

Hardware Software Codesign of Embedded System



CPSC689-602

Rabi Mahapatra

Today's topics



- Course Organization
- Introduction to HS-CODES
- Codesign Motivation
- Some Issues on Codesign of Embedded System

Readings In Hardwaresoftware Codesign

**Jean-Michel Bergé, Oz Levia, Jacques
Rouillard**



Readings In Hardware/software Codesign:

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

The Codesign of Embedded Systems: A Unified Hardware/Software Representation Sanjaya Kumar, James H. Aylor, Barry W. Johnson, Wm.A. Wulf, 1995-11-30 Current practice dictates the separation of the hardware and software development paths early in the design cycle These paths remain independent with very little interaction occurring between them until system integration In particular hardware is often specified without fully appreciating the computational requirements of the software Also software development does not influence hardware development and does not track changes made during the hardware design phase Thus the ability to explore hardware software tradeoffs is restricted such as the movement of functionality from the software domain to the hardware domain and vice versa or the modification of the hardware software interface As a result problems that are encountered during system integration may require modification of the software and or hardware resulting in potentially significant cost increases and schedule overruns To address the problems described above a cooperative design approach one that utilizes a unified view of hardware and software is described This approach is called hardware software codesign

The Codesign of Embedded Systems develops several fundamental hardware software codesign concepts and a methodology that supports them A unified representation referred to as a decomposition graph is presented which can be used to describe hardware or software using either functional abstractions or data abstractions Using a unified representation based on functional abstractions an abstract hardware software model has been implemented in a common simulation environment called ADEPT Advanced Design Environment Prototyping Tool This model permits early hardware software evaluation and tradeoff exploration Techniques have been developed which support the identification of software bottlenecks and the evaluation of design alternatives with respect to multiple metrics The application of the model is demonstrated on several examples A unified representation based on data abstractions is also explored This work leads to investigations regarding the application of object oriented techniques to hardware design

The Codesign of Embedded Systems A Unified Hardware Software Representation describes a novel approach to a topic of immense importance to CAD researchers and designers alike

A Practical Introduction to Hardware/Software Codesign Patrick R. Schaumont, 2012-11-27 This textbook serves as an introduction to the subject of embedded systems design with emphasis on integration of custom hardware components with software The key problem addressed in the book is the following how can an embedded systems designer strike a balance between flexibility and efficiency The book describes how combining hardware design with software design leads to a solution to this important computer engineering problem The book covers four topics in hardware software codesign fundamentals the design space of custom architectures the hardware software interface and application examples The book comes with an associated design

environment that helps the reader to perform experiments in hardware software codesign Each chapter also includes exercises and further reading suggestions Improvements in this second edition include labs and examples using modern FPGA environments from Xilinx and Altera which will make the material in this book applicable to a greater number of courses where these tools are already in use More examples and exercises have been added throughout the book If I were teaching a course on this subject I would use this as a resource and text If I were a student who wanted to learn codesign I would look for a course that at least used a similar approach If I were an engineer or engineering manager who wanted to learn more about codesign from a very practical perspective I would read this book first before any other When I first started learning about codesign as a practitioner a book like this would have been the perfect introduction Grant Martin Tensilica

A Practical Introduction to Hardware/Software Codesign Springer,2012-11-26 *Hardware/Software Co-Design* Jørgen Staunstrup,Wayne Wolf,2013-04-17 Introduction to Hardware Software Co Design presents a number of issues of fundamental importance for the design of integrated hardware software products such as embedded communication and multimedia systems This book is a comprehensive introduction to the fundamentals of hardware software co design Co design is still a new field but one which has substantially matured over the past few years This book written by leading international experts covers all the major topics including fundamental issues in co design hardware software co synthesis algorithms prototyping and emulation target architectures compiler techniques specification and verification system level specification Special chapters describe in detail several leading edge co design systems including Cosyma LYCOS and Cosmos Introduction to Hardware Software Co Design contains sufficient material for use by teachers and students in an advanced course of hardware software co design It also contains extensive explanation of the fundamental concepts of the subject and the necessary background to bring practitioners up to date on this increasingly important topic **The Codesign of Embedded Systems** Sanjaya Kumar,James H Aylor,Barry W Johnson,1995-11-01 **Special Section on Hardware, Software Codesign for Embedded Systems** ,1998 Hardware-software codesign for embedded systems G. De Micheli,W. Wolf,1994 **Handbook of Hardware/Software Codesign** Soonhoi Ha,Jürgen Teich,2017-10-11 This handbook presents fundamental knowledge on the hardware software HW SW codesign methodology Contributing expert authors look at key techniques in the design flow as well as selected codesign tools and design environments building on basic knowledge to consider the latest techniques The book enables readers to gain real benefits from the HW SW codesign methodology through explanations and case studies which demonstrate its usefulness Readers are invited to follow the progress of design techniques through this work which assists readers in following current research directions and learning about state of the art techniques Students and researchers will appreciate the wide spectrum of subjects that belong to the design methodology from this handbook **Hardware-software Codesign for Embedded Systems** James Harrison,Institution of Electrical Engineers,1998 **The Codesign of Embedded Systems: A Unified**

Hardware/Software Representation Sanjaya Kumar, James H. Aylor, Barry W. Johnson, Wm.A. Wulf, 1995-11-30 Current practice dictates the separation of the hardware and software development paths early in the design cycle. These paths remain independent with very little interaction occurring between them until system integration. In particular, hardware is often specified without fully appreciating the computational requirements of the software. Also, software development does not influence hardware development and does not track changes made during the hardware design phase. Thus, the ability to explore hardware/software tradeoffs is restricted, such as the movement of functionality from the software domain to the hardware domain and vice versa, or the modification of the hardware/software interface. As a result, problems that are encountered during system integration may require modification of the software and/or hardware, resulting in potentially significant cost increases and schedule overruns. To address the problems described above, a cooperative design approach, one that utilizes a unified view of hardware and software, is described. This approach is called hardware/software codesign. The Codesign of Embedded Systems develops several fundamental hardware/software codesign concepts and a methodology that supports them. A unified representation, referred to as a decomposition graph, is presented, which can be used to describe hardware or software using either functional abstractions or data abstractions. Using a unified representation based on functional abstractions, an abstract hardware/software model has been implemented in a common simulation environment called ADEPT (Advanced Design Environment Prototyping Tool). This model permits early hardware/software evaluation and tradeoff exploration. Techniques have been developed which support the identification of software bottlenecks and the evaluation of design alternatives with respect to multiple metrics. The application of the model is demonstrated on several examples. A unified representation based on data abstractions is also explored. This work leads to investigations regarding the application of object-oriented techniques to hardware design. The Codesign of Embedded Systems: A Unified Hardware/Software Representation describes a novel approach to a topic of immense importance to CAD researchers and designers alike.

Hardware/Software Co-Design and Co-Verification Jean-Michel Bergé, Oz Levia, Jacques Rouillard, 2013-03-09 Co-Design is the set of emerging techniques which allows for the simultaneous design of hardware and software. In many cases where the application is very demanding in terms of various performances, time, surface, power, consumption, trade-offs between dedicated hardware and dedicated software are becoming increasingly difficult to decide upon in the early stages of a design. Verification techniques such as simulation or proof techniques that have proven necessary in the hardware design must be dramatically adapted to the simultaneous verification of software and hardware. Describing the latest tools available for both Co-Design and Co-Verification of systems, Hardware/Software Co-Design and Co-Verification offers a complete look at this evolving set of procedures for CAD environments. The book considers all trade-offs that have to be made when co-designing a system. Several models are presented for determining the optimum solution to any co-design problem, including partitioning, architecture synthesis, and code generation. When deciding on trade-offs, one of the main factors to be considered

is the flow of communication especially to and from the outside world This involves the modeling of communication protocols An approach to the synthesis of interface circuits in the context of co design is presented Other chapters present a co design oriented flexible component data base and retrieval methods a case study of an ethernet bridge designed using LOTOS and co design methodologies and finally a programmable user interface based on monitors Hardware Software Co Design and Co Verification will help designers and researchers to understand these latest techniques in system design and as such will be of interest to all involved in embedded system design

A Practical Introduction to Hardware/Software Codesign Patrick Schaumont, 2011-03-02 This is a practical book for computer engineers who want to understand or implement hardware software systems It focuses on problems that require one to combine hardware design with software design such problems can be solved with hardware software codesign When used properly hardware software co sign works better than hardware design or software design alone it can improve the overall performance of digital systems and it can shorten their design time Hardware software codesign can help a designer to make trade offs between the exibility and the performance of a digital system To achieve this a designer needs to combine two radically different ways of design the sequential way of dec position in time using software with the parallel way of decomposition in space using hardware Intended Audience This book assumes that you have a basic understanding of hardware that you are miliar with standard digital hardware components such as registers logic gates and components such as multiplexers and arithmetic operators The book also assumes that you know how to write a program in C These topics are usually covered in an introductory course on computer engineering or in a combination of courses on digital design and software engineering

Proceedings of the ... International Symposium on Hardware/Software Codesign, 2001

A Methodology for Hardware-software Codesign Myron Decker King, Massachusetts Institute of Technology. Department of Electrical Engineering and Computer Science, 2013 Special purpose hardware is vital to embedded systems as it can simultaneously improve performance while reducing power consumption The integration of special purpose hardware into applications running in software is difficult for a number of reasons Some of the difficulty is due to the difference between the models used to program hardware and software but great effort is also required to coordinate the simultaneous execution of the application running on the microprocessor with the accelerated kernel s running in hardware To further compound the problem current design methodologies for embedded applications require an early determination of the design partitioning which allows hardware and software to be developed simultaneously each adhering to a rigid interface contract This approach is problematic because often a good hardware software decomposition is not known until deep into the design process Fixed interfaces and the burden of reimplementaion prevent the migration of functionality motivated by repartitioning This thesis presents a two part solution to the integration of special purpose hardware into applications running in software The first part addresses the problem of generating infrastructure for hardware accelerated applications We present a methodology in which the application is represented as a

dataflow graph and the computation at each node is specified for execution either in software or as specialized hardware using the programmer's language of choice. An interface compiler has been implemented which takes as input the FIFO edges of the graph and generates code to connect all the different parts of the program including those which communicate across the hardware/software boundary. This methodology, which we demonstrate on an FPGA platform, enables programmers to effectively exploit hardware acceleration without ever leaving the application space. The second part of this thesis presents an implementation of the Bluespec Codesign Language (BCL) to address the difficulty of experimenting with hardware/software partitioning alternatives. Based on guarded atomic actions, BCL can be used to specify both hardware and low-level software. Based on Bluespec SystemVerilog (BSV) for which a hardware compiler by Bluespec Inc is commercially available, BCL has been augmented with extensions to support more efficient software generation. In BCL, the programmer specifies the entire design, including the partitioning, allowing the compiler to synthesize efficient software and hardware along with transactors for communication between the partitions. The benefit of using a single language to express the entire design is that a programmer can easily experiment with many different hardware/software decompositions without needing to re-write the application code. Used together, the BCL and interface compilers represent a comprehensive solution to the task of integrating specialized hardware into an application.

A New Methodology for System Level Hardware-software Codesign Mara Tanelli, 2003

[Hardware/Software Co-Design](#) Giovanni DeMicheli, M.G. Sami, 2013-11-11

Concurrent design or co-design of hardware and software is extremely important for meeting design goals such as high performance, which are the key to commercial competitiveness. Hardware/Software Co-Design covers many aspects of the subject, including methods and examples for designing:

1. general purpose and embedded computing systems based on instruction set processors
2. telecommunication systems using general purpose digital signal processors as well as application specific instruction set processors
3. embedded control systems and applications to automotive electronics

The book also surveys the areas of emulation and prototyping systems with field programmable gate array technologies, hardware/software synthesis and verification, and industrial design trends. Most contributions emphasize the design methodology, the requirements, and state of the art of computer-aided co-design tools, together with current design examples.

Hardware-Software codesign for embedded systems Heinrich Theodor Vierhaus, Paul G. Plöger, J. Wilberg, 1997

Hardware/Software Co-Design for Data Flow Dominated Embedded Systems Ralf Niemann, 1998-10-31

Introduces different tasks of hardware/software co-design, including system specification, hardware/software partitioning, co-synthesis, and co-simulation. Summarizes and classifies co-design tools and methods for these tasks and presents the co-design tool COOL, useful for solving co-design tasks for the class of data flow dominated embedded systems. Primary emphasis is on hardware/software partitioning and the co-synthesis phase and their coupling. A mathematical formulation of the hardware/software partitioning problem is given, and several novel approaches are presented and compared for solving the partitioning problem. Annotation copyrighted by Book

News Inc Portland OR *Proceedings of the Seventh International Workshop on Hardware/Software Codesign (CODES'99)*
Association for Computing Machinery, 1999

Whispering the Strategies of Language: An Mental Quest through **Readings In Hardwaresoftware Codesign**

In a digitally-driven earth where monitors reign supreme and instant connection drowns out the subtleties of language, the profound techniques and emotional subtleties hidden within phrases usually get unheard. However, situated within the pages of **Readings In Hardwaresoftware Codesign** a charming fictional treasure pulsating with organic thoughts, lies a fantastic quest waiting to be undertaken. Written by a talented wordsmith, that marvelous opus attracts visitors on an introspective trip, lightly unraveling the veiled truths and profound influence resonating within the fabric of each word. Within the emotional depths of the touching evaluation, we shall embark upon a honest exploration of the book is core styles, dissect its fascinating publishing model, and fail to the strong resonance it evokes strong within the recesses of readers hearts.

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