Chapter 6
Efficient Configurations for Dynamic Applications in Next Generation Mobile Systems

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ABSTRACT

Next generation wireless systems support a wide range of communication protocols and services, opening new design challenges. The desired flexibility presupposes effective approaches that exploit the system configurations with an optimal way. A well-known state-of-the-art example of a wireless platform is the Software Defined Radio (SDR). SDRs are characterized by strict performance requirements that introduce a lot of dynamism in respect with the resource utilization. Additionally, these devices experience transient overloads due to workload bursts or hardware malfunctions. The aforementioned reasons lead the system to take timely reactions to unexpected usage scenarios. The current chapter concentrates on these design challenges exploiting the system scenario methodology, proposing solutions especially for wireless communication systems. More precisely, it will be studied the tradeoffs between the representativeness of the scenarios (clustering overhead), the implementation of the scenario detection (detection overhead) and the platform tuning cost (switching overhead).

1. INTRODUCTION

Radios exist in a multitude of items such as cell phones, tablet pcs, digital TVs etc. The different type of applications demand different type of communication standards. Although all these systems have almost similar components, the ways that these components behave differ greatly. A typical handset has several chips to establish a variety of wireless links, one to talk to a cell phone, another to communicate with a Wi-Fi base station, a third to process Global Positioning System (GPS) signals.

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Each chip supports particular spectrum areas and modulation schemes of a single communication standard following a standardized development procedure. Thus, after their development they are exploitable only for the specific purposes that are designed. This confines the potential scalability of the radio handsets, restricting the update capabilities without providing real operation extensions. However, this approach cannot follow the ever-changing requirements of the modern transceivers.

1.1 SDR Characteristics

On the other hand, a family of products with a common hardware basis requires much less implementation and design effort. The trade-off between the scalability and development cost leads to an intermediate solution, where the individual functionality can be performed by modifiable software. This opens significant opportunities at the follow-on-support services. New revenue features can be generated upgrading the core software, allowing a better exploitation by the end-users.

Besides that another open issue is the efficient utilization of the available spectrum area. Radio bandwidth is a scarce resource, which is distributed in a dynamic way. The efficient exploitation of the frequency bandwidth depends on a number of factors, which are related with the local geographical characteristics and the transmission activity of the target area. The critical issue, for a sufficient bandwidth utilization, is the spectrum fragmentation. The gaps between the transmission channels, which ensure the interference avoidance and the unused licensed frequency bands create substantial amounts of unused spectrum segments "white spaces". Wireless devices able to access these spectrum segments, can dramatically improve the spectrum utilization. In this direction, re-configurability is the key.

As Radio re-configurability, the capability to be adapted in multiple frequency bands and multiple modulation schemes is considered. An extra motivation for such an approach is the fact that the standard wireless processes like filtering, decoding, signal modulation, can also benefit from it. A well-known example of a platform with these capabilities is Software Defined Radio (SDR). The main idea behind SDR is to implement the critical functionality parts in software, leaving only the high performance operations to hardware. SDR technology attempts to integrate a common interface for all the wireless communication protocols. This challenge becomes bigger if it is combined with the restrictions of the mobility. SDR platforms are portable systems with tight resource constraints. Besides that, high performance solutions are required, which can only be provided by MultiProcessor System-on-Chip (MPSoC) systems (Dresden, 2009) while the functionality heterogeneity highlights the need for high adaptability. To summarize the four most important features of the SDRs are: 1) the high performance, 2) the low power, 3) the adaptability, and 4) the scalability.

1.2 Problem Statement

SDRs have been designed to satisfy the requirements of embedded applications. These systems sometimes experience transient overloads due to hardware malfunctions or workload bursts. Thus, they need to take timely reactions at the occurrences of unexpected usage scenarios. The development of smart techniques that focus the available computing power on these urgent events and, at the same time, slow down the processing during inactive periods could be the key for preserving energy. Several research groups are performing studies in this promising direction. An intra-task voltage scheduling mechanism for signal processing tasks, which changes at runtime the supply voltage based on the splitting of a task in several slots, was proposed in (Lee, Choi, & Yoo, 2002). A similar technique was presented in (Mosse, D. & all), where the authors propose intelligent ways for selecting the voltage scaling points. However, the first Dynamic Voltage Scal-