Lecture Notes in Electrical Engineering

Volume 105

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VLSI 2010 Annual Symposium

Selected papers

Springer

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ISSN 1876-1100
ISBN 978-94-007-1487-8
DOI 10.1007/978-94-007-1488-5
Springer Dordrecht Heidelberg London New York

e-ISSN 1876-1119
e-ISBN 978-94-007-1488-5

Cover design: eStudio Calamar, Berlin/Figueres

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

During the last years, significant changes have taken place in markets that traditionally had nothing in common. For example, markets like telecommunication, automotive, consumer electronics and medical equipment converge as far as the underlying systems of their products are concerned. The common needs come from the fact that modern devices contain, in most cases, complex parts relying on advanced hardware equipment. The increasing competition and the market pressure have created the need for hardware products of high reliability with short time-to-market.

The traditional development techniques, where the system development was relying on the experience of highly qualified engineers, are no longer adequate. The complexity of modern hardware systems calls for methodologies and tools supporting them to deal with the increasing market requirements.

The existence of large number of computational intensive structures with diverse features leads also to hardware solutions that are no longer monolithic but able to adapt according to design needs. Moreover, energy aware systems and increased performance requirements are more and more important in an era where the size of most devices decreases while their complexity increases exponentially. Data intensive processing is also receiving renewed attention, due to rapid advancements in areas like multimedia computing and high-speed telecommunications. Many of these applications demand very high performance circuits for computationally intensive operations, often under real-time requirements. Furthermore, their computation power appetite tends to soar faster than Moore's law.

Moreover, the next generation of systems in most markets relies on the "computing everywhere" paradigm, which implies computing chips dedicated by market while at the same time development costs are exploding. This results in an increasing need of flexibility not only at the program level (by software) but also at the chip level (by hardware). So, combining flexibility and performance is now a key enabler for future hardware platforms. In that respect, current solutions are reaching their limits:

- Current computing solutions are out of breath: challenge of computing density and low power.
- Current development and programming tools do not provide the required productivity.

On one hand, the performance of most hardware architectures, in spite of the continuous increase in processors' speed, are, not surprisingly, lagging behind. Processors efficiency is more and more impaired by the memory bandwidth problem of traditional von Neumann architectures.

On the other hand, the conventional way to boost performance through Application Specific Integrated Circuits (ASIC) suffers from sky-rocketing manufacturing costs (requiring high volumes to be amortized) and long design development cycles. In the nanometre era, increasing non recurrent engineering costs could relegate system-on-chip to very few high volume products unless some standardization process is undertaken.

Modern Field Programmable Gate Arrays can implement an entire system-on-chip, but at the cost of large silicon area and high power consumption. Moreover, a huge design productivity issue is raised by the difficulty of embedding algorithms on complex massively parallel architectures, while defining the processing architecture, under time to market pressure. Defining a programming paradigm for new hardware architectures is a difficult problem, where Computer Aided Design technologies call for new design paradigms. Current CAD tools have synthesis capabilities that don't reach the abstraction level required to handle complex hardware implementation.

Although the book *Designing Very Large Scale Integration Systems: Emerging Trends and Challenges* does not intend to provide answers to all the aforementioned open issues, it intends to identify and present in a comprehensive way the trends and research challenges of designing the next generation VLSI systems and systems-on-chip. Throughout the chapters of the book, the reader will have the chance to get an insight to state-of-the-art technology and research results on areas like:

- Emerging devices and nanocomputing,
- Architecture level design of highly complex hardware systems and systems-on-chip,
- Reconfigurable hardware technology, and
- Embedded systems.

All the book chapters are written by experts in the relevant domains and is envisaged to become the starting point for young scientists and practitioners to move science and technology one step further, in an attempt to deal with the ever increasing challenges of modern VLSI systems and systems-on-chip.

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