ABSTRACT

Cloud computing is a novel paradigm which enables ubiquitous, on-demand, convenient network access to a shared pool of computing resources, that are flexibly provisioned and released with minimal management effort or service provider interaction. The cloud resources are available in the Data Centre (DC), which are geographically distributed in the cloud environment. The computing resources namely Virtual Machines (VM), storage resources and networking resources are the basic elements of the data centre in cloud computing. Cloud computing is composed of five essential characteristics, three service types and four deployment models. The essential characteristics are multi-tenancy, scalable, service oriented, virtualized, self-healing and backup. Infrastructure as a Service (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS) are the basic services provided by cloud computing. Private Cloud, Public Cloud, Hybrid Cloud and Community Cloud are four basic deployment models of cloud computing. Reduced IT cost, scalability, flexibility, automatic updates and business continuity are the benefits of cloud computing.

The main goal of cloud provider is to achieve more profit always. Profit means maximum income from the investments. Resource provisioning in cloud is a challenging issue as the user demands vary time to time. As the cloud provider has fixed amount of resources, during lesser demands, the resources are underutilized whereas in peak hours, it may reject the user request. As the user demands vary dynamically, the cloud provider has to manage and deliver the resources to satisfy their needs. Cloud federation eliminates these drawbacks mentioned, allowing the cloud provider to rent their resources to other providers and also dynamically outsource the
resources from other providers according to demand variation. The cloud federation improves the profit of a cloud provider with the inclusion of overheads by cloud collaborator or cloud exchange. An alternate solution to improve the profit of cloud provider in fluctuating load condition is to utilize one of the cloud deployment model namely hybrid cloud. Private cloud is more secured than public cloud. Reduced cost, increased monetary benefit, scalability, universal accessibility, automatic upgrade and backup for data and applications are the main advantages of public cloud. Hybrid cloud is mostly preferred as it combines the benefits of private and public cloud. In hybrid cloud, when the resource of the private cloud is not sufficient, then it can avail the resources from external public clouds for the users requests, ensuring the elastic nature of cloud computing.

Proper scheduling of the tasks to resources should be carried out to improve the profit. There are several meta-heuristic algorithms available to schedule the tasks to the appropriate resources. Particle Swarm Optimization (PSO) algorithm is a population based stochastic optimization, inspired by the social behavior of bird flocking or fish schooling. PSO differs from other evolutionary algorithms by its efficient learning process. Ant Colony Optimization (ACO) is an artificial intelligence based algorithm in which ants are simulated to move from one food source to other. ACO is best known for solving Travelling Salesman Problem (TSP) efficiently. By merging the benefits of ACO and PSO algorithms, an ACO-PSO hybrid algorithm is proposed to maximize the profit of a cloud provider. The proposed hybrid algorithm is implemented to schedule the task to the appropriate VMs in the private cloud as well as external cloud to maximize the profit of the cloud provider with assured QoS to the end users with slightly higher runtime compared to existing algorithms. CPU and memory utilization rate of private cloud is also improved.
Since both ACO and PSO algorithm traps into local optima, other meta-heuristic algorithms may be combined for further improvement of profit of cloud provider. Orthogonal Learning Particle Swarm Optimization (OLPSO) is preferred on account of its fast convergence speed and higher solution accuracy. OLPSO is useful for solving global optimization problems and also more robust. Cuckoo Search (CS) algorithm is based on the breeding behavior of cuckoo birds. CS algorithm increases the convergence speed while solving complicated problems. So a novel hybrid algorithm consisting of OLPSO and Cuckoo Search CS is proposed. This OLPSO-CS hybrid approach achieved better profit with reduced runtime than the previously proposed ACO-PSO approach.

An important objective of a cloud provider is to maximize its profit, as it is necessary for its survival in the cloud market. At the same it is also important for the cloud provider to improve the performance in better way to satisfy the customers so that they use the same provider for their future needs. Satisfied customers also recommend the same provider to others which in turn increases the revenue for the provider. The overall cloud performance depends on the performance of VM, since all the cloud workloads are currently running in VMs. VMs are created with its own Operating System (OS) by a hypervisor layer. So VMs are heavy in nature, dependent on hypervisor and also slow while booting and shutting down. Hence the performance of VM has a great impact on the overall cloud performance.

Container based virtualization restructures the current operating system avoiding full operating system on virtual hardware. Docker is a popular open source project based on Linux containers that automatically pack, ship and deploy any software application as a light weight container. Docker containers are created without guest OS. Hence start-up and shutdown time is very less in Docker Containers compared to VMs. Bare-metal
performance is achieved in Docker containers, due to the lack of hypervisor and guest OS. Performance enhancement of cloud provider by replacing the underlying VMs with Docker containers is proposed. An open source testing software tool namely Apache JMeter is employed to perform load test on VM and Docker container. The metrics such as Throughput, Average Response Time, Error Rate etc., are used to compare the performance of VM and Docker container. The performance analysis of VMs and Docker Containers in public cloud and hybrid cloud is carried to prove the enhanced performance of Docker Containers. This research work concentrates on two issues such as profit maximization with assured QoS and performance enhancement of a cloud provider, in hybrid cloud environment, which are achieved.