Hardware Software Co Design And Co Verification

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 performanceof 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 understandingof hardware that you are - miliar with standard digital hardware componentssuch 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.
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 reimplementation 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 as 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.
This book introduces a modern approach to embedded system design, presenting software design and hardware design in a unified manner. It covers trends and challenges, introduces the design and use of single-purpose processors ("hardware") and general-purpose processors ("software"), describes memories and buses, illustrates hardware/software tradeoffs using a digital camera example, and discusses advanced computation models, controls systems, chip technologies, and modern design tools. For courses found in EE, CS and other engineering departments.
A Unified Hardware/Software Introduction
Embedded System Design
2019 International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS).
Verification of Hardware Software Codesign
Hardware-Software Co-Design of Embedded Systems
Proceedings of the Third International Workshop on Hardware/Software Codesign
Hierarchical design methods were originally introduced for the design of digital ICs, and they appeared to provide for significant advances in design productivity, Time-to-Market, and first-time right design. These concepts have gained increasing importance in the semiconductor industry in recent years. In the course of time, the supportive quality of hierarchical methods and their advantages were confirmed. System Level Hardware/Software Co-design: An Industrial Approach demonstrates the applicability of hierarchical methods to hardware / software codesign, and mixed analogue / digital design following a similar approach. Hierarchical design methods provide for high levels of design support, both in a qualitative and a quantitative sense. In the qualitative sense, the presented methods support all phases in the product life cycle of electronic products, ranging from requirements analysis to application support. Hierarchical methods furthermore allow for efficient digital hardware design, hardware / software codesign, and mixed analogue / digital design, on the basis of commercially available formalisms and design tools. In the quantitative sense, hierarchical methods have prompted a substantial increase in design productivity. System Level Hardware/Software Co-design: An Industrial Approach reports on a six year study during which time the number of square millimeters of normalized complexity an individual designer contributed every week rose by more than a factor of five. Hierarchical methods therefore enabled designers to keep track of the ever increasing design complexity, while effectively reducing the number of design iterations in the form of redesigns. System Level Hardware/Software Co-design: An Industrial Approach is the first book to provide a comprehensive, coherent system design methodology that has been proven to increase productivity in industrial practice. The book will be of interest to all managers, designers and researchers working in the semiconductor industry.
As the complexity of modern embedded systems increases, it becomes less practical to design monolithic processing platforms. As a result, reconfigurable computing is being adopted widely for more flexible design. Reconfigurable Computers offer the spatial parallelism and fine-grained customizability of application-specific circuits with the postfabrication programmability of software. To make the most of this unique combination of performance and flexibility, designers need to be aware of both hardware and software issues. FPGA users must think not only about the gates needed to perform a computation but also about the software flow that supports the design process. The goal of this book is to help designers become comfortable with these issues, and thus be able to exploit the vast opportunities possible with reconfigurable logic.
The recent evolution of digital technology has resulted in the design of digital processors with increasingly complex capabilities. The implementation of hardware/software co-design methodologies provides new opportunities for the development of low power, high speed DSPs and processor networks. Dedicated digital processors are digital processors with an application specific computational task. Dedicated Digital Processors presents an integrated and accessible approach to digital processor design principles, processes, and implementations based upon the author's considerable experience in teaching digital systems design and digital signal processing. Emphasis is placed on presentation of hardware/software co-design methods, with examples and illustrations provided throughout the text. System-on-a-chip and embedded systems are described and examples of high speed real-time processing are given. Coverage of standard and emerging DSP architectures enable the reader to make an informed selection when undertaking their own designs. Presents readers with the elementary building blocks for the design of digital hardware systems and processor networks Provides a unique evaluation of standard DSP architectures whilst providing up-to-date information on the latest architectures, including the TI 55x and TigerSharc chip families and the Virtex FPGA (field-programmable gate array) Introduces the concepts and methodologies for describing and designing hardware VHDL is presented and used to illustrate the design of a simple processor A practical overview of hardware/software codesign with design techniques and considerations illustrated with examples of real-world designs Fundamental reading for graduate and senior undergraduate students of computer and electronic engineering, and Practicing engineers developing DSP applications.
September 22-24, 1994, Grenoble, France
Proceedings of the ... International Symposium on Hardware/Software Codesign
A Contemporary Design Tool
2021 International Conference on Hardware Software Codesign and System Synthesis (CODES ISSS)

Principles and Practice
The International Conference on Hardware Software Codesign and System Synthesis is the premier event in system level design, modeling, analysis, and implementation of modern embedded and cyber physical systems, from system level specification and optimization down to system synthesis of multi processor hardware software implementations The conference is a forum bringing together academic research and industrial practice for all aspects related to system level and hardware software co design High quality original papers will be accepted for oral presentation followed by interactive poster sessions
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 of Embedded SystemsThe POLIS ApproachSpringer Science & Business Media
Proceedings : International Conference on Hardware/Software Codesign and System Synthesis
Dedicated Digital Processors
The POLIS Approach
Hardware/Software Codesign of Embedded Systems with Reconfigurable and Heterogeneous Platforms
Reconfigurable Computing
A Methodology for Hardware-software Codesign
Embedded systems are informally defined as a collection of programmable parts surrounded by ASICs and other standard components, that interact continuously with an environment through sensors and actuators. The programmable parts include micro-controllers and Digital Signal Processors (DSPs). Embedded systems are often used in life-critical situations, where reliability and safety are more important criteria than performance. Today, embedded systems are designed with an ad hoc approach that is heavily based on earlier experience with similar products and on manual design. Use of higher-level languages such as C helps structure the design somewhat, but with increasing complexity it is not sufficient. Formal verification and automatic synthesis of implementations are the surest ways to guarantee safety. Thus, the POLIS system which is a co-design environment for embedded systems is based on a formal model of computation. POLIS was initiated in 1988 as a research project at the University of California at Berkeley and, over the years, grew into a full design methodology with a software system supporting it. Hardware-Software Co-Design of Embedded Systems: The POLIS Approach is intended to give a complete overview of the POLIS system including its formal and algorithmic aspects. Hardware-Software Co-Design of Embedded Systems: The POLIS Approach will be of interest to embedded system designers (automotive electronics, consumer electronics and telecommunications), micro-controller designers, CAD developers and students.
Embedded Systems: A Contemporary Design Tool, Second Edition Embedded systems are one of the foundational elements of today's evolving and growing computer technology. From operating our cars, managing our smart phones, cleaning our homes, or cooking our meals, the special computers we call embedded systems are quietly and unobtrusively making our lives easier, safer, and more connected. While working in increasingly challenging environments, embedded systems give us the ability to put increasing amounts of capability into ever-smaller and more powerful devices. Embedded Systems: A Contemporary Design Tool, Second Edition introduces you to the theoretical hardware and software foundations of these systems and expands into the areas of signal integrity, system security, low power, and hardware-software co-design. The text builds upon earlier material to show you how to apply reliable, robust solutions to a wide range of applications operating in today's often challenging environments. Taking the user's problem and needs as your starting point, you will explore each of the key theoretical and practical issues to consider when designing an application in today's world. Author James Peckol walks you through the formal hardware and software development process covering: Breaking the problem down into major functional blocks; Planning the digital and software architecture of the system; Utilizing the hardware and software co-design process; Designing the physical world interface to external analog and digital signals; Addressing security issues as an integral part of the design process; Managing signal integrity problems and reducing power demands in contemporary systems; Debugging and testing throughout the design and development cycle; Improving performance. Stressing the importance of security, safety, and reliability in the design and development of embedded systems and providing a balanced treatment of both the hardware and the software aspects, Embedded Systems: A Contemporary Design Tool, Second Edition gives you the tools for creating embedded designs that solve contemporary real-world challenges.
Concurrent design, or co-design of hardware and software is extremely important for meeting design goals, such as high performance, that 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.
2020 International Conference on Hardware Software Codesign and System Synthesis (CODES ISSS)
Colloquium : Papers and Programme
Readings in Hardware/software Co-design
Hardware/Software Co-Design
2017 International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS)
A Unified Hardware/Software Representation
This textbook introduces the concept of embedded systems with exercises using Arduino Uno. It is intended for advanced undergraduate and graduate students in computer science, computer engineering, and electrical engineering programs. It contains a balanced discussion on both hardware and software related to embedded systems, with a focus on co-design aspects. Embedded systems have applications in Internet-of-Things (IoT), wearables, self-driving cars, smart devices, cyberphysical systems, drones, and robotics. The hardware chapter discusses various microcontrollers (including popular microcontroller hardware examples), sensors, amplifiers, filters, actuators, wired and wireless communication topologies, schematic and PCB designs, and much more. The software chapter describes OS-less programming, bitmath, polling, interrupt, timer, sleep modes, direct memory access, shared memory, mutex, and smart algorithms, with lots of C-code examples for Arduino Uno. Other topics discussed are prototyping, testing, verification, reliability, optimization, and regulations. Appropriate for courses on embedded systems, microcontrollers, and instrumentation, this textbook teaches budding embedded system programmers practical skills with fun projects to prepare them for industry products. Introduces embedded systems for wearables, Internet-of-Things (IoT), robotics, and other smart devices; Offers a balanced focus on both hardware and software co-design of embedded systems; Includes exercises, tutorials, and assignments.
This title serves as an introduction ans reference for the field, with the papers that have shaped the hardware/software co-design since its inception in the early 90s.
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 Sixth International Workshop on Hardware/Software Co-Design (CODES/CASHE '98)
Hardware Software Co-Design of a Multimedia SOC Platform
Co-verification of Hardware and Software for ARM SoC Design
Dependable Embedded Systems
From FPGAs to Hardware/Software Codesign
March 15-18, 1998, Seattle, Washington, USA
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.
The proceedings of the September 1994 workshop comprise 28 technical papers that represent several important trends in co-design research: use of design case studies to drive research; algorithms for hardware- software partitioning; algorithms for system verification and validation; and a continuing interest in design representations. No index. Annotation copyright by Book News, Inc., Portland, OR.
Hardware Software Co-Design of a Multimedia SOC Platform is one of the first of its kinds to provide a comprehensive overview of the design and implementation of the hardware and software of an SoC platform for multimedia applications. Topics covered in this book range from system level design methodology, multimedia algorithm implementation, a sub-word parallel, single-instruction-multiple data (SIMD) processor design, and its virtual platform implementation, to the development of an SIMD parallel compiler as well as a real-time operating system (RTOS). Hardware Software Co-Design of a Multimedia SOC Platform is written for practitioner engineers and technical managers who want to gain first hand knowledge about the hardware-software design process of an SoC platform. It offers both tutorial-like details to help readers become familiar with a diverse range of subjects, and in-depth analysis for advanced readers to pursue further.
International Conference on Hardware/Software Codesign and System Synthesis
A Hardware / Software Co-Design Flow Based on the Discrete Event System Specification Model of Computation
Partitioning in Hardware Software Codesign of Embedded Systems for Minimization of Power

Hardware/Software Co-Design and Co-Verification
CODES+ISSS ...
Hardware-Software codesign for embedded systems

Embedded computer systems use both off-the-shelf microprocessors and application-specific integrated circuits (ASICs) to implement specialized system functions. Examples include the electronic systems inside laser printers, cellular phones, microwave ovens, and an automobile anti-lock brake controller. Embedded computing is unique because it is a co-design problem - the hardware engine and application software architecture must be designed simultaneously. Hardware-Software Co-Synthesis of Distributed Embedded Systems proposes new techniques such as fixed-point iterations, phase adjustment, and separation analysis to efficiently estimate tight bounds on the delay required for a set of multi-rate processes preemptively scheduled on a real-time reactive distributed system. Based on the delay bounds, a gradient-search co-synthesis algorithm with new techniques such as sensitivity analysis, priority prediction, and idle- processing elements elimination are developed to select the number and types of processing elements in a distributed engine, and determine the allocation and scheduling of processes to processing elements. New communication modeling is also presented to analyze communication delay under interaction of computation and communication, allocate interprocessor communication links, and schedule communication. Hardware-Software Co-Synthesis of Distributed Embedded Systems is the first book to describe techniques for the design of distributed embedded systems, which have arbitrary hardware and software topologies. The book will be of interest to: academic researchers for personal libraries and advanced-topics courses in co-design as well as industrial designers who are building high-performance, real-time embedded systems with multiple processors.

This book describes a comprehensive framework for hardware/software co-design, optimization, and use of robust, low-cost, and cyberphysical digital microfluidic systems. Readers with a background in electronic design automation will find this book to be a valuable reference for leveraging conventional VLSI CAD techniques for emerging technologies, e.g., biochips or bioMEMS. Readers from the circuit/system design community will benefit from methods presented to extend design and testing techniques from microelectronics to mixed-technology microsystems. For readers from the microfluidics domain, this book presents a new design and development strategy for cyberphysical microfluidics-based biochips suitable for large-scale bioassay applications. • Takes a transformative, "cyberphysical" approach towards achieving closed-loop and sensor feedback-driven biochip operation under program control; • Presents a "physically-aware" system reconfiguration technique that uses sensor data at intermediate checkpoints to dynamically reconfigure biochips; • Enables readers to simplify the structure of biochips, while facilitating the "general-purpose" use of digital microfluidic biochips for a wider range of applications.

The complexity of modern embedded systems has increased rapidly in the recent past. Introducing models of computation into the design flow has significantly raised the abstraction in system level design of embedded systems. Establishing such high abstraction levels in common hardware /software co-design flows is still in its infancy. H. Gregor Molter develops a hardware / software co-design flow based on the Discrete Event System Specification model of computation. He advocates that such a system level design flow should exploit a timed model of computation to allow a broad application field. The presented design flow will transform timed DEVS models to both synthesizable VHDL source code and embeddable C++ source code.

Unleash the Power of Arduino!
a new technology or just a new name?
Hardware-Software Co-Synthesis of Distributed Embedded Systems
Hardware/Software Co-Design for Data Flow Dominated Embedded Systems
SynDEVS Co-Design Flow
Hardware/Software Co-Design and Optimization for Cyberphysical Integration in Digital Microfluidic Biochips

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.

The International Conference on Hardware Software Codesign and System Synthesis is the premier event in system level design, modeling, analysis, and implementation of modern embedded and cyber physical systems, from system level specification and optimization down to system synthesis of multi processor hardware software implementations

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.

A Practical Introduction to Hardware/Software Codesign
Handbook of Hardware/Software Codesign
Reconfigurable computing and hardware/software codesign
The Codesign of Embedded Systems: A Unified Hardware/Software Representation
2019 International Conference on Hardware Software Codesign and System Synthesis (CODES ISSS)
15-20 Oct. 2017

This Open Access book introduces readers to many new techniques for enhancing and optimizing reliability in embedded systems, which have emerged particularly within the last five years. This book introduces the most prominent reliability concerns from today's points of view and roughly recapitulates the progress in the community so far. Unlike other books that focus on a single abstraction level such circuit level or system level alone, the focus of this book is to deal with the different reliability challenges across different levels starting from the physical level all the way to the system level (cross-layer approaches). The book aims at demonstrating how new hardware/software co-design solution can be proposed to ef-fectively mitigate reliability degradation such as transistor aging, processor variation, temperature effects, soft errors, etc. Provides readers with latest insights into novel, cross-layer methods and models with respect to dependability of embedded systems; Describes cross-layer approaches that can leverage reliability through techniques that are pro-actively designed with respect to techniques at other layers; Explains run-time adaptation and concepts/means of self-organization, in order to achieve error resiliency in complex, future many core systems.

*Hardware/software co-verification is how to make sure that embedded system software works correctly with the hardware, and that the hardware has been properly designed to run the software successfully -before large sums are spent on prototypes or manufacturing. This is the first book to apply this verification technique to the rapidly growing field of embedded systems-on-a-chip(SoC). As traditional embedded system design evolves into single-chip design, embedded engineers must be armed with the necessary information to make educated decisions about which tools and methodology to deploy. SoC verification requires a mix of expertise from the disciplines of microprocessor and computer architecture, logic design and simulation, and C and Assembly language embedded software. Until now, the relevant information on how it all fits together has not been available. Andrews, a recognized expert, provides in-depth information about how co-verification really works, how to be successful using it, and pitfalls to avoid. He illustrates these concepts using concrete examples with the ARM core - a technology that has the dominant market share in embedded system product design. The companion CD-ROM contains all source code used in the design examples, a searchable e-book version, and useful design tools. * The only book on verification for systems-on-a-chip (SoC) on the market * Will save engineers and their companies time and money by showing them how to speed up the testing process, while still avoiding costly mistakes * Design examples use the ARM core, the dominant technology in SoC, and all the source code is included on the accompanying CD-Rom, so engineers can easily use it in their own designs*

Embedded Systems - A Hardware-Software Co-Design Approach
System Level Hardware/Software Co-Design
Methods in Hardware/Software Co-Design
An Industrial Approach
Embedded Systems