



Finding an Optimal Datacenter in Mobile Cloud using Heuristic Technique

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Abstract— *cloud computing alleviate infrastructures, platforms and applications by supplying resources in dynamic and pay-per-usage manner. Mobile Cloud is different from normal cloud in the form of datacenter location, mobility, band width and network coverage. To find an optimal datacenter for virtual machines resource allocation is a challenging task in mobile cloud computing. This paper concentrates on how Particle Swarm Optimization (PSO) is effectively applied for finding the optimal datacenter in mobile cloud environment. The promising results were obtained to justify that PSO can be effectively used for finding the optimal datacenter in minimal time.*

Keywords— *Mobile Cloud Computing, Datacenter, Resource Allocation, PSO*

I. INTRODUCTION

Now days, Mobile Cloud Computing (MCC) is gaining popularity in academic and corporate world because of its characteristics of elastic resource management [1] [25] [27] [33]. MCC helps to use energy consumed applications effectively in resource constrained mobile devices. It acts as a bridge between mobile devices and cloud datacenters [29][30]. We can access resources like applications, virtual machines, anywhere, anytime with the exploitation of the mobile devices, network providers and cloud providers. Cisco Internet Business Solutions Group (IBSG) predicts [2], approximately 80 percent world's population accessing mobile devices like Smart phones, tablets and palmtops.

According to Juniper research [3], accessing cloud-based services by unique consumers will be increased to 3.6bn by 2018. The report also states that the collection of cloud-based storage, music and games will increase the demand of customer in the next five years. The Developers design, build and host applications using cloud computing techniques and not constrained by mobile device computing power, operating system and memory in mobile cloud computing model. With the support of mobile cloud computing, a browser enabled mobile devices access resources in terms of infrastructure, platform, storage and software or applications from servers or datacenter through cloud computing techniques without installing the application on client or mobile devices.

In Mobile Cloud Computing, cloud providers and network providers plays a vital role for accessing cloud resources. Dejan Kovachev [4] defined as "Mobile cloud computing is a model for transparent elastic augmentation of mobile device capabilities via ubiquitous wireless access to cloud storage and computing resources, with context-aware dynamic adjusting of offloading in respect to change in operating conditions, while preserving available sensing and interactivity capabilities of mobile devices."

Based on the study, we state, "Mobile cloud computing is a combined model for elastic computing resource allocation between cloud datacenter and mobile device, in which users access all resources as a service basis through the mutual effective finding, partitioning and offloading contribution resources such as infrastructures, application, bandwidth reservation limit, backup mechanism of network service provider and cloud provider".

Resource management [26] [31] [32] is a significant challenge in normal cloud and mobile cloud environment. To find an optimal datacenter for dynamic resource allocation is an important challenge in mobile cloud. While comparing with the traditional searching techniques, heuristic techniques appear are to be better in finding the optimal datacenter. In this paper, we apply particle swarm optimization method [5] [6] [7] [28] to find the nearest optimal datacenter in mobile cloud environment. PSO can be effectively used to find an optimal datacenter in search space.

The remaining part of the paper is formed as follows. Related works of mobile cloud computing are reviewed in section II. In section III, heuristic method PSO is discussed. Results and discussions are presented in section IV. Finally, conclusion and future work of this paper is discussed.

II. RELATED WORKS

Pinheiro et al. [8] proposed a technique for power management which has been employed at the datacenter level. They used a technique for power consumption minimization which deals with power or performance trade-off of physical nodes for multiple web applications in a heterogeneous cluster environment. To minimize the power consumption they proposed an algorithm which sporadically supervises the usage of resources and produces decisions on switching

mechanism of node. Dinh Thai Hoang et al. [12] proposed a model to provide a better Quality of Service (QoS) for different kinds of mobile users. This model concentrates on resource allocation and admission control challenges in the cloudlet which contains a mobile application module.

Enhanced mobility prediction model considered a target speed, accuracy and delay of constant positioning, acceleration to find if the target is proceeding or not [21]. The concept of resource allocation computation was explicated by Gomoluch J et al. [9]. They described four different approaches such as state based, non pre-emptive, pre-emptive and model based for computation and discussed proportional share protocol, continuous double actions and round robin algorithms. The parameters which are taken for measurement in the distributed system are message delay, processing delay, task creation and the number and speed of the servers. The communication overhead is reduced in State and non pre-emptive based system mode. System and pre-emptive based system model are dynamic and flexible.

Mapreduce algorithm was discussed by sathish narayana srirama et al. [10] using combined mapreduce techniques with iterative algorithms for solving scientific problems and efficiently utilizes resources in a cloud computing environment. A new architecture Mobile Cloud-Hybrid Architecture (MOCHA) [11] introduced for face recognition applications which combines cloud servers, cloudlet and mobile devices. This architecture is used to reduce the face recognition process response time. Lyapunov optimization techniques are used by the Stable and Adaptive Link Selection Algorithm (SALSA) to balance the tradeoff between the energy consumption and energy delay in online. These four techniques determine the lowest energy link without taking any application requirement [18] [19].

Limited battery capacity is one of the strict constrain in mobile device. The power exhausted by the network interface represents a large fraction of the total power consumed by the mobile device [13]. Since, the popularity for the mobile cloud computing is increasing, this situation is considered to be the worst situation [14]. To improve the energy efficiency of mobile devices, efforts have been made on the transmission scheduling of radio interfaces. Fangming Liu et al. [15] discoursed the three kinds of mobile cloud architectures which are mobile cloud peer-based ad hoc model, cloudlet and centralized cloud of mobile cloud computing. Moreover, they presented the future of MCC and cloud computing contribution in mobile computing area.

There are existing works which tried to achieve the energy competence by reassigning the data amongst the mobile devices. Coolspots [16] [17] used application's bandwidth to determine when to use wifi and Bluetooth whereas Context for wireless uses statistical information to decide when to use the wifi for improving the energy efficiency in data transferring. Farrell et al. [20] considered a target speed and constant positing delay for monitoring mobile objects. Paek et al. [22] used a consistent cell-ID sequence matching points and travelled route consistency for efficient energy utilization on smartphones. This model stores GPS position sequence, Cell-ID history.

Marshall et al. [23] proposed an elastic site manager which is capable of providing resources for scientific applications in dynamic manner on both private and public clouds. Kannan Govindarajan et al. [24] proposed a cloud resource broker for managing cloud resources in an efficient manner and complete jobs within a user-specified limit. They integrated Particle Swarm Optimization and dead line based job scheduling based resource allocation mechanism.

III. PARTICLE SWARM OPTIMIZATION ALGORITHM

Particle Swarm Optimization is an algorithm based on swarm intelligence. It is a semi-robotic, unadventurous and optimization algorithm. An amalgamation of the association unruffled from the individuals from the past proficiencies and other social interactions is the main concept of Swarm Intelligence. Organism's social behaviour to populate and interact in a large search space is the inspiration for the PSO. Since, the PSO does not have a crossover and mutations, and its particle motion depends only on the velocity, it is the more suitable algorithm for operation execution than the Genetic Algorithm. It is an arithmetical computation which produces a better solution. It optimizes the objectives by repeatedly improving the candidate solution. The movement of the particle is affected by the local best position. The local best position channels the particles to stumble on the best known position (P_{best}).

The $P_{best,i}$ is calculated by using the formula

$$P_{best,i} = \begin{cases} P_{best,i} & \text{if } f(x_i) > P_{best,i} \\ x_i & \text{if } f(x_i) \leq P_{best,i} \end{cases} \quad \text{----> (1)}$$

The formula used to calculate Global Best Position G_{best} is

$$G_{best} = \{ \min \{ P_{best,i} \}, \text{ where } i \in [1, \dots, n] \text{ where } n > 1 \} \quad \text{----> (2)}$$

Velocity can be updated by using the formula

$$V_i^{t+1} = wv_i(t) + c_1r_1[x_i(t) - x_i(t)] + c_2r_2[g(t) - x_i(t)] \quad \text{----> (3)}$$

Where, $v_i(t)$ -> velocity

w, c_1 and c_2 -> supplied co-efficient.

r_1 and r_2 -> random values

$x_i(t)$ -> individual best solution

$g(t)$ -> swarm's global best candidate solution

$WV_i(t)$ -> inertia component

$c_1r_1 [(x_i(t) - x_i(t))]$ -> cognitive component

$c_2r_2 [(g(t) - x_i(t))]$ -> social component

The pseudo code of the Particle Swarm Optimization Algorithm is as given below.

Algorithm PSO

Input: Randomly initialized position and velocity of the particles: $X_i(0)$ and $V_i(0)$

Output: Position of the approximate global optima X^*

Begin

While terminating condition is not reached **do**

Begin

For $i = 1$ to number of particles

Evaluate the fitness:= $f(X_i)$;

Update p_i and g_i ;

Adapt velocity of the particle using equations (3);

Update the position of the particle;

increase i ;

end while

end

IV. RESULTS AND DISCUSSION

The existing algorithm is simulated and compared with Neural Network approach, Round Robin Algorithm and First come First Serve approach. The results obtained are promising and supports the PSO algorithm which finds the optimal data centre for effective resource allocation in Mobile Cloud environment in minimum time. The parameters taken for measuring the strength of the algorithm is bandwidth and response time. The experimentation is arbitrarily giving the cloud resources in terms of datacenter, virtual machines, processing limit, bandwidth limit, memory, nodes and user access range. The usages of cloud resources and the configuration of the simulation environment for the problem are presented in table 1.

Table 1 Configuration and the usage of resources

S. No	CLOUD CONFIGURATION REQUIREMENTS	VALUE
1	Number of Datacenter	3 - 6
2	Number of Virtual Machines	25 – 100
3	Processing Limit	1000-3000 MIPS
3	Bandwidth Limit	50000 - 200000 MBPS
4	Memory	512 MB - 4GB
5	Number of Nodes	10- 50
6	User Base and Region	1-6

The PSO parameters are listed in the Table 2. In this work, the maximum number of generations used is 1000. The values for social and personal learning factors c_1 and c_2 which should be less than 4, therefore it is assumed to be 1.2 and 2.5. The Inertia value was assumed as 0.7. The parametric value for the PSO is tabulated in Table 2.

Table 2 PSO parameter details

S. No	PARAMETERS	VALUE
1	Max. number of generations	1000
2	Number of particles	40
3	Social learning factor c_1	1.2
4	Personal learning factor c_2	2.5
5	Inertia weight	0.7

The figure 1 shows the performance measurement of the proposed algorithm with respect to Bandwidth (Mbps) along with Number of Virtual Machines. It is also evident that the PSO algorithm gives better result than the other existing algorithms. The resource allocation is not decreased with increased number of VMs. Where as the other existing algorithms, are not shown the better performance as the PSO.

The figure 2 depicts the performance of the PSO with respect to the response time. The response time is measured with respect to the number of VMs. With increase in the number of VMs, the PSO detects the optimal data centre in minimum time.

V. CONCLUSIONS

Resource Allocation in the Mobile Cloud environment is a challenging task in the advent of the modern technology. In resource allocation, finding an optimal data centre is another exigent task for mobile cloud users. The PSO technique finds the optimal data centre within the minimum time. This supports the use of PSO in finding the optimal data centre.

The results obtained shows that PSO requires only a minimum time for finding the optimal data centre while comparing with other existing algorithms. The future direction in this work is to combine PSO with other heuristic technique to minimize the time in finding the optimal datacenter and to improve the elasticity of the cloud computing environment.

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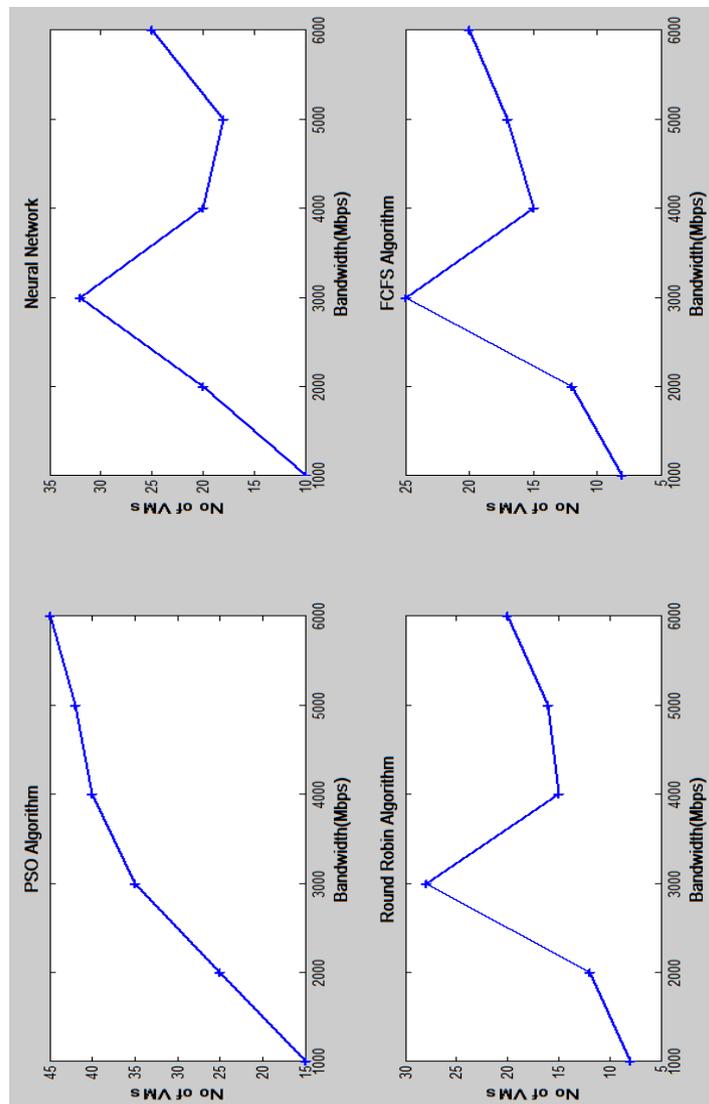


Fig. 1 Bandwidth measurement of Different Algorithms

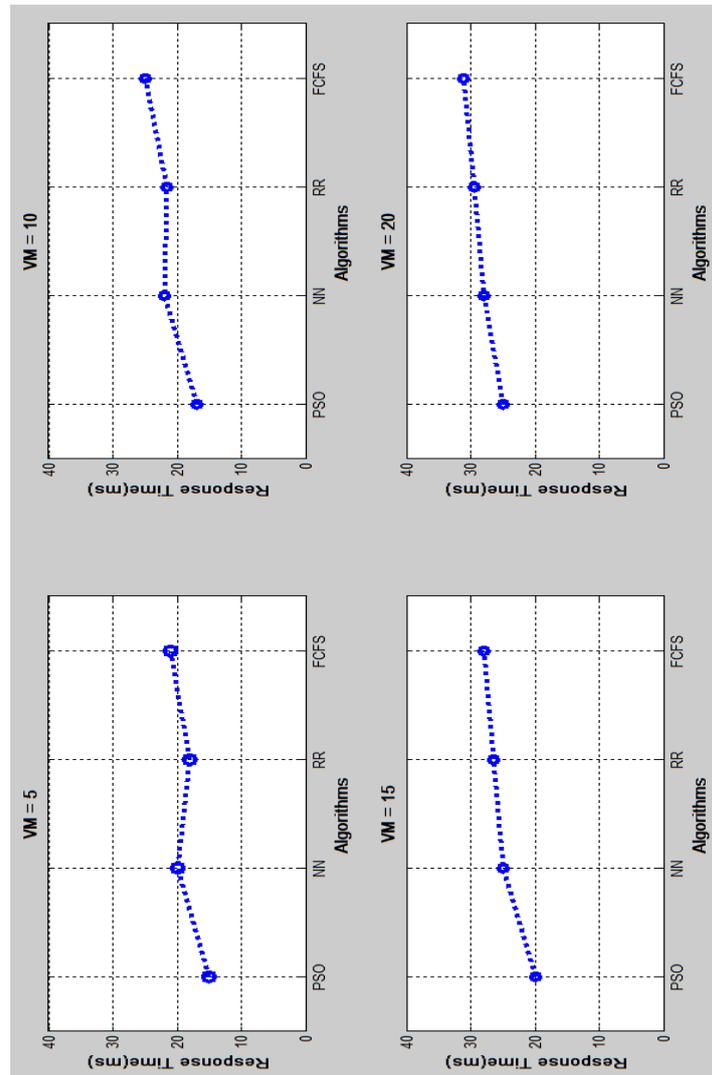


Fig.2 Performance of algorithms while measuring the response time