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Process State Synchronization-based Application Execution Management for Mobile Edge/ Cloud Computing

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Abstract—Mobile cloud computing (MCC) and mobile edge computing (MEC) facilitate the mobile devices to augment their capabilities by utilizing the resources and services offered by Cloud and Edge Cloud, respectively. However, due to mobility, network connection becomes unstable that causes application execution disruption. Such disruption increases the execution time and in some cases restrain the mobile devices from getting execution results from the cloud. This research work analyzes the impact of user mobility on the execution of cloud-based mobile applications. We propose a Process State Synchronization (PSS)-based execution management to solve the aforementioned problem. We analytically compute a sufficient condition on synchronization interval that ensure reduction in mobile application execution time under PSS in case of disconnection. Similarly, we compute the upper bound on synchronization interval whereby a larger synchronization interval did not result in significant benefits in terms of execution time for the mobile application. The analytical results were confirmed by the sample implementation of PSS with the computed synchronization intervals. Moreover, we also compare the performance of proposed solution with the state-of-the-art solutions. The results show that the PSS-based execution outperforms the other contemporary solutions.

Index Terms—Mobile Cloud Computing, Mobile Edge Computing, User Mobility, Synchronization, Distributed Computing, Cloud-based Mobile Application Execution.

1 Introduction

One of the results of population increase in metropolitan cities is the increase in commuting time. The US Census Bureau has presented data indicating that approximately 10.8 million commuters travel at least one hour to and from work each day [1].

A total of 84% of smartphone users utilize their mobile devices while they commute. In particular, these smartphone users often prefer applications for entertainment, online games, video streaming, and social interaction. Moreover, users' productivity is evident when they use applications to complete their responsibilities at work while they commute. To illustrate, the Microsoft e-bus was introduced in 2007. In this service, each seat was provided with a thin client that is connected to the network of Microsoft. Hence, workers would be able to connect to the network and commence working while they are on the way to the office. Accordingly, they make their time while commuting official work hours. Evidently, the increase in mobile device use, specifically while users are in transit, necessitates extensive enhancements in terms of wireless network performance and the potential of mobile device resources. Meanwhile, mobile devices improve their resource capabilities by utilizing cloud server resources and services, thereby establishing a new computing paradigm for mobile computing [2], [3].

Mobile cloud computing (MCC) is a computational paradigm, which allows users to run compute-intensive mobile applications on resource-constrained mobile devices supported by clouds and cloudlets [4]. Cloudlet is defined as a small-scale cloud, which is positioned at the Internet edge and works as an improved minor cloud data center. Accordingly, cloudlet deployment reduces the latency of a wide area network by appropriating powerful computing resources in the edge network. Cloudlet is considered as a form of Edge computing. The Edge Computing can facilitate the applications that are interactive and resource-intensive by allocating potent computing-resources to mobile devices with latency that is considerably low [5], [6]. Due to explosive growth of Internet of Things [7], [8] and mobile devices, the importance of Edge computing has significantly increased.

Cisco reported that by 2019, 90% of the total mobile data traffic will be generated by cloud applications [9]. Even though the cloud augmentation of mobile applications could lessen mobile device issues, user experience could still be substantially affected by user mobility and the subsequent network conditions. Moreover, limited bandwidth and frequent network disconnections affect the performance of mobile applications based on the cloud, specifically inter-

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