Software Architectural Solutions for Mobile Cloud Computing Systems

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ABSTRACT

Context: Mobile Cloud Computing (MCC) represents state-of-the-art for mobile computing technology that enables portable and context-aware computation by exploiting virtually unlimited hardware/software resources offered by cloud computing. Architecture of a software abstracts the complexities during design, development, and evolution phases to implement MCC systems effectively and efficiently.

Objectives: We aim to identify, taxonomically classify and systematically map the state-of-research on architecting MCC based software systems. We focus on investigating the existing challenges, their architectural solutions and dimensions of futuristic research.

Methodology: We used *Evidence-Based Software Engineering* (EBSE) approach to conduct a Systematic Mapping Study (SMS) based on 102 research studies (published from 2006 - 2017). Taxonomical classification and holistic mapping of the existing research themes guide the results of the mapping study.

Results: Research themes highlight that architectural solutions for MCC systems are mainly focused on supporting (i) *software as a service for mobile computing*, (ii) *off-loading mobile device data to cloud-servers*, and various aspects like (iii) *security and privacy of mobile device data*. The majority of existing architectural solutions aim to alleviate the resource poverty of mobile devices by exploiting cloud computing resources. The emerging research aims to address challenges that relate to MCC based Internet of Things (IoTs), mobile-based edge systems, green and energy efficient computing, and connected healthcare. The results of this SMS facilitate knowledge transfer that could benefit researchers and practitioners to understand the role that software architecture plays to engineer and develop MCC software systems.

Keywords: Software Architecture; Mobile Cloud Computing; Systematic Mapping Study; Evidence-based Software Engineering

INTRODUCTION

Mobile Cloud Computing (MCC) represents the state-of-the-art mobile computing technology that aims to minimize the resource poverty of mobile devices by exploiting the resource sufficient and pay-per-use cloud-based hardware and software resources [1, 2]. To compensate for resource constrained mobile devices [4, 5], cloud computing servers exploit the 'pay-per-use' hardware/software services to provide virtually unlimited processing and storage resources [3]. The unification of mobile and cloud computing[1] can benefit from the mobility and context awareness of front-end mobile devices and the computation and storage services of back-end cloud servers to enable systems that are portable, yet resource sufficient [1, 2, 3]. In recent years, the industrial development and academic research have proposed variety of MCC based solutions that address issues such as real-time analytics of the mobile-sensed data, provisioning of context aware medical services, mobile apps as a service, and mobile edge computing. The research and development activities are currently focused on utilizing software engineering methodologies to minimize the complexities and enhance the efficiency to model, develop, operate and evolve MCC systems effectively and efficiently [1].

Software Architecture[2] represents a blueprint of the system under consideration by abstracting out complex implementation specific details with high-level representation of the software system [3]. Specifically, architecture of a software-intensive systems represents the lower-level modules of source code and their interactions as higher-level architectural components and connectors respectively [2]. This means that architecture-centric development of software-intensive systems involves architectural components (i.e., computational entities and data stores) that interact with each other using the connectors. The research on

[1] NIST (National Institute of Standards and Technology) – Information Technology Library. The Intersection of Cloud and Mobility. http://www.nist.gov/itl/cloud/intersection-of-cloud-and-mobility.cfm

[2] ISO/IEC/IEEE 42010:2011, Systems and software engineering — Architecture description. http://www.iso-architecture.org/ieee-1471/

MCC systems highlights that researchers from different communities (such as mobile computing, software engineering, cloud computing, and artificial intelligence) have successfully utilized architectural models for the research and development of the mobile cloud software. Architecture-centric solutions for the MCC systems have proven to be successful to integrate the context-aware mobile computing (front-end) layer with resource sufficient cloud computing (back-end) layer. Architecture-centric engineering of the MCC systems aims to model (i) software (e.g.; algorithms and libraries) and (ii) hardware (processors and data storage) services offered by the cloud, that are manipulated by mobile-devices acting as portable and context-aware user interfaces.

In recent years, there is a steady growth of research on software architecture related issues and solutions for mobile cloud software. However, there has been no effort to systematically investigate the state-of-research on architecting MCC systems. Therefore, we used Evidence-Based Software Engineering (EBSE) approach, and the guidelines from to conduct a Systematic Mapping Study that analyzes and synthesize the research – investigating 102 published studies from 2006 to 2017 – that utilizes architecture-based solutions to engineer MCC Systems. The objective(s) of this SMS is to '*systematically identify and taxonomically classify the software architectural solutions for MCC systems; and provide a holistic mapping of these solutions to highlight their strengths, limitations alongside emerging and future research trends'*. This SMS can disseminate a systemized knowledge about software architecture related issue for MCC systems with the following contributions:

– Classification of the collective impact of existing research that highlights (i) predominant research themes and challenges, (ii) architectural solutions and reusable patterns for each theme.

– Mapping of the progression and maturation of research overtime to highlight existing and emerging trends of research.

The results of the SMS can be beneficial to the researchers who need to understand the state-of-the-art to derive new hypotheses to be tested, analyze innovative solutions and identify the areas of future research. It can also help practitioners to understand the reported solutions in terms of architecture driven development of the MCC based software systems.

References

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