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Review

A Review on mobile application energy profiling: Taxonomy, state-of-the-art, and open research issues

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ABSTRACT

The shift of the information access paradigm to a mobile platform motivates research in mobile application energy profiling to augment device battery lifetime. Energy profiling schemes estimate mobile application power consumption when it is executed on resource-constrained mobile devices. Accurate power estimation helps identify rogue applications to optimize mobile battery power usage. The lack of a comprehensive survey on mobile application energy profiling schemes that covers various energy profiling aspects, such as profiling granularity, types, measurement resources, and model flexibility, has motivated us to review the existing literature comprehensively. Application energy profiling schemes exploit either hardware-equipment or software-based solutions to track battery-draining behavior during application execution in mobile devices. This study comprehensively reviews state-of-the-art mobile application energy profiling schemes to investigate the strengths and weaknesses of existing schemes. We propose a detailed thematic taxonomy based on the extensive literature review on mobile application energy profiling to classify the existing literature. The critical aspects and related features of existing energy profiling schemes are examined through an exhaustive qualitative analysis. The significant parameters from the reported literature are also extracted to investigate commonalities and differences among existing schemes. Finally, several research issues in mobile application energy profiling are put forward that should be addressed to increase energy profiling strength.

Contents

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1. Introduction

The ever-increasing energy demands of innovative mobile applications reduce battery lifetime because of inadequate advancements in contemporary mobile phone battery design (Alagöz et al., 2014). Recent mobile phone applications, such as video on demand (Abolfazli et al., 2014b), mobile-gaming (Hsieh et al., 2014), location-aware social networking (Durand et al., 2011), real-time pedestrian tracking (Yoon et al., 2012), and context-aware advertisement services (Giammarini et al., 2011), are the most energy consuming and resource-intensive services. However, while serving these applications on the resource constrained mobile phones, a noteworthy amount of processor, network bandwidth, and storage capacity, is needed that rapidly depletes the battery-charge. Nowadays, mobile application development is swiftly expanding because users prefer to continue their social, entertainment, and business activities while on the go. According to *Forrester* report, the mobile application development market will detonate exponentially to $38 billion by 2015 because of substantial growth in the popularity of the mobile phones (Donohoo et al., 2011). However, despite the tremendous growth in the application market of mobile phones, their usage remains limited by battery life-time, size, and intermittent wireless connectivity. The lifetime of a battery can be improved by optimizing the application design of mobile phones. The key enabler to mobile application energy optimization is energy profiling, which pinpoints the contribution of individual application components to the total energy consumption budget (Alagöz et al., 2014).

Application energy profiling characterizes the energy consumption behavior of a mobile application while executing it on resource constrained mobile devices. Energy profiling schemes exploit the power models of mobile components (e.g., CPU, Wi-Fi, LCD, and 3G) to estimate mobile application power consumption (Alagöz et al., 2014). The design of power models is based on either software solutions or hardware equipment (e.g., power meter) to characterize the power drawn behavior of mobile applications during their execution on mobile phone (Abolfazli et al., 2014b; Hsieh et al., 2014). Application energy profiling facilitates in (a) identifying rogue applications (Durand et al., 2011), (b) diagnosing system energy consumption (Yoon et al., 2012), (c) estimating per-application energy usage (Giammarini et al., 2011), (d) optimizing application energy usage, and (e) designing an energy-aware application scheduler (Lin et al., 2013; Navda et al., 2013; Papalkar et al., 2014; Van Beeck et al., 2011). Based on the energy requirements of applications, a CPU reconsiders an application execution schedule to augment mobile battery lifetime. Similarly, for pedestrian tracking applications, increasing delay-interval among position updates adaptively surges battery lifetime (Geronimo et al., 2010).

To best of our knowledge, there exists only one survey on mobile application energy profiling schemes. However, reported survey (Cui et al., 2013) is too generic and has only considered wireless communication power consumption methods with special emphasis on Wi-Fi power management. Moreover, authors neither analysed the existing profiling schemes nor discussed the potential future research directions. Major contribution of this study is to conduct a comprehensive literature review on state-of-the-art mobile application energy profiling schemes by considering several diversified aspects of energy profiling such as, profiling granularity, overhead, design pattern, and energy measurement methods. In this current study, state-of-the-art mobile application energy profiling schemes are critically reviewed and their strengths are identified. The weaknesses and issues that need further research in this domain of research are also identified. A novel thematic taxonomy for mobile application energy profiling schemes is proposed to classify the literature based on the common characteristics among existing schemes. The critical aspects and significant features of the mobile application energy profiling schemes are investigated through qualitative analysis. Finally, some open research issues in energy profiling are discussed in order to design an optimized energy profiler.

The organization of paper is as follows. Section 2 discusses background on mobile application energy profiling with special emphasis on recent mobile application features and energy models. Section 3 briefly discusses a thematic taxonomy on mobile application energy profiling schemes. Section 4 debates on state-of-the-art energy profiling schemes. Section 5 critically analyses the energy profiling schemes. Section 6 debates on some interesting open research issues in mobile application energy profiling domain. Section 7 concludes the whole paper and presents some future directions for further research in this domain of study.

2. Background

This section debates on mobile phone energy features and profiling models. Throughout this article, we used the keywords “mobile” and “smartphones” interchangeably to denote the