System Level Modelling and Performance Estimation of Embedded Systems

The advances seen in the semiconductor industry within the last decade have brought the possibility of integrating evermore functionality onto a single chip forming functionally highly advanced embedded systems. These integration possibilities also imply that as the design complexity increases, so does the design time and eort. This challenge is widely recognized throughout academia and the industry and in order to address this, novel frameworks and methods, which will automate design steps as well as raise the level of abstraction used to design systems, are being called upon. To support an efficient system level design methodology, a modelling framework for performance estimation and design space exploration at the system level is required. This thesis presents a novel component based modelling framework for system level modelling and performance estimation of embedded systems. The framework is simulation based and allows performance estimation to be carried out throughout all design phases ranging from early functional to cycle accurate and bit true descriptions of the system, modelling both hardware and software components in a unied way. Design space exploration and performance estimation is performed by having the framework produce detailed quantitative information about the system model under investigation. The project is part of the national Danish research project, Danish Network of Embedded Systems (DaNES), which is funded by the Danish National Advanced Technology Foundation. The project is carried out in collaboration with the Danish company and DaNES partner, Bang & Olufsen ICEpower. Bang & Olufsen ICEpower provides industrial case studies which will allow the proposed modelling framework to be exercised and assessed in terms of ease of use, production speed, accuracy and efficiency. The framework allows a given embedded system to be constructed and explored before a physical realization is present and it can be used in the design of completely new systems or for modification of legacy systems. The primary benets of the framework are the possibilities of exploring a large number of candidate systems within a short time frame leading to better designs, easier design verication through an iterative renement of the executable system description, and nally the possibility of a reduction of the time-to-market of the design and implementation of the system under consideration. In practice, however, additional time spent on software development in order to provide commercial quality tools supporting the method is required.

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A compositional modelling framework for exploring MPSoC systems
This paper presents a novel compositional framework for system level performance estimation and exploration of Multi-
Processor System On Chip (MPSoC) based systems. The main contributions are the definition of a compositional model
which allows quantitative performance estimation to be carried out throughout all design phases ranging from early
functional specification to actual cycle accurate and bit true descriptions of the system. This is possible, because a
seamless refinement of models is supported by allowing the existence of models described at multiple levels of abstraction
to co-exist and communicate. In order to illustrate the use of the framework, a mobile digital audio processing platform,
supplied by the company Bang & Olufsen ICEpower a/s, is considered.

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Exploration of a digital audio processing platform using a compositional system level performance estimation framework
This paper presents the application of a compositional simulation based system-level performance estimation framework
on a non-trivial industrial case study. The case study is provided by the Danish company Bang & Olufsen ICEpower a/s
and focuses on the exploration of a digital mobile audio processing platform. A short overview of the compositional
performance estimation framework used is given followed by a presentation of how it is used for performance estimation
using an iterative refinement process towards the final implementation. Finally, an evaluation in terms of accuracy and
speed of simulations is discussed based on the presented design flow applied to the case study in question.

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A service based component model for composing and exploring MPSoC platforms
This paper presents an abstract service based modelling method for use in performance estimation and design space exploration of Multi Processor System On Chip (MPSoC) based systems. The method provides the infrastructure for composing abstract hardware and software models of stream based systems which can be used to produce detailed quantitative information regarding runtime properties of a given system through simulations. The method is based on a service oriented model of computation which is a modified version of Hierarchical Coloured Petri Nets.

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A service based estimation method for MPSoC performance modelling
This paper presents an abstract service based estimation method for MPSoC performance modelling which allows fast, cycle accurate design space exploration of complex architectures including multi processor configurations at a very early stage in the design phase. The modelling method uses a service oriented model of computation based on Hierarchical Colored Petri Nets and allows the modelling of both software and hardware in one unified model. To illustrate the potential of the method, a small MPSoC system, developed at Bang & Olufsen ICEpower a/s, is modelled and performance estimates are produced for various configurations of the system in order to explore the best possible implementation.

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