ABSTRACT

Mobile Cloud Computing (MCC) is an integration of cloud computing, mobile computing and wireless networks to bring resource-rich environment for the mobile users, network operators and cloud service providers. Smartphones are the significant thin client devices in MCC and also an essential part of human life, owing to the rapid growth of mobile applications that offer a rich experience in highly sophisticated services. The powerful applications demand significant computing resources on the mobile devices such as battery life, storage, and processor due to the resource-intensive operations. Being a small device, the resource constraints significantly degrade the performance and end user’s experience. In addition, executing the large-scale applications on the mobile device is an arduous task due to the inherent problems of the mobile computing, such as mobility, storage, resource scarcity, and context-awareness. The extension of mobile cloud computing with the dynamic Internet of Things (IoT) environment leads the next generation of computing and communication paradigm. However, in mobile cloud IoT (MCIoT) paradigm, the mobile devices are incapable of storing the real-time streaming data from the IoT devices due to the resource-scarcity problem. Also, the workflow of each IoT-based mobile application is likely to vary according to the application domain, dynamic requirements and processing capability of the mobile devices, which imposes several challenges in providing adaptive infrastructure for mobile cloud applications. Nevertheless, the adaptability and energy-efficient mobile application execution are still in the infancy stage due to the diversity of the IoT applications, manipulating workflow of an application and handling a large volume of streaming data in the heterogeneous resource-rich environment. In order to overcome the above challenges, this research work aims to develop an energy-efficient MCC framework for mobile application execution by implementing load balancing, task scheduling, resource allocation, optimization, and workflow management techniques.

The load balancing approach depends on the task scheduling and resource allocation techniques in the mobile cloud environment. The mobile cloud task scheduling and resource allocation techniques require the
dynamic contextual information. This information considers the local execution tasks, task dependency, and dynamic resource availability in the mobile device and also the task scheduling of a mobile application in the remote cloud server. The mobile cloud load balancing requires both load balancing among the resources in the cloud environment and the tasks of a mobile application. To achieve this, the present research framework developed the QoS-aware load balancing approach that avoids VM migration, which results in minimizing the total time taken to complete the overall processing of the tasks, minimizing the load deviation value of resources, maximizing resource utilization, and saving the energy level of the mobile devices efficiently.

Even though the load balancing approach offers the services with high-level user convenience, the numerous challenges for the cloud service providers have to be addressed in MCC environment. The service provider makes Service Level Agreements (SLA) with the end user’s requirements, where the specific and measurable characteristics of SLA are end user’s mobile device energy, response time, and profit of the service provider. In order to achieve SLA’s between the end users and cloud service providers, the SLA-based optimization approach is developed in this research work by implementing optimal task offloading, task scheduling, resource allocation, and provider selection in the dynamic MCC framework. The optimal task offloading presents Dynamic Programming based Offloading Method (DPOM) to find the optimal partitioning of tasks (mobile tasks and cloud tasks). In optimal task scheduling and resource allocation, the proposed approach implements non-recursive dynamic programming based Ant Colony Optimization (ACO) technique and Bellman’s optimality principle respectively. This approach schedules the cloud tasks to data center resources by considering SLA objective functions such as minimum completion time, minimum load, and maximum profit while selecting the virtual machine resources. Based on the experimental results, it is proved that the proposed SLA-based optimization approach minimizes the application completion time, balances the load, extends the battery energy of
the mobile device, and maximizes the provider’s profit during task-resource mapping in the dynamic MCC environment.

In MCIoT, the workflow management process plays a crucial role in modeling the automatic execution of scientific workflows. The workflow facilitates the application management and simplifies the complexity of executing the tasks sequentially. Moreover, the monitoring and scheduling mechanism of the workflow management system facilitates the real-time monitoring and optimized performance of the running process in MCIoT. In this view, this research work also proposed an adaptive workflow management approach that overcomes the obstacles of IoT-based mobile application execution with an intelligent machine learning algorithms with the support of Cloudlet architecture. The proposed approach employs Game-theory and Fuzzy logic assisted adaptive task scheduler in determining hierarchical workflow model. This approach also generates non-dominant task execution for the cloud-based IoT mobile applications by satisfying best-fit policy on the cloud resources for the set of stream data. The experimental results show that the proposed approach offers high Quality of Service (QoS) and improves resource utilization, thereby resulting in an energy-efficient system while executing the real-time IoT-based mobile applications in MCIoT.

An energy-efficient adaptive optimization framework strives to ensure energy efficiency in mobile cloud and in MCIoT environment. The mobile cloud framework has been simulated using the Cloudsim toolkit with mobile users, mobile cloud architecture (cloud broker), cloud offloader and remote cloud server (cloud pool) to run large-scale applications by accessing infrastructure, platform, and application services. All the methods have been implemented in Java language. The significant performance improvement is attained by focusing on the QoS-aware and SLA-based mobile application execution. The experimental results prove that the proposed MCC framework is more efficient on various performance metrics. This framework reduces the makespan value by 5.88% with substantial latency, conserves the device energy by 13%, and increases the profit of the service provider by 11% when compared with the existing techniques.