Chapter 9
Energy Consumption Analysis and Adaptive Energy Saving Solutions for Mobile Device Applications

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Abstract. Recent trends, motivated by user preferences towards carrying smaller and more complex devices, have focused on integrating different user-centric applications in a single general-purpose mobile hand-held device. Hence, Laptops, smart phones and PDAs are rapidly replacing computers as the most commonly-used Internet-access devices. This has resulted in much higher energy consumption and consequently, a reduced battery life of a wireless device. In fact, the biggest problem today in the mobile world is that they are battery driven and the battery technologies are not matching the required energy demand. This chapter focuses on different energy consuming components in the high-end wireless devices, with specific emphasis on adaptive energy efficient display and decoding mechanisms.

9.1 Introduction

The amount of computations and services in smart phones has increased exponentially over the last couple of years. Currently, a Moore's law-style growth is observed in the design of codecs, video compression techniques, efficient display screens, etc. and will continue to become better over time. However, the battery depletion problem still remains the biggest drawback of the electronic world in general; and smart phones/wireless devices in particular. There are quite a few default energy-saving techniques in iPhone and smart phones which allow the user to adapt certain application layer functionalities. For example, use of an on-device light sensor to monitor the ambient light and lower the display brightness. Another example is to manage CPU-intensive background applications. However, these techniques do not provide any step-wise change and real-time change in the energy consumption and is an inherent limitation of the system.

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9.1.1 Background

It is predicted that by 2013, mobile devices such as smart phones and PDAs will overtake PCs as the most popular devices used for accessing the Internet [1]. Most modern mobile phones are capable of playing video and audio, provide high-speed Internet access, enable photography and also support video capturing and video streaming. More advanced devices can interface with GPS systems and include additional sensors (for e.g. accelerometers). While these devices follow a functionality improvement rate similar to Moore's law, developments in battery life have lagged behind considerably. Panasonic, one of the world's leading battery manufacturers, estimates the annual improvement in the life of their batteries to be just 11% [2]. In 2011, a Deloitte study explained that progress in battery life for existing battery technologies is a slow process and that big improvements are observed only when a new battery technology or electrical storage technology is discovered [3]. A classic example of the gap between functionality and power-supply is the iPhone 4. When used continuously, for web browsing over 3G, the battery life lasts a mere 6 hours [4].

9.1.2 Current Solutions

Several research works have been carried in recent years to optimize the required power while simultaneously providing all the requisite functionalities. The different energy consuming operations are targeted without causing severe degradation to the user quality-of-experience (QoE), also defined as the user perception of the quality-of-service (QoS).

i. ***Specialized Hardware***

In a smart phone/high end mobile device, there are several specific hardware configurations that can be exploited to achieve energy savings. Bahl *et al.* [5] investigated a technique using a low-power radio in conjunction with a regular 802.11 Wireless Network Interface Card (WNIC). One benefit of this mechanism is that it allows a mobile device and its radio to be powered off, while the low-power radio maintains a network presence that can be used to wake the device up, in the event of any data reception. One example where this approach would be effective is voice over IP (VoIP), where a user can maintain an online presence with minimal bandwidth and only requires a high speed connection while interacting with another user. Another example is the use of hardware acceleration in video decoding. Adobe Flash Player has utilized this functionality since version 10.1. The player uses both hardware H.264 decoding and hardware graphics. The main benefit is that by offloading all the processing from device's CPU to purpose designed hardware, the performance and energy efficiency increase dramatically.