EMBEDDED SYSTEMS ARCHITECTURE

IN Tech House

PWM

Analog IN

Analog OUT

Timer/PWM

ADC

DAC

UART — TX, RX

Flash Memory — Cache

SRAM

SPI — SCK, MOSI, MISO

DBG Interface

JTAG

Processor

I2C — SCL, SDA

USB PHY — D-, D+

Clock controller — CLK

GPIO controller

GPIO pins

Software Engineering For Embedded Systems Chapter 11 Optimizing Embedded Software For Performance

Nabil Abdennadher

Software Engineering For Embedded Systems Chapter 11 Optimizing Embedded Software For Performance:

   Software Engineering for Embedded Systems Robert Oshana,2013-04-01 Code optimization is a critical step in the development process as it directly impacts the ability of the system to do its intended job Code that executes faster means more channels more work performed and competitive advantage Code that executes in less memory enables more application features to fit into the cell phone Code that executes with less overall power consumption increases battery life or reduces money spent on powering a base station This chapter is intended to help programmers write the most efficient code possible whether that is measured in processor cycles memory or power It starts with an introduction to using the tool chain covers the importance of knowing the embedded architecture before optimization then moves on to cover a wide range of optimization techniques Techniques are presented which are valid on all programmable architectures C language optimization techniques and general loop transformations Real world examples are presented throughout   **Software Engineering for Embedded Systems** Robert Oshana,2013-04-01 This Expert Guide gives you the techniques and technologies in software engineering to optimally design and implement your embedded system Written by experts with a solutions focus this encyclopedic reference gives you an indispensable aid to tackling the day to day problems when using software engineering methods to develop your embedded systems With this book you will learn The principles of good architecture for an embedded system Design practices to help make your embedded project successful Details on principles that are often a part of embedded systems including digital signal processing safety critical principles and development processes Techniques for setting up a performance engineering strategy for your embedded system software How to develop user interfaces for embedded systems Strategies for testing and deploying your embedded system and ensuring quality development processes Practical techniques for optimizing embedded software for performance memory and power Advanced guidelines for developing multicore software for embedded systems How to develop embedded software for networking storage and automotive segments How to manage the embedded development process Includes contributions from Frank Schirrmeister Shelly Gretlein Bruce Douglass Erich Styger Gary Stringham Jean Labrosse Jim Trudeau Mike Brogioli Mark Pitchford Catalin Dan Udma Markus Levy Pete Wilson Whit Waldo Inga Harris Xinxin Yang Srinivasa Addepalli Andrew McKay Mark Kraeling and Robert Oshana Road map of key problems issues and references to their solution in the text Review of core methods in the context of how to apply them Examples demonstrating timeless implementation details Short and to the point case studies show how key ideas can be implemented the rationale for choices made and design guidelines and trade offs   *Software Engineering for Embedded Systems* Mike Brogioli,2013-04-01 Optimization metrics for compiled code are not always measured in resulting execution clock cycles on the target architecture Consider a modern cellular telephone or wireless device which may download executables over a wireless network connection or backhaul infrastructure In such cases it is often advantageous for the compiler to reduce the size of the compiled code which must be

downloaded to the wireless device By reducing the size of the code needed to be downloaded savings are achieved in terms of bandwidth required for each wireless point of download Optimization metrics such as the memory system performance of compiled code are other metrics which are often important to developers These are metrics correlated to the dynamic run time behavior of not only the compiled code on the target processor but also the underlying memory system caches DRAM and buses etc By efficiently arranging the data within the application or more specifically the order in which data and corresponding data structures are accessed by the application dynamically at run time significant performance improvements can be gained at the memory system level In addition vectorizing compilers can also improve performance due to spatial locality of data when SIMD instruction sets are present and varying memory system alignment conditions are met

Software Engineering for Embedded Systems Robert Oshana,2013-04-01 Embedded systems often have one or more real time requirements The complexity of modern embedded software systems requires a systematic approach for achieving these performance targets An ad hoc process can lead to missed deadlines poorly performing systems and cancelled projects There is a maturity required to define manage and deliver on multiple real time performance requirements Software performance engineering SPE is a discipline within the broader systems engineering area that can improve the maturity of the performance engineering process SPE is a systematic quantitative approach to constructing software systems that meet performance objectives SPE is a software oriented approach it focuses on architecture design and implementation choices It focuses on the activities techniques and deliverables that are applied at every phase of the embedded software development life cycle especially responsiveness and scalability to ensure software is being architected and implemented to meet the performance related requirements of the system *Advances in Grid and Pervasive Computing* Nabil Abdennadher,2009-04-22 This book constitutes the refereed proceedings of the 4th International Conference on Grid and Pervasive Computing GPC 2009 held in Geneva Switzerland in May 2009 The 42 revised full papers presented were carefully reviewed and selected from 112 submissions The papers are organized in topical sections on grid economy grid security grid applications middleware scheduling load balancing pervasive computing sensor networks peer to peer as well as fault tolerance **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 *Software Engineering for Embedded Systems* Robert Oshana,2013-04-01 One of the most important considerations in the product life cycle of an embedded project is to understand and optimize the power consumption of the device Power consumption is highly visible for hand held devices which require battery power to be able to guarantee certain minimum usage idle times between recharging Other main embedded applications such as medical equipment test measurement media and wireless base stations are very sensitive to power as well due to the need to manage the heat dissipation of increasingly powerful processors power supply cost and energy consumption cost so the fact is that power consumption cannot be overlooked The responsibility for setting and keeping power requirements often falls on the shoulders of hardware designers but the software programmer has the ability to provide a large contribution to power optimization Often the impact that the software engineer has on the power consumption of a device is overlooked or underestimated The goal of this chapter is to discuss how software can be used to optimize power consumption starting with the basics of what power consumption consists of how to properly measure power consumption and then moving on to techniques for minimizing power consumption in software at the algorithmic level hardware level and data flow level This will include demonstrations of the various techniques and explanations of both how and why certain methods are effective at reducing power so the reader can take and apply this work to their application immediately **Software Engineering for Embedded Systems** Mark Kraeling,2013-04-01 This chapter provides some guidelines that are commonly used in embedded software development It starts with principles of programming including readability testability and maintainability The chapter then proceeds with discussing how to start an embedded software project including considerations for hardware file organization and development guidelines The focus then shifts to programming guidelines that are important to any software development project which includes the importance of a syntax coding standard The chapter concludes with descriptions of variables and definitions and how they are typically used in an embedded software project *Software Engineering for Embedded Systems* Robert Oshana,2013-04-01 An embedded system is a computer system designed for a specific function within a larger system and often has one or more real time computing constraints It is embedded as part of a larger device which can include hardware and mechanical parts This is in stark contrast to a general purpose computer which is designed to be flexible and meet a wide range of end user needs The methods techniques and tools for developing software systems that

were successfully applied to general purpose computing are not as readily applicable to embedded computing Software systems running on networks of mobile embedded devices must exhibit properties that are not always required of more traditional systems such as near optimal performance robustness distribution dynamism and mobility This chapter will examine the key properties of software systems in the embedded resource constrained mobile and highly distributed world The applicability of mainstream software engineering methods is assessed and techniques e g software design component based development software architecture system integration and test are also discussed in the context of this domain This chapter will overview embedded and real time systems   *IEEE Transactions on Circuits and Systems* ,2006   <u>12th International Symposium on Software Reliability Engineering</u> ,2001 The papers in this volume constitute the proceedings of the 12th International Symposium on Software Reliability Engineering ISSRE 2001   <u>Software Engineering for Embedded Systems</u> Whitson G Waldo,2013-04-01 This chapter provides information to successfully organize and manage any embedded software project or program It introduces quality systems the OSI model of architecting software into stacks several software development models and ways in which teams may be organized and overviews communications Managing the constraints of scope schedule costs including resources quality and customer satisfaction fully addresses all the work and activities of any project or program The natural progression of software development from its concept through its life cycle until release is discussed Tools are presented for successful planning and execution of resource management risk management problem solving and the traceability of work extending from requirements to respective engineering responses to testing against those software specifications   <u>Software Engineering for Embedded Systems</u> Robert Oshana,2013 This Expert Guide gives you the techniques and technologies in software engineering to optimally design and implement your embedded system Written by experts with a solutions focus this encyclopedic reference gives you an indispensable aid to tackling the day to day problems when using software engineering methods to develop your embedded systems With this book you will learn The principles of good architecture for an embedded system Design practices to help make your embedded project successful Details on principles that are often a part of embedded systems including digital signal processing safety critical principles and development processes Techniques for setting up a performance engineering strategy for your embedded system software How to develop user interfaces for embedded systems Strategies for testing and deploying your embedded system and ensuring quality development processes Practical techniques for optimizing embedded software for performance memory and power Advanced guidelines for developing multicore software for embedded systems How to develop embedded software for networking storage and automotive segments How to manage the embedded development process Includes contributions from Frank Schirrmeister Shelly Gretlein Bruce Douglass Erich Styger Gary Stringham Jean Labrosse Jim Trudeau Mike Brogioli Mark Pitchford Catalin Dan Udma Markus Levy Pete Wilson Whit Waldo Inga Harris Xinxin Yang Srinivasa Addepalli Andrew McKay Mark Kraeling and Robert Oshana Road map of key problems issues and references to their solution in the

text Review of core methods in the context of how to apply them Examples demonstrating timeless implementation details Short and to the point case studies show how key ideas can be implemented the rationale for choices made and design guidelines and trade offs   Seventeenth IEEE Real-Time Systems Symposium ,1996 Encompassing both computer science and engineering aspects of real time systems the 31 papers cover scheduling experimental systems and applications formal methods synchronization models and tools communications databases timing analysis resource allocation and system implementation Among the specific topics are optimizing interprocess communications for embedded systems analyzing cache related pre emption delay in fixed priority preemptive scheduling exploiting data semantics to schedule transactions with temporal constraints queuing theory message transmission with timing constraints in ring networks and approximate reachability analysis of times automata No subject index Annotation copyrighted by Book News Inc Portland OR   *Software Engineering for Embedded Systems* Mark Pitchford,2013-04-01 State of the art techniques and best practices in the development of embedded software apply not only to high integrity devices such as those for safety critical applications like aircraft flight controllers car braking systems or medical devices but also to lesser integrity applications when the need to optimize the effectiveness of the available test time and budget demands that pragmatic decisions should be made To complement this multitude of software test techniques there is a similar plethora of test tools available to automate them These tools are commonplace in the development of safety critical applications but elsewhere not everyone has the budget to buy all or indeed any of them Of course the providers of these tools would advocate the purchase of each and every one of them so how can a limited budget best be allocated And where no budget exists how can similar principles be applied to provide confidence that the finished item is of adequate quality In addressing these issues not only are the concepts behind the techniques presented but also some case study software code examples to drill a little deeper and illustrate how some of them are implemented in practice   **Tenth International Conference on VLSI Design** ,1997   *Software Engineering for Embedded Systems* Bruce Douglass,2013-04-01 The software architecture of embedded computing systems is a depiction of the system as a set of structures that aids in the reasoning and understanding of how the system will behave Software architecture acts as the blueprint for the system as well as the project developing it The architecture is the primary framework of important embedded system qualities such as performance modifiability and security none of which can be achieved without a unifying architectural vision Architecture is an artifact for early analysis to ensure that a design approach will lead to an acceptable system This chapter will discuss the details of these aspects of embedded software architectures   **Proceedings, ... International Symposium on VLSI Design** ,1997   Graduate Studies ,1991   **Who's who in Finance and Business** ,2008

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