

# Process Improvement Solution for Co-design in Radio Base Station DSP SW

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**Abstract.** Process improvement studies have tended to focus on one technology area at a time, and on process improvement frameworks, like CMMI (Capability Maturity Model Integration), and measurements from the top-down point of view. In addition, the management has been the trigger force of process improvement activities. Much less interest at process level has been shown in cross-technological issues, such as co-design, and on the bottom-up approach. In this paper, we point out the importance of the defined co-design activities and the synchronisation of software and hardware processes. Hardware and software designers are the best experts in this difficult co-design process area and thus the development staff involvement together with a bottom-up approach is a respectable alternative to improving processes and practices along with traditional SPI (Software Process Improvement) frameworks. The study is based on empirical studies carried out in Nokia Networks base station unit ASIC (Application-Specific Integrated Circuit) development and DSP (Digital Signal Processing) software development teams. The bottom-up approach was used to study the processes and the CMMI was used in analysing the findings and linking them to different process areas. We found that, despite the software and hardware, the processes themselves are quite well defined, the deficiencies are related to the invisibility of co-design activities. The technical experience and view was found to be relevant in improving the processes related to the interfaces between two technologies, like hardware and software. Traditional SPI and other process areas improvement work concern themselves typically with their own technology area only, and the process deficiencies close to other technology areas might be blurred. The paper also presents new process improvements for the software and hardware co-work area.

## 1 Introduction

Tough competition in the telecommunication business pressures companies to shorten their time-to-market, widen their product portfolio as well as improve their product quality and performance. These aspects force companies to critically study working practices and put effort into upgrading processes.

3G (third generation) standards require complex algorithmic calculations for voice and data channels. The major share of the required processing occurs in the baseband portion of the 3G-channel card, as well as the terminal as the radio base station part

[2]. A baseband typically consists of HW accelerators, i.e. Application-Specific Integrated Circuits (ASIC), and DSP (Digital Signal Processing) software producing the signal processing capacity for a baseband. A radio base station, as an embedded system, provides a complex challenge for the product development process. Concurrent specification, design and verification work of hardware and software can be viewed as co-design. As signal-processing requirements grow, the role of hardware-software co-design becomes increasingly important in system design [12].

From the development process point of view, hardware and software development typically follows its own process flows and co-work in the interface area of two technologies strongly relies on personal contacts not supported by the processes. Several studies present software process improvement (SPI) frameworks and experiments using those in product development. [9], [6] Process improvement is then the elimination of differences between an existing process and a standard baseline. The top-down approach compares an organisation's process with some generally accepted standard process [19].

This paper reveals the experiences of processes in the co-design area in base station development of Nokia Networks and suggests improvements for these process areas. The study is based on empirical studies performed with DSP software and ASIC teams on the basis of their own needs to improve working practices. In the context of empirical software engineering, the study consists of a qualitative part and a literature part. [5] The selected starting point for the process improvement is a bottom-up approach. The bottom-up approach assumes that the organisation must first understand its process, products, characteristics and goals before it can improve its processes [19]. Collecting information is performed via interviews, questionnaires and projects' documentation reading, forming the qualitative part of the empirical study. The other aspect to the study is to compare the findings to the process literature. The focus in the literature survey is the CMMI (Capability Maturity Model Integration) literature, as CMMI is generally used in Nokia Networks process improvement projects [14].

The text of this study consists of five parts. In the following section, we introduce the factors influencing base station development and the profile of a base station product compared to other network elements. Section three focuses on the improvement frame, how the problem was studied. The findings of the studies and the suggested process improvements are presented in sections four and five. Section 6 contains the conclusion along with recommended tasks to be undertaken in future studies.

## 2 Base Station Development

Standardisation has a strong role in the mobile network business. In a 3GPP (3<sup>rd</sup> Generation Partnership Project) standardisation commission, competitors and customers, network suppliers together with operators, define the most useful, value-adding new features to be implemented into UMTS (Universal Mobile Telecommunications System) network. [20] Layer 1 fulfils the standard requirements