

Retargetable Code Generation for Digital Signal Processors

Rainer Leupers

Foreword by Peter Marwedel

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Retargetable Code Generation For Digital Signal Processors

Randall S. Janka



Retargetable Code Generation For Digital Signal Processors:

Retargetable Code Generation for Digital Signal Processors Rainer Leupers, 1997-06-30 According to market analysts the market for consumer electronics will continue to grow at a rate higher than that of electronic systems in general. The consumer market can be characterized by rapidly growing complexities of applications and a rather short market window. As a result more and more complex designs have to be completed in shrinking time frames. A key concept for coping with such stringent requirements is re use. Since the re use of completely fixed large hardware blocks is limited to subproblems of system level applications for example MPEG 2 flexible programmable processors are being used as building blocks for more and more designs. Processors provide a unique combination of features they provide flexibility and re use. The processors used in consumer electronics are however in many cases different from those that are used for screen and keyboard based equipment such as PCs. For the consumer market in particular efficiency of the product plays a dominating role. Hence processor architectures for these applications are usually highly optimized and tailored towards a certain application domain.

Retargetable Code Generation for Digital Signal Processors Rainer Leupers, 2013-03-09 According to market analysts the market for consumer electronics will continue to grow at a rate higher than that of electronic systems in general. The consumer market can be characterized by rapidly growing complexities of applications and a rather short market window. As a result more and more complex designs have to be completed in shrinking time frames. A key concept for coping with such stringent requirements is re use. Since the re use of completely fixed large hardware blocks is limited to subproblems of system level applications for example MPEG 2 flexible programmable processors are being used as building blocks for more and more designs. Processors provide a unique combination of features they provide flexibility and re use. The processors used in consumer electronics are however in many cases different from those that are used for screen and keyboard based equipment such as PCs. For the consumer market in particular efficiency of the product plays a dominating role. Hence processor architectures for these applications are usually highly optimized and tailored towards a certain application domain.

Code Generation for Embedded Processors Peter Marwedel, Gert Goossens, 2013-03-14 Modern electronics is driven by the explosive growth of digital communications and multi media technology. A basic challenge is to design first time right complex digital systems that meet stringent constraints on performance and power dissipation. In order to combine this growing system complexity with an increasingly short time to market new system design technologies are emerging based on the paradigm of embedded programmable processors. This concept introduces modularity flexibility and re use in the electronic system design process. However its success will critically depend on the availability of efficient and reliable CAD tools to design programme and verify the functionality of embedded processors. Recently new research efforts emerged on the edge between software compilation and hardware synthesis to develop high quality code generation tools for embedded processors. Code Generation for Embedded Systems provides a survey of these new developments. Although not

limited to these targets the main emphasis is on code generation for modern DSP processors Important themes covered by the book include the scope of general purpose versus application specific processors machine code quality for embedded applications retargetability of the code generation process machine description formalisms and code generation methodologies Code Generation for Embedded Systems is the essential introduction to this fast developing field of research for students researchers and practitioners alike

Evolutionary Algorithms for Embedded System Design Rolf Drechsler,Nicole Drechsler,2012-12-06 Evolutionary Algorithms for Embedded System Design describes how Evolutionary Algorithm EA concepts can be applied to circuit and system design an area where time to market demands are critical EAs create an interesting alternative to other approaches since they can be scaled with the problem size and can be easily run on parallel computer systems This book presents several successful EA techniques and shows how they can be applied at different levels of the design process Starting on a high level abstraction where software components are dominant several optimization steps are demonstrated including DSP code optimization and test generation Throughout the book EAs are tested on real world applications and on large problem instances For each application the main criteria for the successful application in the corresponding domain are discussed In addition contributions from leading international researchers provide the reader with a variety of perspectives including a special focus on the combination of EAs with problem specific heuristics Evolutionary Algorithms for Embedded System Design is an excellent reference for both practitioners working in the area of circuit and system design and for researchers in the field of evolutionary concepts

Code Optimization Techniques for Embedded Processors Rainer Leupers,2013-03-09 The building blocks of today s and future embedded systems are complex intellectual property components or cores many of which are programmable processors Traditionally these embedded processors mostly have been programmed in assembly languages due to efficiency reasons This implies time consuming programming extensive debugging and low code portability The requirements of short time to market and dependability of embedded systems are obviously much better met by using high level language e g C compilers instead of assembly However the use of C compilers frequently incurs a code quality overhead as compared to manually written assembly programs Due to the need for efficient embedded systems this overhead must be very low in order to make compilers useful in practice In turn this requires new compiler techniques that take the specific constraints in embedded system design into account An example are the specialized architectures of recent DSP and multimedia processors which are not yet sufficiently exploited by existing compilers

The Compiler Design Handbook Y.N. Srikant,Priti Shankar,2018-10-03 Today s embedded devices and sensor networks are becoming more and more sophisticated requiring more efficient and highly flexible compilers Engineers are discovering that many of the compilers in use today are ill suited to meet the demands of more advanced computer architectures Updated to include the latest techniques The Compiler Design Handbook Second Edition offers a unique opportunity for designers and researchers to update their knowledge refine their skills and

prepare for emerging innovations The completely revised handbook includes 14 new chapters addressing topics such as worst case execution time estimation garbage collection and energy aware compilation The editors take special care to consider the growing proliferation of embedded devices as well as the need for efficient techniques to debug faulty code New contributors provide additional insight to chapters on register allocation software pipelining instruction scheduling and type systems Written by top researchers and designers from around the world The Compiler Design Handbook Second Edition gives designers the opportunity to incorporate and develop innovative techniques for optimization and code generation

Handbook of Signal Processing Systems Shuvra S. Bhattacharyya, Ed F. Deprettere, Rainer Leupers, Jarmo Takala, 2013-06-20 Handbook of Signal Processing Systems is organized in three parts The first part motivates representative applications that drive and apply state of the art methods for design and implementation of signal processing systems the second part discusses architectures for implementing these applications the third part focuses on compilers and simulation tools describes models of computation and their associated design tools and methodologies This handbook is an essential tool for professionals in many fields and researchers of all levels *Computer Systems: Architectures, Modeling, and Simulation*

Andy Pimentel, Stamatis Vassiliadis, 2004-07-05 This book constitutes the refereed proceedings of the 4th International Workshop on Systems Architectures Modeling and Simulation SAMOS 2004 held in Samos Greece on July 2004 Besides the SAMOS 2004 proceedings the book also presents 19 revised papers from the predecessor workshop SAMOS 2003 The 55 revised full papers presented were carefully reviewed and selected for inclusion in the book The papers are organized in topical sections on reconfigurable computing architectures and implementation and systems modeling and simulation

Architecture Exploration for Embedded Processors with LISA Andreas Hoffmann, Heinrich Meyr, Rainer Leupers, 2013-06-29 Already today more than 90% of all programmable processors are employed in embedded systems This number is actually not surprising contemplating that in a typical home you might find one or two PCs equipped with high of embedded systems performance standard processors but probably dozens including electronic entertainment household and telecom devices each of them equipped with one or more embedded processors Moreover the electronic components of upper class cars incorporate easily over one hundred processors Hence efficient embedded processor design is certainly an area worth looking at The question arises why programmable processors are so popular in embedded system design The answer lies in the fact that they help to narrow the gap between chip capacity and designer productivity Embedded processors cores are nothing but one step further towards improved design reuse just along the lines of standard cells in logic synthesis and macrocells in RTL synthesis in earlier times of IC design Additionally programmable processors permit to migrate functionality from hardware to software resulting in an even improved reuse factor as well as greatly increased flexibility Building ASIPs: The Mescal Methodology Matthias Gries, Kurt Keutzer, 2006-07-01 An increasing number of system designers are using ASIPs rather than ASICs to implement their system solutions Building ASIPs The Mescal

Methodology gives a simple but comprehensive methodology for the design of these application specific instruction processors ASIPs The key elements of this methodology are Judiciously using benchmarking Inclusively identifying the architectural space Efficiently describing and evaluating the ASIPs Comprehensively exploring the design space Successfully deploying the ASIP This book includes demonstrations of applications of the methodologies using the Tipi research framework as well as state of the art commercial toolsets from CoWare and Tensilica *Software and Compilers for Embedded Systems* Andreas Krall,2003-10-24 This volume contains the proceedings of the 7th International Workshop on Software and Compilers for Embedded Systems SCOPES 2003 held in Vienna Austria September 24 26 2003 Initially the workshop was referred to as the International Workshop on Code Generation for Embedded Systems The rst workshop took place in 1994 in Schloss Dagstuhl Germany From its beg nings the intention of the organizers was to create an atmosphere in which the researchers could participate actively in dynamic discussions and profit from the assembly of international experts in the field It was at the fourth workshop in St Goar Germany in 1999 that the spectrum of topics of interest for the workshop was extended and not only code generation but also software and compilers for embedded systems were considered The change in fields of interest led to a change of name and this is when the present name was used for the rst time Since then SCOPES has been held again in St Goar Germany in 2001 Berlin Germany in 2002 and this year 2003 in Vienna Austria In response to the call for papers 43 very strong papers from all over the world were submitted The program committee selected 26 papers for presentation at SCOPES 2003 All submitted papers were reviewed by at least three experts in order to ensure the quality of the work presented at the workshop **Algorithms for VLSI Design Automation** Sabih H. Gerez,1999-01-05 Modern microprocessors such as Intel's Pentium chip typically contain many millions of transistors They are known generically as Very Large Scale Integrated VLSI systems and their sheer scale and complexity has necessitated the development of CAD tools to automate their design This book focuses on the algorithms which are the building blocks of the design automation software which generates the layout of VLSI circuits Courses on this area are typically elective courses taken at senior undergrad or graduate level by students of Electrical and Electronic Engineering and sometimes in Computer Science or Computer Engineering SSA-based Compiler Design Fabrice Rastello,Florent Bouchez Tichadou,2022-12-08 This book provides readers with a single source reference to static single assignment SSA based compiler design It is the first and up to now only book that covers in a deep and comprehensive way how an optimizing compiler can be designed using the SSA form After introducing vanilla SSA and its main properties the authors describe several compiler analyses and optimizations under this form They illustrate how compiler design can be made simpler and more efficient thanks to the SSA form This book also serves as a valuable text reference for lecturers making the teaching of compilers simpler and more effective Coverage also includes advanced topics such as code generation aliasing predication and more making this book a valuable reference for advanced students and practicing engineers EDA for IC System

Design, Verification, and Testing Louis Scheffer, Luciano Lavagno, Grant Martin, 2018-10-03 Presenting a comprehensive overview of the design automation algorithms tools and methodologies used to design integrated circuits the Electronic Design Automation for Integrated Circuits Handbook is available in two volumes The first volume EDA for IC System Design Verification and Testing thoroughly examines system level design microarchitectural design logical verification and testing Chapters contributed by leading experts authoritatively discuss processor modeling and design tools using performance metrics to select microprocessor cores for IC designs design and verification languages digital simulation hardware acceleration and emulation and much more Save on the complete set **Specification and Design Methodology for**

Real-Time Embedded Systems Randall S. Janka, 2012-12-06 Specification and design methodology has seen significant growth as a research area over the last decade tracking but lagging behind VLSI design technology in general and the CAD industry in particular The commercial rush to market tries to leverage existing technology which fuels CAD design tool development Paralleling this is very active basic and applied research to investigate and move forward rational and effective methodologies for accomplishing digital design especially in the field of hardware software codesign It is this close relationship between industry and academia that makes close cooperation between researchers and practitioners so important and monographs like this that combine both abstract concept and pragmatic implementation deftly bridge this often gaping chasm It was at the IEEE ACM Eighth International Symposium on Hardware Software Codesign where I met the author of this monograph Dr Randall Janka who was presenting some of his recent dissertation research results on specification and design methodology or as he has so succinctly defined this sometimes ambiguous concept the tools and rules Where so many codesign researchers are trying to prove out different aspects of codesign and using toy applications to do so Dr Janka had developed a complete specification and design methodology and prototyped the infrastructure and proven its viability utility and effectiveness using a demanding real world application of a real time synthetic aperture radar imaging processor that was implemented with embedded parallel processors Electronic Design Automation for IC System Design,

Verification, and Testing Luciano Lavagno, Igor L. Markov, Grant Martin, Louis K. Scheffer, 2017-12-19 The first of two volumes in the Electronic Design Automation for Integrated Circuits Handbook Second Edition Electronic Design Automation for IC System Design Verification and Testing thoroughly examines system level design microarchitectural design logic verification and testing Chapters contributed by leading experts authoritatively discuss processor modeling and design tools using performance metrics to select microprocessor cores for integrated circuit IC designs design and verification languages digital simulation hardware acceleration and emulation and much more New to This Edition Major updates appearing in the initial phases of the design flow where the level of abstraction keeps rising to support more functionality with lower non recurring engineering NRE costs Significant revisions reflected in the final phases of the design flow where the complexity due to smaller and smaller geometries is compounded by the slow progress of shorter wavelength lithography New coverage

of cutting edge applications and approaches realized in the decade since publication of the previous edition these are illustrated by new chapters on high level synthesis system on chip SoC block based design and back annotating system level models Offering improved depth and modernity Electronic Design Automation for IC System Design Verification and Testing provides a valuable state of the art reference for electronic design automation EDA students researchers and professionals

Readings in Hardware/Software Co-Design Giovanni De Micheli, Rolf Ernst, Wayne Wolf, 2002 This title serves as an introduction and reference for the field with the papers that have shaped the hardware software co design since its inception in the early 90s **Compiler Construction** Stefan Jähnichen, 2004-01-27 ETAPS 99 is the second instance of the European Joint Conferences on Theory and Practice of Software ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences This year it comprises five conferences FOSSACS FASE ESOP CC TACAS four satellite workshops CMCS AS WAGA CoFI seven invited lectures two invited tutorials and six contributed tutorials The events that comprise ETAPS address various aspects of the system development process including specification design implementation analysis and improvement The languages methodologies and tools which support these activities are all well within its scope Different blends of theory and practice are represented with an inclination towards theory with a practical motivation on one hand and soundly based practice on the other Many of the issues involved in software design apply to systems in general including hardware systems and the emphasis on software is not intended to be exclusive

Embedded System Design Peter Marwedel, 2021-01-25 A unique feature of this open access textbook is to provide a comprehensive introduction to the fundamental knowledge in embedded systems with applications in cyber physical systems and the Internet of things It starts with an introduction to the field and a survey of specification models and languages for embedded and cyber physical systems It provides a brief overview of hardware devices used for such systems and presents the essentials of system software for embedded systems including real time operating systems The author also discusses evaluation and validation techniques for embedded systems and provides an overview of techniques for mapping applications to execution platforms including multi core platforms Embedded systems have to operate under tight constraints and hence the book also contains a selected set of optimization techniques including software optimization techniques The book closes with a brief survey on testing This fourth edition has been updated and revised to reflect new trends and technologies such as the importance of cyber physical systems CPS and the Internet of things IoT the evolution of single core processors to multi core processors and the increased importance of energy efficiency and thermal issues **Fast, Efficient and**

Predictable Memory Accesses Lars Wehmeyer, Peter Marwedel, 2006-09-08 Speed improvements in memory systems have not kept pace with the speed improvements of processors leading to embedded systems whose performance is limited by the memory This book presents design techniques for fast energy efficient and timing predictable memory systems that achieve high performance and low energy consumption In addition the use of scratchpad memories significantly improves the timing

predictability of the entire system leading to tighter worst case execution time bounds

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