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Embedded systems are a ubiquitous component of our everyday lives. We interact with hundreds of tiny computers every day that are embedded into our houses, our cars, our toys, and our work. As our world has become more complex, so have the capabilities of the microcontrollers embedded into our devices. The ARM® Cortex™-M3 is represents the new class of microcontroller much more powerful than the devices available ten years ago. The purpose of this book is to present the design methodology to train young engineers to understand the basic building blocks that comprise devices like a cell phone, an MP3 player, a pacemaker, antilock brakes, and an engine controller. This book is the third in a series of three books that teach the fundamentals of embedded systems as applied to the ARM® Cortex™-M3. This third volume is primarily written for senior undergraduate or first-year graduate electrical and computer engineering students. It could also be used for professionals wishing to design or deploy a real-time operating system onto an Arm

platform. The first book Embedded Systems: Introduction to the ARM Cortex-M3 is an introduction to computers and interfacing focusing on assembly language and C programming. The second book Embedded Systems: Real-Time Interfacing to the ARM Cortex-M3 focuses on interfacing and the design of embedded systems. This third book is an advanced book focusing on operating systems, high-speed interfacing, control systems, and robotics. Rather than buying and deploying an existing OS, the focus is on fundamental principles, so readers can write their-own OS. An embedded system is a system that performs a specific task and has a computer embedded inside. A system is comprised of components and interfaces connected together for a common purpose. Specific topics include microcontrollers, design, verification, hardware/software synchronization, interfacing devices to the computer, real-time operating systems, data collection and processing, motor control, analog filters, digital filters, and real-time signal processing. This book employs many approaches to learning. It will not include an exhaustive recapitulation of the infor-

mation in data sheets. First, it begins with basic fundamentals, which allows the reader to solve new problems with new technology. Second, the book presents many detailed design examples. These examples illustrate the process of design. There are multiple structural components that assist learning. Checkpoints, with answers in the back, are short easy to answer questions providing immediate feedback while reading. Simple homework, with answers to the odd questions on the web, provides more detailed learning opportunities. The book includes an index and a glossary so that information can be searched. The most important learning experiences in a class like this are of course the laboratories. Each chapter has suggested lab assignments. More detailed lab descriptions are available on the web. Specifically for Volume 1, look at the lab assignments for EE319K. For Volume 2 refer to the EE445L labs, and for this volume, look at the lab assignments for EE345M/EE380L.6. There is a web site accompanying this book <http://users.ece.utexas.edu/~valvano/arm>. Posted here are Keil uVision projects for each the example programs in the book. You will also find data sheets and Excel spreadsheets relevant to the material in this book. The book will cover embedded systems for the ARM® Cortex™-M3 with specific details on the LM3S811, LM3S1968, and LM3S8962. Most of the topics can be run on the simple LM3S811. DMA interfacing will be presented on the LM3S3748. Ethernet and CAN examples can be run on the LM3S8962. In this book the term LM3Sxxx family will refer to any of the Texas Instruments Stellaris® ARM® Cortex™-M3-based microcontrollers. Although the solutions are specific for the LM3Sxxx family, it will be possible to use

this book for other Arm derivatives.

Many systems, devices and appliances used routinely in everyday life, ranging from cell phones to cars, contain significant amounts of software that is not directly visible to the user and is therefore called "embedded". For coordinating the various software components and allowing them to communicate with each other, support software is needed, called an operating system (OS). Because embedded software must function in real time (RT), a RTOS is needed. This book describes a formally developed, network-centric Real-Time Operating System, OpenComRTOS. One of the first in its kind, OpenComRTOS was originally developed to verify the usefulness of formal methods in the context of embedded software engineering. Using the formal methods described in this book produces results that are more reliable while delivering higher performance. The result is a unique real-time concurrent programming system that supports heterogeneous systems with just 5 Kbytes/node. It is compatible with safety related engineering standards, such as IEC61508.

The presence and use of real-time systems is becoming increasingly common. Examples of such systems range from nuclear reactors, to automotive controllers, and also entertainment software such as games and graphics animation. The growing importance of rea.

For Introductory Courses in Operating Systems in Computer Science, Computer Engineering, and Electrical Engineering programs. The widely anticipated revision of this worldwide best-seller incorporates the latest developments in operating systems (OS) technologies. The Third Edition includes up-to-date materials on relevant. OS such as Linux, Windows, and embedded real-time and multimedia systems. Tanenbaum also provides infor-

mation on current research based on his experience as an operating systems researcher.

A growing concern of mine has been the unrealistic expectations for new computer-related technologies introduced into all kinds of organizations. Unrealistic expectations lead to disappointment, and a schizophrenic approach to the introduction of new technologies. The UNIX and real-time UNIX operating system technologies are major examples of emerging technologies with great potential benefits but unrealistic expectations. Users want to use UNIX as a common operating system throughout large segments of their organizations. A common operating system would decrease software costs by helping to provide portability and interoperability between computer systems in today's multivendor environments. Users would be able to more easily purchase new equipment and technologies and cost-effectively reuse their applications. And they could more easily connect heterogeneous equipment in different departments without having to constantly write and rewrite interfaces. On the other hand, many users in various organizations do not understand the ramifications of general-purpose versus real-time UNIX. Users tend to think of "real-time" as a way to handle exotic heart-monitoring or robotics systems. Then these users use UNIX for transaction processing and office applications and complain about its performance, robustness, and reliability. Unfortunately, the users don't realize that real-time capabilities added to UNIX can provide better performance, robustness and reliability for these non-real-time applications. Many other vendors and users do realize this, however. There are indications even now that general-purpose UNIX will go away

as a separate entity. It will be replaced by a real-time UNIX. General-purpose UNIX will exist only as a subset of real-time UNIX.

Real-Time Systems Development introduces computing students and professional programmers to the development of software for real-time applications. Based on the academic and commercial experience of the author, the book is an ideal companion to final year undergraduate options or MSc modules in the area of real-time systems design and implementation. Assuming a certain level of general systems design and programming experience, this text will extend students' knowledge and skills into an area of computing which has increasing relevance in a modern world of telecommunications and 'intelligent' equipment using embedded microcontrollers. This book takes a broad, practical approach in discussing real-time systems. It covers topics such as basic input and output; cyclic executives for bare hardware; finite state machines; task communication and synchronization; input/output interfaces; structured design for real-time systems; designing for multitasking; UML for real-time systems; object oriented approach to real-time systems; selecting languages for RTS development; Linux device drivers; and hardware/software co-design. Programming examples using GNU/Linux are included, along with a supporting website containing slides; solutions to problems; and software examples. This book will appeal to advanced undergraduate Computer Science students; MSc students; and, undergraduate software engineering and electronic engineering students. * Concise treatment delivers material in manageable sections * Includes handy glossary, references and practical exercises based on familiar scenarios * Supporting website

contains slides, solutions to problems and software examples

A survey of real-time systems and the programming languages used in their development. Shows how modern real-time programming techniques are used in a wide variety of applications, including robotics, factory automation, and control. A critical requirement for such systems is that the software must

Real-time Operating Systems are an increasingly important tool, as integration of networking functionality, reliability, modularity, and complex multitasking become ever-more prominent concerns for embedded developers. However, mastering the many benefits offered by an RTOS can be challenging and time-consuming. This practical new book from embedded software expert Colin Walls provides a perfect solution to that problem. It offers a readable and concise introduction to the world of real-time operating systems, providing readers with all the background they need to understand why an RTOS is helpful, how an RTOS can be used, and how an RTOS actually works. The book first introduces all the main concepts of real-time programming and real-time operating systems, and then provides detailed, step-by-step instructions to implementing an RTOS, supported by thorough explanations of the included source code. In addition, the entire source code to a real RTOS is included on the CD-ROM.

Build a strong foundation in designing and implementing real-time systems with the help of practical examples
 Key Features
 Get up and running with the fundamentals of RTOS and apply them on STM32
 Enhance your programming skills to design and build real-world embedded systems
 Get to grips with advanced techniques for implementing

embedded systems
 Book Description
 A real-time operating system (RTOS) is used to develop systems that respond to events within strict timelines. Real-time embedded systems have applications in various industries, from automotive and aerospace through to laboratory test equipment and consumer electronics. These systems provide consistent and reliable timing and are designed to run without intervention for years. This microcontrollers book starts by introducing you to the concept of RTOS and compares some other alternative methods for achieving real-time performance. Once you've understood the fundamentals, such as tasks, queues, mutexes, and semaphores, you'll learn what to look for when selecting a microcontroller and development environment. By working through examples that use an STM32F7 Nucleo board, the STM32CubeIDE, and SEGGER debug tools, including SEGGER J-Link, Ozone, and SystemView, you'll gain an understanding of preemptive scheduling policies and task communication. The book will then help you develop highly efficient low-level drivers and analyze their real-time performance and CPU utilization. Finally, you'll cover tips for troubleshooting and be able to take your new-found skills to the next level. By the end of this book, you'll have built on your embedded system skills and will be able to create real-time systems using microcontrollers and FreeRTOS. What you will learn
 Understand when to use an RTOS for a project
 Explore RTOS concepts such as tasks, mutexes, semaphores, and queues
 Discover different microcontroller units (MCUs) and choose the best one for your project
 Evaluate and select the best IDE and middleware stack for your project
 Use professional-grade tools for analyzing and debugging your application
 Get FreeR-

TOS-based applications up and running on an STM32 board Who this book is for This book is for embedded engineers, students, or anyone interested in learning the complete RTOS feature set with embedded devices. A basic understanding of the C programming language and embedded systems or microcontrollers will be helpful.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 89. Chapters: Real-time operating system, OS-9, QNX, Palm OS, Plan 9 from Bell Labs, FreeDOS, VxWorks, Symbian, OpenBSD, NetBSD, Rockbox, Smallfoot, List of real-time operating systems, Inferno, Cisco IOS, OpenBSD security features, BlackBerry OS, UTasker, QP, Timeline of OpenBSD, Junos, Cosmos, DioneOS, OpenComRTOS, TinyOS, GlobalPlatform, Windows Embedded, Clinux, Nucleus RTOS, Integrity, ECos, Contiki, Operating System Embedded, Symbian Foundation, Series 40, MQX, ChibiOS/RT, PikeOS, Symobi, RTEMS, OSEK, LynuxWorks, A/ROSE, FreeRTOS, Tandy Video Information System, LynxOS, XPC Target, Windows Embedded POSReady, MicroC/OS-II, FunkOS, JavaOS, RT-Thread, TOPPERS project, Passport Carrier Release, Versatile Real-Time Executive, Unison Operating System, ERIKA Enterprise, OS2000, DSPnano RTOS, LeJOS, Mobilinux, Embedded Linux, BeRTOS, DuinOS, Nano-RK, Prex, ExtremeXOS, OS-X, Phoenix-RTOS, Nokia OS, Pilot-link, Matchbox, XMK, Java Card OpenPlatform, TrueCookPlus, BlackBerry Tablet OS, VisualDSP++ Kernel, Series 80, LINX, BrickOS, TiMOS, nOS, LiteOS, Series 30, Embedded operating system, AmiQNX, Convergent Linux Platform, IGUANA Computing, Scout, RTXC Quadros, PSXLinux, NxtOSEK.

Four 5-star reviews at

<https://www.amazon.com/dp/B00GO6VSGE> This book deals with the fundamentals of operating systems for use in real-time embedded systems. It is aimed at those who wish to develop RTOS-based designs, using either commercial or free products. It does not set out to give you the knowledge to design an RTOS; leave that to the specialists. The target readership includes: Students, Engineers, scientists and mathematicians moving into software systems. Professional and experienced software engineers entering the embedded field. Programmers having little or no formal education in the underlying principles of software-based real-time systems. The material covers the key 'nuts and bolts' of RTOS structures and usage (as you would expect, of course). In many cases it shows how these are handled by practical real-time operating systems. After studying this even the absolute beginner will see that it isn't particularly difficult to implement RTOS-based designs and should be confident to take on such work. Now, that's the easy part; the really challenging aspect is how to best structure the application software in the first place. If your design is poorly-structured then, no matter which RTOS you use, you are very likely to run into problems of reliability, performance, safety and maintainability. Hence the book places great emphasis on ways to structure the application software so that it can be effectively implemented using an RTOS. The author: Jim Cooling has had many years experience in the area of real-time embedded systems, including electronic, software and system design, project management, consultancy, education and course development. He has published extensively on the subject, his books covering many aspects of embedded-systems work such as real-time interfacing, programming,

software design and software engineering. Currently he is a partner in Lindentree Associates (which he formed in 1998), providing consultancy and training for real-time embedded systems. See: www.lindentreeuk.co.uk

Do you think RTOS kernel is a complex black box and hard to implement? Shred your opinion and transform your self from the beginner of RTOS to a designer.

Real-time computing systems are vital to a wide range of applications. For example, they are used in the control of nuclear reactors and automated manufacturing facilities, in controlling and tracking air traffic, and in communication systems. In recent years, real-time systems have also grown larger and become more critical. For instance, advanced aircraft such as the space shuttle must depend heavily on computer systems [Carlow 84]. The centralized control of manufacturing facilities and assembly plants operated by robots are other examples at the heart of which lie embedded real-time systems. Military defense systems deployed in the air, on the ocean surface, land and underwater, have also been increasingly relying upon real-time systems for monitoring and operational safety purposes, and for retaliatory and containment measures. In telecommunications and in multi-media applications, real time characteristics are essential to maintain the integrity of transmitted data, audio and video signals. Many of these systems control, monitor or perform critical operations, and must respond quickly to emergency events in a wide range of embedded applications. They are therefore required to process tasks with stringent timing requirements and must perform these tasks in a way that these timing requirements are guaranteed to be met. Real-time scheduling al

gorithms attempt to ensure that system timing behavior meets its specifications, but typically assume that tasks do not share logical or physical resources. Since resource-sharing cannot be eliminated, synchronization primitives must be used to ensure that resource consistency constraints are not violated.

This classroom-tested textbook describes the design and implementation of software for distributed real-time systems, using a bottom-up approach. The text addresses common challenges faced in software projects involving real-time systems, and presents a novel method for simply and effectively performing all of the software engineering steps. Each chapter opens with a discussion of the core concepts, together with a review of the relevant methods and available software. This is then followed with a description of the implementation of the concepts in a sample kernel, complete with executable code. Topics and features: introduces the fundamentals of real-time systems, including real-time architecture and distributed real-time systems; presents a focus on the real-time operating system, covering the concepts of task, memory, and input/output management; provides a detailed step-by-step construction of a real-time operating system kernel, which is then used to test various higher level implementations; describes periodic and aperiodic scheduling, resource management, and distributed scheduling; reviews the process of application design from high-level design methods to low-level details of design and implementation; surveys real-time programming languages and fault tolerance techniques; includes end-of-chapter review questions, extensive C code, numerous examples, and a case study implementing the methods in real-world applications; supplies additional

material at an associated website. Requiring only a basic background in computer architecture and operating systems, this practically-oriented work is an invaluable study aid for senior undergraduate and graduate-level students of electrical and computer engineering, and computer science. The text will also serve as a useful general reference for researchers interested in real-time systems.

This book integrates new ideas and topics from real time systems, embedded systems, and software engineering to give a complete picture of the whole process of developing software for real-time embedded applications. You will not only gain a thorough understanding of concepts related to microprocessors, interrupts, and system boot process, appreciating the importance of real-time modeling and scheduling, but you will also learn software engineering practices such as model documentation, model analysis, design patterns, and standard conformance. This book is split into four parts to help you learn the key concept of embedded systems; Part one introduces the development process, and includes two chapters on microprocessors and interrupts---fundamental topics for software engineers; Part two is dedicated to modeling techniques for real-time systems; Part three looks at the design of software architectures and Part four covers software implementations, with a focus on POSIX-compliant operating systems. With this book you will learn: The pros and cons of different architectures for embedded systems POSIX real-time extensions, and how to develop POSIX-compliant real time applications How to use real-time UML to document system designs with timing constraints The challenges and concepts related to cross-development Multitasking design and inter-

task communication techniques (shared memory objects, message queues, pipes, signals) How to use kernel objects (e.g. Semaphores, Mutex, Condition variables) to address resource sharing issues in RTOS applications The philosophy underpinning the notion of "resource manager" and how to implement a virtual file system using a resource manager The key principles of real-time scheduling and several key algorithms Coverage of the latest UML standard (UML 2.4) Over 20 design patterns which represent the best practices for reuse in a wide range of real-time embedded systems Example codes which have been tested in QNX---a real-time operating system widely adopted in industry

Forecasting is required in many situations. Stocking an inventory may require forecasts of demand months in advance. Telecommunication routing requires traffic forecasts a few minutes ahead. Whatever the circumstances or time horizons involved, forecasting is an important aid in effective and efficient planning. This textbook provides a comprehensive introduction to forecasting methods and presents enough information about each method for readers to use them sensibly.

There's something really satisfying about turning theory into practice, bringing with it a great feeling of accomplishment. Moreover it usually deepens and solidifies your understanding of the theoretical aspects of the subject, while at the same time eliminating misconceptions and misunderstandings. So it's not surprising that the the fundamental philosophy of this book is that 'theory is best understood by putting it into practice'. Well, that's fine as it stands. Unfortunately the practice may a bit more challenging, especially in the field of real-time op-

erating systems. First, you need a sensible, practical toolset on which to carry out the work. Second, for many self-learners, cost is an issue; the tools mustn't be expensive. Third, they mustn't be difficult to get, use and maintain. So what we have here is our approach to providing you with a low cost toolset for RTOS experimentation. The toolset used for this work consists of: A graphical tool for configuring microcontrollers (specifically STM32F variants) - STM32CubeMX software application. An Integrated Development Environment for the production of machine code. A very low cost single board computer with inbuilt programmer and debugger. All software, which is free, can be run on Windows, OSX or Linux platforms. The Discovery kit is readily available from many electronic suppliers. The RTOS used for this work is FreeRTOS, which is integrated with the CubeMX tool. The author: Jim Cooling has had many years experience in the area of real-time embedded systems, including electronic, software and system design, project management, consultancy, education and course development. He has published extensively on the subject, his books covering many aspects of embedded-systems work such as real-time interfacing, programming, software design and software engineering. Currently he is a partner in Lindentree Associates (which he formed in 1998), providing consultancy and training for real-time embedded systems. See: www.lindentreeuk.co.uk

From the Foreword: "...the presentation of real-time scheduling is probably the best in terms of clarity I have ever read in the professional literature. Easy to understand, which is important for busy professionals keen to acquire (or refresh) new knowledge without being bogged down in a convoluted narrative and an

excessive detail overload. The authors managed to largely avoid theoretical-only presentation of the subject, which frequently affects books on operating systems. ... an indispensable [resource] to gain a thorough understanding of the real-time systems from the operating systems perspective, and to stay up to date with the recent trends and actual developments of the open-source real-time operating systems." —Richard Zurawski, ISA Group, San Francisco, California, USA Real-time embedded systems are integral to the global technological and social space, but references still rarely offer professionals the sufficient mix of theory and practical examples required to meet intensive economic, safety, and other demands on system development. Similarly, instructors have lacked a resource to help students fully understand the field. The information was out there, though often at the abstract level, fragmented and scattered throughout literature from different engineering disciplines and computing sciences. Accounting for readers' varying practical needs and experience levels, *Real Time Embedded Systems: Open-Source Operating Systems Perspective* offers a holistic overview from the operating-systems perspective. It provides a long-awaited reference on real-time operating systems and their almost boundless application potential in the embedded system domain. Balancing the already abundant coverage of operating systems with the largely ignored real-time aspects, or "physicality," the authors analyze several realistic case studies to introduce vital theoretical material. They also discuss popular open-source operating systems—Linux and FreeRTOS, in particular—to help embedded-system designers identify the benefits and weaknesses in deciding whether or not to adopt more traditio-

nal, less powerful, techniques for a project.

Research on real-time Java technology has been prolific over the past decade, leading to a large number of corresponding hardware and software solutions, and frameworks for distributed and embedded real-time Java systems. This book is aimed primarily at researchers in real-time embedded systems, particularly those who wish to understand the current state of the art in using Java in this domain. Much of the work in real-time distributed, embedded and real-time Java has focused on the Real-time Specification for Java (RTSJ) as the underlying base technology, and consequently many of the Chapters in this book address issues with, or solve problems using, this framework. Describes innovative techniques in: scheduling, memory management, quality of service and communication systems supporting real-time Java applications; Includes coverage of multiprocessor embedded systems and parallel programming; Discusses state-of-the-art resource management for embedded systems, including Java's real-time garbage collection and parallel collectors; Considers hardware support for the execution of Java programs including how programs can interact with functional accelerators; Includes coverage of Safety Critical Java for development of safety critical embedded systems.

The textbook is used at the Faculty of Electrical Engineering of the University of Ljubljana. It introduces the students of Electronics into the operating systems and real-time concepts having the embedded systems perspective in mind. In the opening chapters, the textbook presents the basic properties of operating systems and computer networks with the Internet Protocol. Linux is used as an example platform. It continues with

embedded system peculiarities using the PYHTEC phyCORE-i.MX27 development kit as a platform. Programming of peripheral devices and graphical applications is described. The characteristics of real-time systems follow. The real-time application structure is given. The principles of the inter-process communication, addressing resource sharing problem with synchronization and deadlock situations are presented.

This book is intended to provide a senior undergraduate or graduate student in electrical engineering or computer science with a balance of fundamental theory, review of industry practice, and hands-on experience to prepare for a career in the real-time embedded system industries. It is also intended to provide the practicing engineer with the necessary background to apply real-time theory to the design of embedded components and systems. Typical industries include aerospace, medical diagnostic and therapeutic systems, telecommunications, automotive, robotics, industrial process control, media systems, computer gaming, and electronic entertainment, as well as multimedia applications for general-purpose computing. This updated edition adds three new chapters focused on key technology advancements in embedded systems and with wider coverage of real-time architectures. The overall focus remains the RTOS (Real-Time Operating System), but use of Linux for soft real-time, hybrid FPGA (Field Programmable Gate Array) architectures and advancements in multi-core system-on-chip (SoC), as well as software strategies for asymmetric and symmetric multiprocessing (AMP and SMP) relevant to real-time embedded systems, have been added. Companion files are provided with numerous project videos, resources, applica-

tions, and figures from the book. Instructors' resources are available upon adoption. FEATURES: • Provides a comprehensive, up to date, and accessible presentation of embedded systems without sacrificing theoretical foundations • Features the RTOS (Real-Time Operating System), but use of Linux for soft real-time, hybrid FPGA architectures and advancements in multi-core system-on-chip is included • Discusses an overview of RTOS advancements, including AMP and SMP configurations, with a discussion of future directions for RTOS use in multi-core architectures, such as SoC • Detailed applications coverage including robotics, computer vision, and continuous media • Includes a companion disc (4GB) with numerous videos, resources, projects, examples, and figures from the book • Provides several instructors' resources, including lecture notes, Microsoft PP slides, etc.

IMPORTANT: This is a rebadged version of Real-time Operating Systems, Book 1, The Theory which (so far) has received eleven 5-star, one 4-star and one 3-star reviews. This book deals with the fundamentals of operating systems for use in real-time embedded systems. It is aimed at those who wish to develop RTOS-based designs, using either commercial or free products. It does not set out to give you a knowledge to design an RTOS; leave that to the specialists. The target readership includes:- Students.- Engineers, scientists and mathematicians moving into software systems.- Professional and experienced software engineers entering the embedded field.- Programmers having little or no formal education in the underlying principles of software-based real-time systems. The material covers the key 'nuts and bolts' of RTOS structures and usage (as you would expect, of course). In many cases

it shows how these are handled by practical real-time operating systems. It also places great emphasis on ways to structure the application software so that it can be effectively implemented using an RTOS. After studying this even the absolute beginner will see that it isn't particularly difficult to implement RTOS-based designs and should be confident to take on such work.

WHAT IS THIS BOOK ABOUT? In recent times real-time computer systems have become increasingly complex and sophisticated. It has now become apparent that, to implement such schemes effectively, professional, rigorous software methods must be used. This includes analysis, design and implementation. Unfortunately few textbooks cover this area well. Frequently they are hardware oriented with limited coverage of software, or software texts which ignore the issues of real-time systems. This book aims to fill that gap by describing the total software design and is given development process for real-time systems. Further, special emphasis of microprocessor-based real-time embedded systems. to the needs WHAT ARE REAL-TIME COMPUTER SYSTEMS? Real-time systems are those which must produce correct responses within a definite time limit. Should computer responses exceed these time bounds then performance degradation and/or malfunction results. WHAT ARE REAL-TIME EMBEDDED COMPUTER SYSTEMS? Here the computer is merely one functional element within a real-time system; it is not a computing machine in its own right. WHO SHOULD READ THIS BOOK? Those involved, or who intend to get involved, in the design of software for real-time systems. It is written with both software and hardware engineers in mind, being suitable for students and professional engineers.

Inhaltsangabe:Abstract: Embedded systems are becoming an integral part of commercial products today. Mobile phones, watches, cars and flights controllers etc. are to name a few. There are critical elements between the system hardware and the software, one of the primary is the Real Time Operating System which ensures control, compatibility and timing. The Real Time Operating System has to interface/communicate well with the hardware below it to prevent casualty, and with the software above to ensure the applications running in a proper way. Therefore, more and more attention is being paid to the porting relationship between Real Time Operating System and Application Software by engineers in embedded field. Comparing and evaluating the performance of different Real Time Operating Systems is getting more important. Measuring is the only way to provide useful information, for example, which Real Time Operating System is best suitable for a specific hardware configuration. The purpose of this thesis paper is to find an approach to exchange MicroC/OS-II with NOKIA Car-kit OS on a micro-controller system. Besides porting MicroC/OS-II to the micro-controller system, the interfaces to higher level application software should be generated to adapt the application software to MicroC/OS-II. Finally, evaluate the advantages and disadvantages of them. In chapter 1, a brief introduction is provided. In chapter 2, the concept of RTOS and the development of Real Time Kernel are introduced. The field on which RTOS is always focusing and why RTOS is especially important in Embedded Systems are explained. The essential performance and the differences among several RTOS are also discussed in this chapter. In chapter 3, the micro Real Time Kernel MicroC/OS-II is introduced in

details. The speciality of MicroC/OS-II and the services provided from MicroC/OS-II are explained. Also, the micro-controllers that MicroC/OS-II supported are introduced. In chapter 4, NOKIA Car-kit OS (NOKIA Car-kit Operating System) is introduced. The development history and some of important service mechanism are introduced briefly. In chapter 5, the evaluation and comparison of these two Operating Systems are made. The most important characteristics, the advantages and disadvantages for both of these two RTOS are discussed. In chapter 6, the software-mapping layer is discussed in detail. In this part, the whole software development procedure is explained. Issues from problem analyse, [...]

This updated edition offers an indispensable exposition on real-time computing, with particular emphasis on predictable scheduling algorithms. It introduces the fundamental concepts of real-time computing, demonstrates the most significant results in the field, and provides the essential methodologies for designing predictable computing systems used to support time-critical control applications. Along with an in-depth guide to the available approaches for the implementation and analysis of real-time applications, this revised edition contains a close examination of recent developments in real-time systems, including limited preemptive scheduling, resource reservation techniques, overload handling algorithms, and adaptive scheduling techniques. This volume serves as a fundamental advanced-level textbook. Each chapter provides basic concepts, which are followed by algorithms, illustrated with concrete examples, figures and tables. Exercises and solutions are provided to enhance self-study, making this an

excellent reference for those interested in real-time computing for designing and/or developing predictable control applications.

Offering comprehensive coverage of the convergence of real-time embedded systems scheduling, resource access control, software design and development, and high-level system modeling, analysis and verification Following an introductory overview, Dr. Wang delves into the specifics of hardware components, including processors, memory, I/O devices and architectures, communication structures, peripherals, and characteristics of real-time operating systems. Later chapters are dedicated to real-time task scheduling algorithms and resource access control policies, as well as priority-inversion control and deadlock avoidance. Concurrent system programming and POSIX programming for real-time systems are covered, as are finite state machines and Time Petri nets. Of special interest to software engineers will be the chapter devoted to model checking, in which the author discusses temporal logic and the NuSMV model checking tool, as well as a chapter treating real-time software design with UML. The final portion of the book explores practical issues of software reliability, aging, rejuvenation, security, safety, and power management. In addition, the book: Explains real-time embedded software modeling and design with finite state machines, Petri nets, and UML, and real-time constraints verification with the model checking tool, NuSMV Features real-world examples in finite state machines, model checking, real-time system design with UML, and more Covers embedded computer programming, designing for reliability, and designing for safety Explains how to make engineering trade-offs of power use and performance Investigates practi-

cal issues concerning software reliability, aging, rejuvenation, security, and power management Real-Time Embedded Systems is a valuable resource for those responsible for real-time and embedded software design, development, and management. It is also an excellent textbook for graduate courses in computer engineering, computer science, information technology, and software engineering on embedded and real-time software systems, and for undergraduate computer and software engineering courses.

'... a very good balance between the theory and practice of real-time embedded system designs.' —Jun-ichiro Ito Jun Hagino, Ph.D., Research Laboratory, Internet Initiative Japan Inc., IETF IPv6 Operations Working Group (v6ops) co-chair 'A cl

In this text performance measures, scheduling, real-time architectures, and algorithms are treated, along with fault-tolerance technology. With "Real-Time Systems", students will gain a deeper insight into the material through the use of numerous exercises and examples. For instance, simple examples found in Chapter 2 illustrate the differences between real-time and non-real-time systems.

Despite its importance, the role of HdS is most often underestimated and the topic is not well represented in literature and education. To address this, Hardware-dependent Software brings together experts from different HdS areas. By providing a comprehensive overview of general HdS principles, tools, and applications, this book provides adequate insight into the current technology and upcoming developments in the domain of HdS. The reader will find an interesting text book with self-contained introductions to the principles of Real-Time Operating Systems (RTOS), the emerging BIOS succes-

sor UEFI, and the Hardware Abstraction Layer (HAL). Other chapters cover industrial applications, verification, and tool environments. Tool introductions cover the application of tools in the ASIP software tool chain (i.e. Tensilica) and the generation of drivers and OS components from C-based languages. Applications focus on telecommunication and automotive systems.

This book is a rich text for introducing diverse aspects of real-time systems including architecture, specification and verification, scheduling and real world applications. It is useful for advanced graduate students and researchers in a wide range of disciplines impacted by embedded computing and software. Since the book covers the most recent advances in real-time systems and communications networks, it serves as a vehicle for technology transition within the real-time systems community of systems architects, designers, technologists, and system analysts. Real-time applications are used in daily operations, such as engine and break mechanisms in cars, traffic light and air-traffic control and heart beat and blood pressure monitoring. This book includes 15 chapters arranged in 4 sections, Architecture (chapters 1-4), Specification and Verification (chapters 5-6), Scheduling (chapters 7-9) and Real world applications (chapters 10-15).

The comprehensive coverage and real-world perspective makes the book accessible and appealing to both beginners and experienced designers. Covers both the fundamentals of software design and modern design methodologies Provides comparisons of different development methods, tools and languages Blends theory and practical experience together Emphasises the use of diagrams and is highly illustrated

This book covers the basic concepts and

principles of operating systems, showing how to apply them to the design and implementation of complete operating systems for embedded and real-time systems. It includes all the foundational and background information on ARM architecture, ARM instructions and programming, toolchain for developing programs, virtual machines for software implementation and testing, program execution image, function call conventions, run-time stack usage and link C programs with assembly code. It describes the design and implementation of a complete OS for embedded systems in incremental steps, explaining the design principles and implementation techniques. For Symmetric Multiprocessing (SMP) embedded systems, the author examines the ARM MP-core processors, which include the SCU and GIC for interrupts routing and inter-processor communication and synchronization by Software Generated Interrupts (SGIs). Throughout the book, complete working sample systems demonstrate the design principles and implementation techniques. The content is suitable for advanced-level and graduate students working in software engineering, programming, and systems theory.

This book comprehensively covers the three main areas of the subject: concepts, design and programming. Information on the applications of the embedded/real-time systems are woven into almost every aspect discussed which of course is inevitable. Hardware architecture and the various hardware platforms, design & development, operating systems, programming in Linux and RTLinux, navigation systems and protocol converter are discussed extensively. Special emphasis is given to embedded database and Java applications, and embedded software development. · Intro-

duction to Embedded Systems· Architecture of Embedded Systems· Programming for Embedded Systems· The Process of Embedded System Development· Hardware Platforms· Communication Interfaces· Embedded/Real-Time Operating System Concepts· Overview of Embedded/Real-Time Operating Systems· Target Image Creation· Representative Embedded Systems· Programming in Linux· Programming in RTLinux· Development of Navigation System· Development of Protocol Converter· Embedded Database Application· Mobile Java Applications· Embedded Software Development on 89C51 Micro-Controller Platform· Embedded Software Development on AVR Micro-Controller Platform· Embedded Systems Applications Using Intel StrongARM Platform· Future Trends	P/C 181
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while providing sufficient theoretical foundations and hardware background to understand the rationale for key decisions in RTOS and application design and implementation. The topics covered in this book include: Cross-compilation for embedded systems development Concurrent programming models used in real-time embedded software Real-time scheduling theory and algorithms used in wide practice Usage and comparison of two application programmer interfaces (APIs) in real-time embedded software: POSIX and the RTEMS Classic APIs Design and implementation in RTEMS of commonly found RTOS features for schedulers, task management, time-keeping, inter-task synchronization, inter-task communication, and networking The challenges introduced by multicore hardware, advances in multicore real-time theory, and software engineering multicore real-time systems with RTEMS All the authors of this book are experts in the academic field of real-time embedded systems. Two of the authors are primary open-source maintainers of the RTEMS software project.

NATO's Division of Scientific and Environmental Affairs sponsored this Advanced Study Institute because it was felt to be timely to cover this important and challenging subject for the first time in the framework of NATO's ASI programme. The significance of real-time systems in everyone's life is rapidly growing. The vast spectrum of these systems can be characterised by just a few examples of increasing complexity: controllers in washing machines, air traffic control systems, control and safety systems of nuclear power plants and, finally, future military systems like the Strategic Defense Initiative (SDI). The importance of such systems for the well-being of people requires considerable efforts in research

and development of highly reliable real-time systems. Furthermore, the competitiveness and prosperity of entire nations now depend on the early application and efficient utilisation of computer integrated manufacturing systems (CIM), of which real-time systems are an essential and decisive part. Owing to its key significance in computerised defence systems, real-time computing has also a special importance for the Alliance. The early research and development activities in this field in the 1960s and 1970s aimed towards improving the then unsatisfactory software situation. Thus, the first high-level real-time languages were defined and developed: RTL/2, Coral 66, Procol, LTR, and PEARL. In close connection with these language developments and with the utilisation of special purpose process control peripherals, the research on real-time operating systems advanced considerably.

MicroC/OS II Second Edition describes the design and implementation of the MicroC/OS-II real-time operating system (RTOS). In addition to its value as a reference to the kernel, it is an extremely detailed and highly readable design study particularly useful to the embedded systems student. While documenting the design and implementation of the kernel

Hard real-time systems are very predictable, but not sufficiently flexible to adapt to dynamic situations. They are built under pessimistic assumptions to cope with worst-case scenarios, so they often waste resources. Soft real-time systems are built to reduce resource consumption, tolerate overloads and adapt to system changes. They are also more suited to novel applications of real-time technology, such as multimedia systems, monitoring apparatuses, telecommunication networks, mobile robotics, virtual re-

ality, and interactive computer games. This unique monograph provides concrete methods for building flexible, predictable soft real-time systems, in order to optimize resources and reduce costs. It is an invaluable reference for developers, as well as researchers and students in Computer Science.