ABSTRACT

This habilitation thesis describes the achievements I have obtained since when I received the PhD scientific title of Politehnica University of Timisoara back in 2005, in the field of Computer and Information Technology. An overview of my activity and the main research work and topics is presented in the first section of the thesis. My recent activity addressed several research topics: energy-efficient and power-aware applications and systems, energy profiling of virtualization solutions, device and workload characterization using power signatures, indoor positioning techniques based on wireless infrastructures, component level energy profiling and runtime thread-level energy accounting.

In these fields of expertise, I have published over 70 scientific and academic works as single author (9), first author (34) or co-author, 4 ISI journal with cumulative impact factor 2,74, 22 ISI proceedings papers, and 41 BDI journals and proceedings papers. I was also involved in more than 10 national and international projects obtained by competition, 4 of them as a project manager or local partner manager.

In Chapter 2 I describe the contribution to an execution framework for power-aware applications running on battery powered devices. This research direction has been supported by two national grants I have managed between 2006 and 2011. Power-aware applications are software applications that implement application specific power management algorithms in order to reduce and optimize the energy consumption of the system while running them. The main goal of this research effort was to promote power consumption management and optimization of mobile and embedded systems at higher abstraction layers of such systems. The main outcome of these projects was to establish a general theoretical background and applicative rules and patterns in order to obtain efficient mobile systems and applications from the point of view of the consumption and the prototype implementation of the framework.

In Chapter 3 I describe the contribution to energy efficiency profiling and evaluating of virtual machines. This work has been carried out during implementation of an FP7-ICT project eMuCo – Embedded Multi-Core Processing for Mobile Communication. Our research effort explores how virtualization influences the power consumption of both physical systems and virtual systems and which is the most efficient way to implement such applications. The main goal of this work has been the study on the power consumption impact of virtualization solutions for common desktop and laptop computers. This work explored how virtualization influences the power consumption of both physical systems and virtual systems and which is the most efficient way to implement such applications. The main contribution to the project is the study on energy and thermal efficiency of virtualization solutions implemented on the two OS used today: Windows and Linux. In order to achieve this result the evaluation methodology and measurement setup have been proposed and implemented.

In Chapter 4 I describe the contribution to electronic and computing device profiling and characterization using the concept of power signatures. In our work we aim to monitor domestic devices in order to automatically extract their workload power profiles in order to identify bad

usage habits, external conditions or aging and finally failures of these devices. The main goal is to detect and model the influence of the identified elements on the energy efficiency of the devices. In our approach we monitor the target devices in order to extract power consumption profiles of different applications, workload, external conditions or usage patterns. Next we apply pattern recognition algorithms to extract relevant behavior or patterns in the power consumption series of measurements. We call the identified patterns in the power profiles, power signatures. Based on these signatures we further try to count device specific usage parameters and to identify abnormal behavior of the device due to aging or malfunctioning. The final goal of our work is to propose an intelligent house level centralized solution to monitor, analyze, predict and control household devices in order to improve their life time usage energy efficiency.

In Chapter 5 I present the contributions to the topic of wireless indoor positioning for mobile equipment. The main research objective of this research topic represents the possibility to use the wireless network infrastructure (i.e. networks adapter, access points, and wireless routers) to determinate indoor position of a mobile system, while using the same infrastructure for the wireless communication. This research work has been performed between 2007 and 2009, but a revival of the topic happened after 2010, along with the spread of smart devices and context-aware applications. We did not received any founding to perform this activity. This research topic converged in our team towards context-aware services development for mobile users.

In Chapter 6 I describe the contribution on component level power characterization of embedded systems using FPGA designs. The work was supported by the CHIST-ERA GEMSCLAIM project: GreenEr Mobile Systems by Cross LAyer Integrated energy Management. The main goal of our work was to perform both hardware and software accurate profiling of any multi-core architecture using low level profiles of its components, such as CPU cores, memories, and buses. Therefore, in this section, we investigate the capacity of FPGA designs to profile the power consumption and energy usage of multi-core embedded architectures and application benchmarks running on them.

In Chapter 7 I describe the contribution to runtime thread level energy accounting research topic. The work was supported by the CHIST-ERA GEMSCLAIM project: GreenEr Mobile Systems by Cross LAyer Integrated energy Management. We aim at designing a generic low-cost and energy efficient hardware infrastructure which supports thread level energy consumption monitoring of hardware components in a multi-core system. The proposed infrastructure provides upper layers (operating system and application threads) with per thread and per component energy accounting API (Application Programming Interface), similar with performance profiling functions. Implementation results indicate that the proposed LEM (Load and Energy Monitor) adds around 10% resource overhead to the monitored system. Regarding the power estimates, the one derived by LEM achieve a correlation degree of more than 95% with the ones obtained from physical power measurements.

In the last chapter I present my academic and scientific development plan for my evolution and the team I work with.