispersed across the globe, but they work with one another.

Data Centers are a grouping of servers. In cloud computing, load balancing is a technique of redistributing loads in a distributed system to ensure that neither computing machine is overburdened or under burdened [4]. And it is a technique of allocating the overall workload to the different nodes of distributed systems to increase resource efficiency and response time. While avoiding the situation where several nodes are overloaded, and others are underloaded [5]. And it is considered one of the challenges of cloud computing. The primary goal of load balancing is to obtain the shortest order execution waiting time with the minimum sources used. Load balancing is a collection of rules that assigns a certain task to a certain virtual machine. Each task requires some execution time depending on the capacity of the virtual machine to which it is assigned. Load balancing ensures the best resource uti-

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lization by equitably allocating jobs to available resources. Load balancing algorithms assign tasks to appropriate and available virtual machines to increase task make span and reduce task reaction time. And load balancing is a technique for distributing workloads among virtual servers in a cloud environment while properly balancing traffic on those machines.

Load balancers supplied two crucial functions: first, they promoted the availability of cloud resources, and second, they promoted performance. The primary goal of load balancing is to prevent any server from becoming overburdened and possibly failing [6]; load balancing is commonly used to improve the speed and performance of all devices, and load balancing technology has been used to provide maximum throughput and minimal response time [7]. And the most algorithms popular for load balancing found in Cloud Analyst are as follows Round Robin algorithm is based on the round-robin concept, which distributes an equal share of an object to each person in turn. This is the oldest and simplest scheduling strategy [8] [9], Equally spread current execution, this is a form of a dynamic algorithm. It prioritizes the job size before distributing the workload to a V.M. with a small load at random. It's also known as the Spread Spectrum approach because it distributes workload across multiple nodes. ESCE relies on a queue to store requests and spread the load to V.M.s if one is overburdened [10].

Throttled This algorithm is applied to every virtual machine. And keep an index table of virtual machines and their statuses (Available or Busy). The client/server first asks that the data centre locate a suitable virtual machine (V.M.) to complete the indicated task. The load balancer is requested by the data centre for the allocation of the virtual machine. The load balancer examines the index table from top to bottom until it finds the first available V.M. or the first available V.M. [11]. Ant-colony is an intelligently enhanced method that can resolve a scheduling issue in cloud computing. The ACO is a heuristic algorithm with significant adaptive and good feedback, among other qualities. ACO is well suited to address the problem of huge job scheduling in cloud computing because of these features. The ant colony algorithm is a type of dynamic algorithm derived from Simulate the behaviour of real ants by examining the path, locating food, and determining the shortest distance between a colony and a source of food in nature; ants can produce a pheromone (an aromatic molecule) as they move along a path. The other ants can sense this substance as they move and use it to choose which way to walk [12]. Honeybee It imitates honey bees' foraging behaviour. The algorithm combines neighbourhood and global search in its basic form and can be used for combinatorial and continuous optimization [13]. The server broker is considered the mediator between user bases and data centres. The primary goal of employing a service broker is to reduce user request latency, charge the data centre with processing user requests, and route user requests to the optimal data centre with the best performance. Cloud analyst employs three service broker policies: closest data centre policy, optimum response time policy, and dynamically reconfigurable routing with task scheduling. The closest data centre server broker policy selects the nearest D.C. based on proximity. The data centre with the minimum network latency is considered the closest; therefore, the policy gives the shortest response time [14]. In the Optimize Response Time server broker policy D.C. is selected based on various characteristics such as network latency, last task response time, and data centre workload [15]. Reconfigure Dynamically with Load this policy is identical to proximity-based routing, except that the broker changes the number of V.M.s allotted in the D.C.s based on the load [16].

This research has added the golden eagle's optimization (GEO) to the current load balancing algorithms existing in the cloud analyst simulator to compare them and extract the best results of response time and data centre processing time for each of the policies within an environment cloud analyst.

2. GOLDEN EAGLE OPTIMIZATION

This research used optimization methods to create an algorithm for load balancing in cloud computing. A number of these algorithms are derived from natural phenomena, such as the GEO algorithm, which is also based on the intelligent foraging action of golden eagles when searching for prey. The golden eagle is one of North America's largest birds of prey. Which has several distinct characteristics, including; Its colour is dark brown with golden feathers, its weight ranging between 6 to 15 pounds, and its speed reaches more than 150 miles/hour [17], so the golden eagle is very fast and has sharp claws, and its speed and sharp claws help golden eagles hunt their prey Such as rabbits, squirrels, reptiles, birds, large insects and fish. The golden eagle's cruising and hunting are distinguished by its spiral path, which means the prey is usually on one side of the eagle [18].

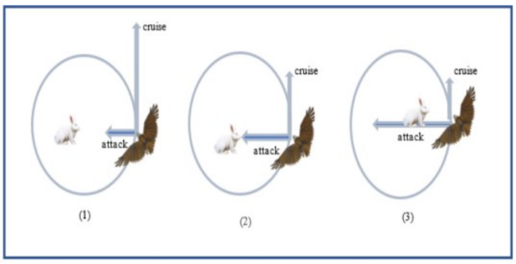

Figure 1 Spiral motion of golden eagles [20]

Golden eagles will occasionally communicate the location of the best prey they have located with the other eagles. If the eagle does not find a suitable location for prey, it will continue to circle in smaller circles

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around the present one before attacking the prey. However, if the eagle discovers a better option, it begins circling the new prey and forgets about the prior one [19]. The golden eagles have a greater tendency to cruise in the early phases of the hunting flight and a greater tendency to attack in the later stages, which leads to more exploration in the early iterations as well as more exploitation in the later iterations.

2.1Pseudo Code of Golden Eagle Optimization Algorithm

The GEO technique is a load-balancing technique used by data centres to efficiently divide received tasks across virtual machines at normal workloads by locating the best V.M. among a set of V.M.s to allocate the workload in cloud computing.

Step1: Initialization parameter of the GEO algorithm
Population size= V.M. Allocation Count. Size ()
Cruise Propensity=0
Attack Propensity=0

Step2: Calculation to get the fitness value of VM
I=0
while (I< V.M. State List. Size ())
if (VM Allocation Counts. get(i)==null)
fitness. put(i,0)
else
fitness. Put (i, Calc New Po (V.M. Allocation Counts. get(I))
I=i+1

Step3: by GEO, we are getting the best V.M. available
I=1
Cruise Propensity=-1
Radius= fitness. get (0)
Converge eagle=Radius
While (I< V.M. state list. size ())
If (fitness. get(I)<converge eagle)
Radius=fitness. get(I)
Attack propensity=I
Converge eagle=Radius
Cruise propensity=converge eagle
I=i+1
X=attack propensity

Step4: Calculate the step vector
int memorize the best source ()
return movement vector ()
int V constrained ()
return to memorize the best source ()
Int Step vector ()
If (Cruise propensity==-1) then V.M. state list. Size ()>0
return Cruise propensity
else calc_ Cruise_ stepvect ()
return V constrained ()
end if

Step5: To get the next available VM
GEO ID← -1
GEO ID← step vector ()
Allocated V.M. (GEO ID)
return (GEOID)

3. RELATIVE WORK

Several researchers suggested many strategies for cloud computing load balancing and work schedules. This section looks at several studies that focused on improving load balancing.

Fang et al. 2010, provide a two-level scheduling algorithm system based on load balancing in computing to achieve high utilization of resources and match dynamic job requirements. They increase reaction time and resource usage by mapping tasks to virtual machines and, subsequently, virtual machines to host resources. They use the first level of scheduling from the application of the user to the V.M. to create a description of the V.M., such as the network resources, the job of computing resources, storage resources, and so on, and the second level of scheduling from the V.M. to host resources to find appropriate resources for the V.M. This strategy may have enhanced resource utilization, but adopting two job scheduling tiers should raise reaction time[21].

Mishra et al. 2012 [22] present a new method based on ant colony technology. Ants rely on the strength of their pheromone to choose the best path to their destination. Similarly, every node within the network has a pheromone. The routing preference for each destination is represented by each row in the pheromone table, and the probability of selecting a neighbour for the next hop is represented by each column. When an ant is at a decision point with no pheromone present, it makes a random selection. If the pheromone occurs, the node with the highest probability is chosen, and the pheromone table is modified by increasing this node's probability while decreasing the other node's probabilities. The key disadvantage of this technique is that it does not consider each node's current workload information. As a result, in some cases, some nodes may well be substantially loaded while others stay inactive.

Dinesh B. L.D. and P.V. Krishna, 2013 presented a Load Balancing Technique Inspired by Honey Bee Behavior (HBB-LB). HBB-LB helps evenly spread the virtual machines' load, maximizing the system's total throughput. This technique also accepts task priorities for virtual machine execution [23].

H. Shoja et al. 2014 discussed the throttled load balancing algorithm is entirely virtual machine based. This client first asks the load balancer to identify the correct virtual machine that has access to that load and performs the activities specified by the user or client. The load balancer keeps a virtual machine index table that includes their state (Available or In Demand). As a result, the client initially asks the load balancer to

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locate an appropriate Virtual Machine to conduct the necessary operations functions [24].

A. P. Utama, 2016 mentioned the algorithm under the Round Robin idea uses time-sharing to control processing time; each process is given CPU time named a quantum time [25]. When the timer runs out, the process is postponed and placed in the ready queue. If a process's CPU burst is less than the time quantum, the process will release the CPU once it has completed its task so that the CPU can be used immediately by the following process. In contrast, if a process has a CPU burst bigger than the time quantum, the process will be halted and queued back to the tail of the ready queue before executing the next process [26].

Alam and Ahmad, 2017 discussed the issues of load balancing in cloud computing, including the Geographical Distributions of the Nodes. It is used in various large-scale programs such as Twitter and Facebook. The complexity of load-balancing algorithms affects the overall performance of the system. Traffic Analysis is conducted across different geographical locations to achieve throughput and maximum asset utilization. The load balancer system keeps up activity in peak hours in each position [27].

Volkova et al. 2018 presented three load-balancing techniques used within cloud computing: Round Robin Method, Throttled Load Balancing Method, and Active Load Balancing Monitoring. They analyzed the results of using the three algorithms for load balancing and noted that the Throttled load balancing algorithm (TLB) has a better response time and data centre time than the other techniques [28].

Afzal and Kavitha, 2019 discussed the many types of cloud computing services. The delivery of such resources is made possible by the use of services. The falls under the Infrastructure as a Service (IaaS) cloud category, while the latter two fall under the Software as Service (SaaS) cloud and Platform as Service (PaaS) cloud category, three basic cloud components. Client Computers are used by end-users to connect with the cloud. Scattered Servers are servers distributed over multiple locations yet work together, while Data Centers are a collection of servers [29].

Aliyu et al. 2019, developed the Hybrid Approach (T.A. & ESCE) to maintain a threshold value as the priority for each V.M. to ensure fair workload allocation. Aside from the reduced response time, it is also cost-effective [30].

Simon et al., in 2020, identified load balancing as a method of redistributing workload in cloud computing, with the main goal of preventing any single server from becoming overwhelmed and possibly breaking down [31].

T. A. N. Abdali et al. (2020) advocated employing the Optimized PSO (OPSO) instead of a non-uniform mutation operation for routing in MANETs. The OPSO is a LAR protocol feature that aids in the improvement of important performance metrics like energy consumption, packet delivery ratio (PDR), end-to-end delay, and control packet overhead [32].

Mishra et al. 2020, proposed a classification of load-balancing algorithms, such as static and dynamic load-balancing algorithms, and discussed the benefits and drawbacks of each. Some policies, including transfer policy, selection policy, placement policy, and information policy, are employed in dynamic load balancing algorithms [33].

Alyouzbaki and Al-Rawi, 2021 proposed a novel technique to improve the energy performance of data centres, the three-threshold energy saving algorithm (TESA) V.M. implementation algorithm, which is based on the straight line between energy usage and the use of processor assets. In TESA, hosts in data centres are split into four groups based on load, including host with a light load, host with an appropriate load, host with a moderate load, and host with a heavy load. By describing TESA, V.M.s on a lightly loaded host or V.M.s on a heavily loaded host are transferred to another host with the appropriate load. This paper will be compared to the current work because it is often utilized in cloud load balancing [34].

4. SIMULATION SCENARIO

The cloud analyst program compares and contrasts different load-balancing techniques. Cloud analyst is a simulator with an interactive graphical interface, the simplify of simulation tools for the user good capabilities for conducting studies and analysis of cloud computing scenarios. So is his focus on the parameters used within the simulation rather than on the software aspect only. And this simulator is open source and may be modified to meet the user's needs [35] [36].

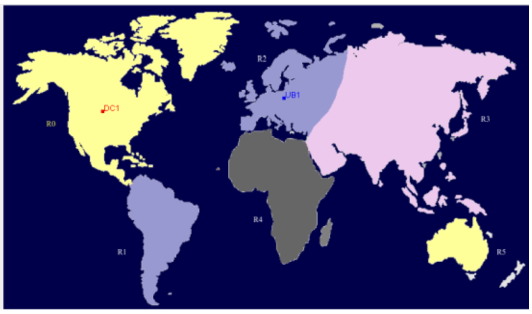

Figure 2 Cloud analyst simulator [8]

Cloud Analyst includes three service broker policies: closest data centre, optimize response time and reconfigure dynamically. Thus, to test the proposed algorithm, it must be added to the previously mentioned algorithms within this program. To do this, we need to work on Cloud Sim through a cloud analyst interface, simulate it and extract the results.

To test the various algorithms, we created a virtual environment with three data centres, DC1 has 50 virtual machines, DC2 has 75 Virtual machines, and DC3

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has 50 virtual machines. When the number userbase is UB1 is 5000, UB2 is 25000, and UB3 is 50000, Each simulation takes 1 hour.

Size of virtual machines: used to host applications in the study.

Service Broker and its executions: it defines the various administrative agents.

Simulation: It simulates the user-supplied parameters.

GUI Main: The graphical user interface controls the front end.

VM-memory: Virtual machines have 1024 MB of RAM.

VM-bandwidth: Virtual machines have 1000MB of available bandwidth.

Cloud Datacenter Controller: This device is in the management of the data centre.

User Base: A user base is a collection of customers/users in one location.

Service Broker and its executions: it defines the various administrative agents.

Data centre architecture: Simulated hosts have x86 architecture.

Datacenter -VMM: virtual machine monitor Xen.
Datacenter O.S.: Linux operating system.

Internet: The term "internet" refers to the behaviour that regulates traffic.

Internet Characteristics: Various internet characteristics include execution time between the client and the Cloud server.

V.M. Load Balancer and its application: It balances the load by altering data centre protocols to distribute V.M. demand.

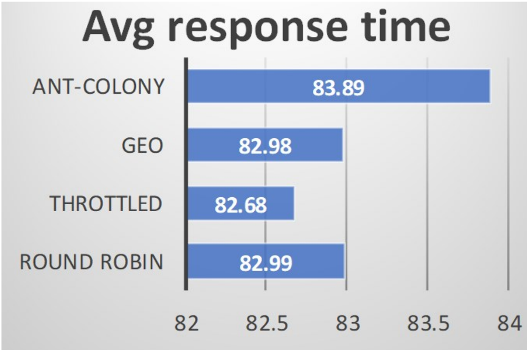
User Base Element: This component keeps records of customer bases.

Data Center Base Element: This component informs the User Interface about data centres and machines.

The various algorithms of load balancing are compared by taking different scenarios as follows:

First scenario: when Closest Data Center is applied as a Service Broker Policy, the result of avg response time and data centre processing time is shown in figures 3 and 4.

In Figure 3, we noticed that the response time for the throttled load balancing algorithm was the best, as it reached 82.68. We also noticed that the response time values converged in the two algorithms GEO and round robin, which reached 82.98 and 82.99, respectively. While the worst response time was for the ant colony algorithm, it reached 83.89.



	Round Robin	Throttled	GEO	Ant-colony
Avg response time	82.99	82.68	82.98	83.89

Figure 3 Average Response Time for Closest Data Center service broker policy

In Figure 4, we noticed that the data centre processing time for the throttled load balancing algorithm was the best, reaching 32.89. We also noticed that the data centre processing time values converged in the two algorithms GEO and round robin, which reached 33.19. while the worst data centre processing time for the ant colony algorithm reached 34.09.

Second scenario: when optimized response time is applied as a Service Broker Policy obtained, the result of avg response time and data centre processing time is shown in Figures 5 and 6.

In Figure 5, when applying the optimized response time server's broker, we noticed that the throttled load balancing algorithm's response time was the best, reaching 82.97. We also noticed that the response time values converged in the two algorithms GEO and round robin, which reached 83.32 and 83.33, respectively. While the worst response time for the ant colony algorithm reached 83.79.

In Figure 6, when applying the optimized response time server's broker, we noticed that the data centre processing time for the throttled load balancing algorithm was the best, reaching 33.09. We also noticed that the response time values converged in the two algorithms GEO and round robin, reaching 33.42 and 33.44, respectively. While the worst data centre pro-

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cessing time for the ant colony algorithm reached 33.90.

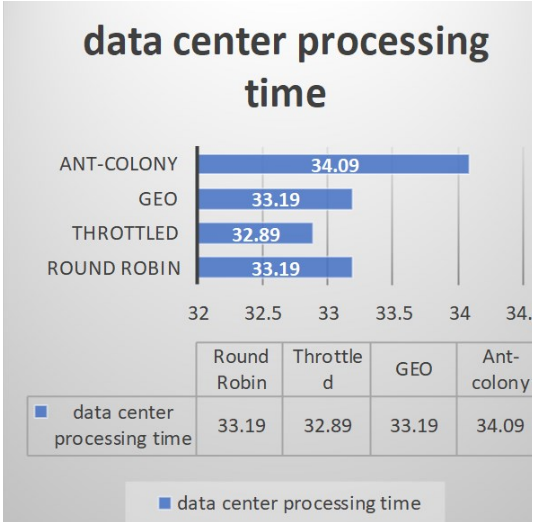

Figure 4 Data center processing time for Closest Data Center service broker policy

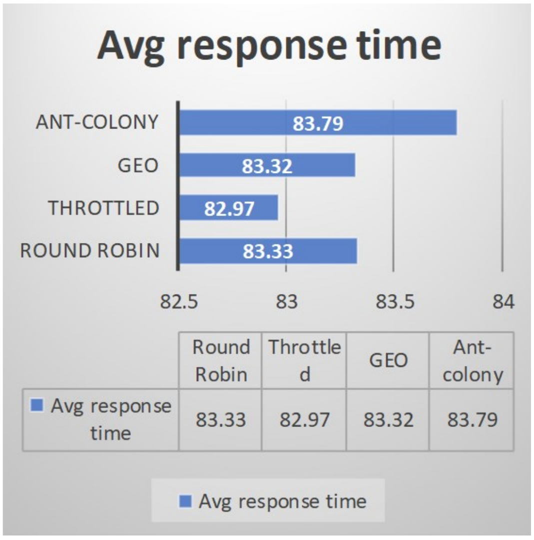

Figure 5 Average Response Time for optimize response time service broker policy

Third scenario: when reconfiguring dynamically is applied as a Service Broker Policy, the result of avg response time and data centre processing time is shown in Figures 7 and 8.

In Figure 7, when applied, reconfigure the server's broker dynamically. The larger response time values for the dynamic performance policy are clearly shown so that the policy is adopted on the current load facing the data centre. The GEO load balancing algorithm's response time was the best, reaching 100.06. We also noticed that the response time in the throttled where reached 100.40. and noticed that the response time in the ant colony is 102.19. while the worst response time for the round-robin algorithm reached 467.81.

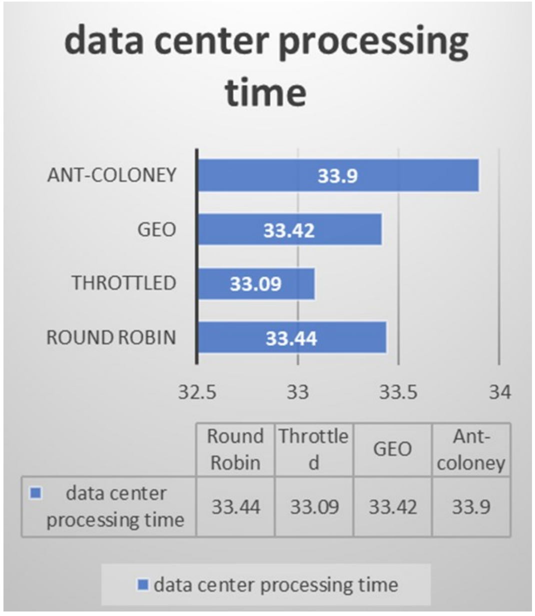

Figure 6 Data centre processing time for optimizing response time service broker policy

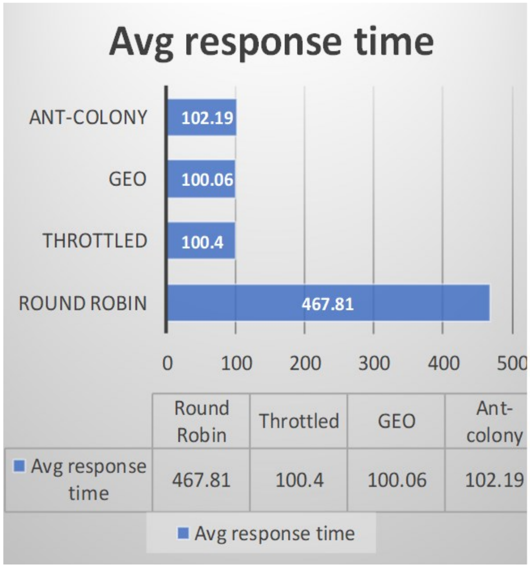

Figure 7 Average Response Time for reconfigure dynamically service broker policy

In Figure 8, when applying the dynamic reconfigured server's broker, we noticed that the data centre processing time for the GEO load balancing algorithm was the best, reaching 50.27. We also noticed that the data centre processing time of throttled is 50.60, and the data centre processing time of the ant colony is 50.40. while the worst data centre processing time was for the round-robin algorithm, which reached 417.81.

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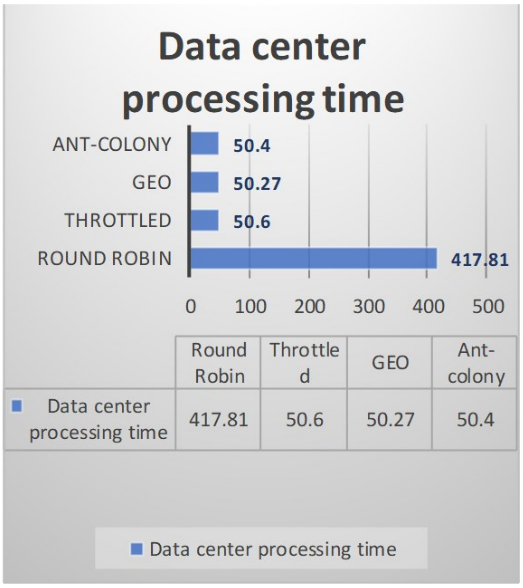

Figure 8 Data center processing time for reconfigure dynamically service broker policy

5. CONCLUSION

We conclude approximate values of the response time and data centre processing time in the closest data centre and optimize response time because both policies depend on the network and transmission delays to choose the best data centre to provide the service. While the larger values of response time for the dynamic performance policy are clearly shown so that the policy is adopted on the current load facing the data centre. And we concluded that the response time value and the processing time of the data centres for the golden eagle optimization algorithm are close to the round-robin algorithm and better than the ant-colony algorithm. Still, it gave the response time and processing time of the data encoders worse than throttled because throttled is considered the best algorithm ever in the closest data centre and optimized response time, while the response time and data centre processing time for GEO are the best in when applied reconfigure server broker dynamically. Future work will involve developing a new dynamic load-balancing technique or hybrid of two load-balancing techniques for improved resource utilization and shorter response times in a cloud computing environment.

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