ABSTRACT

Cloud computing has become the most popular technology today due to its economical and operational benefits. Cloud provides computing as a service and allows scaling up and down quickly with the help of virtualization. Since virtualization is the core technology for cloud computing, virtual machine placement becomes a hot topic. While allocating the Virtual Machines (VMs), efforts should be made to utilize the resources efficiently for the benefit of the providers. Efficient mapping of VMs onto Physical Machines (PMs) is a key problem for cloud providers as PM utilization directly impacts revenue. This thesis examines the resource management problem in datacenters. In the cloud computing archetype, the virtual machine is one of the most commonly used resource carriers in which the services are encapsulated. Virtual machine placement optimization that is finding optimal placement designs for virtual machines, and reconfigurations according to the changes of environments, become challenging issues. This virtual machine mapping is said to be an NP-hard problem. The amount of time needed to solve such an NP-hard scheduling problem increases with the problem size and it is intolerable for scheduling large and complex problem. In cloud, it is preferable to find the sub-optimal solution in a reasonable amount of time. Meta-heuristic procedures have been shown to get near-optimal solution in a short amount of time. The objective of this research is to propose enhanced meta-heuristic algorithms to address the problem of mapping virtual machines to the cloud datacenters to minimize the power consumption and resource wastage of the datacenters.

Apart from the gains of cloud computing, cloud datacenters consume enormous amounts of energy resulting in high operating costs and carbon dioxide emissions. The proposed algorithm is focused on the
formulation of power-aware VM allocation algorithm with dynamic power model and Enhanced Particle Swarm Optimization (EPSO). Power-efficiency of the host differs according to its CPU power-efficiency and speed. The objective of the proposed algorithm is to minimize the power consumption of datacenters by efficient mapping of virtual machines. It has been shown through different trials that the proposed Power-Aware Enhanced Particle Swarm Optimization (PA-EPSO) algorithm is found to be better than existing Self-Adaptive PSO (SAPSO) and standard PSO in terms of power consumption.

As VM workloads fluctuate and server availability varies, any initial mapping is bound to become suboptimal over time. In order to get further improvement in power efficiency, dynamic consolidation of servers is done for eliminating idle power wastage. Dynamic VM consolidation continuously reallocates VMs using live migration to minimize the number of active physical nodes. Power consumption is reduced by dynamically deactivating and reactivating physical nodes to meet the current resource demand. The proposed algorithm dynamically changes the state of the physical nodes based on the load imposed on it. The power management techniques such as system sleep states and dynamic consolidations are used in the proposed research work to prevent the system from consuming more power. System’s states are taken as defined by Advanced Configuration and Power Interface (ACPI) specification. The results of the proposed algorithm power aware dynamic consolidation are compared with Modified Best Fit Decreasing algorithm (MBFD). From the results, it has been observed that it minimizes the power consumption, Service Level Agreement (SLA) violation and the number of virtual machine migration compared to MBFD.

If the resources are not properly scheduled, there may be chance of failure in virtual machine creation. Even though the resources are available
in the datacenter, but scattered across the host results in failures of virtual machine creation. From the literature survey, it is observed that many of the existing work considered the resource wastage with the heuristic algorithm or not considered the resource wastage in a multidimensional way. To overcome the drawbacks of the existing works, the proposed work focuses on the formulation of avoidance of unused resource holes / resource wastage, which combines the merits of Enhanced PSO and resource wastage model that considers the resources in a multidimensional way. In order to effectively manage the resource utilization of a cloud datacenters, to figure out the resources usage and identify unused resource holes occurrence in the datacenter is essential. So resource wastage model which reckons the resources in multidimensional way is established. In the point of view of the computing resources used, it can be broadly categorized into compute-intensive, memory-intensive or bandwidth-intensive. The recommendation is to place the dissimilar virtual machines in the host thus all the resources of the host can be used evenly which increases the overall resource utilization.

The proposed Resource Wastage Aware EPSO (RW-aware-EPSO) is compared against the existing PSO algorithm. From the results obtained, it has been found that the proposed algorithm outperforms the existing PSO Algorithm in terms of reducing the resource wastage.

When servers are overloaded with virtual machines, then decision like which virtual machine to migrate, where to migrate is of important concern. So efficient algorithms are required which take correct decision and thus minimizes the number of VM migrations. Live migration of VMs is the concept of moving VMs between PMs without interruption in service. RW-aware-VM-Migration algorithm is proposed to choose VMs for migration. The proposed algorithm chooses the VM which contribute more in the RW of the host. The proposed RW-aware-VM-Migration algorithm is
compared against the existing Black-Box algorithm. It is observed from the results that the proposed algorithm works better than the Black-Box algorithm in terms reducing the number of VM migrations.

Private cloud setup on the open source platform Eucalyptus and the open source cloud management platform Openstack were created. The existing dashboard of OpenStack Horizon shows the memory size and number of virtual CPUs allocated to each instance but does not give the summary of the resources consumed on the whole by the hosts. Chrome extension for OpenStack is developed that provides the state of the instances and total amount of resources consumed in each host. This extension also provides an alert message to the administrator when there is over-utilization and under-utilization of resources in a host. This resource utilization information can be utilized by the administrator to do the virtual machine migration to use the resources in an effective way, minimize the power consumption by migrating instances from less utilized hosts to other hosts. Virtual machine placement algorithms used in the open source IaaS platforms such as OpenStack, OpenNebula and Eucalyptus are studied. In future work, the proposed algorithms will be implemented in the private cloud setup.