Modeling and Analysis of Real-Time and Embedded Systems with UML and MARTE

Developing Cyber-Physical Systems

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Foreword by Richard Soley

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Modeling And Analysis Of Real Time And Embedded Systems With Uml And Marte Developing Cyber Physical Systems The Mkomg Press

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Modeling and Analysis of Real-Time and Embedded Systems with UML and MARTE Bran Selic,Sebastien Gerard,2013-10-16 Modeling and Analysis of Real Time and Embedded Systems with UML and MARTE explains how to apply the complex MARTE standard in practical situations This approachable reference provides a handy user guide illustrating with numerous examples how you can use MARTE to design and develop real time and embedded systems and software Expert co authors Bran Selic and S bastien G rard lead the team that drafted and maintain the standard and give you the tools you need apply MARTE to overcome the limitations of cyber physical systems The functional sophistication required of modern cyber physical systems has reached a point where traditional code centric development methods are proving less and less capable of delivering a reliable product in a timely manner In Modeling and Analysis of Real Time and Embedded Systems with UML and MARTE you will learn how to take advantage of modern model based engineering methods and corresponding industry standards to overcome these limitations These methods take full advantage of computer supported automation allowing timely detection of design flaws to reduce engineering risk leading thereby to better overall product quality and greater productivity Understand the design rationale behind the MARTE standard needed to take full advantage of its many powerful modeling capabilities Best apply the various MARTE features for the most common use cases encountered in the design of real time and embedded software Learn how MARTE can be used together with the SysML language for the design of complex cyber physical systems Discover how MARTE can be used for different kinds of computer supported engineering analyses to predict key system characteristics early in development Customize MARTE for a specific domain or project *Embedded Systems* Fabrice Kordon,Jérôme Hugues,Agusti Canals,Alain Dohet,2013-05-06 Since the construction of the first embedded system in the 1960s embedded systems have continued to spread They provide a continually increasing number of services and are part of our daily life The development of these systems is a difficult problem which does not yet have a global solution Another difficulty is that systems are plunged into the real world which is not discrete as is generally understood in computing but has a richness of behaviors which sometimes hinders the formulation of simplifying assumptions due to their generally autonomous nature and they must face possibly unforeseen situations incidents for example or even situations that lie outside the initial design assumptions Embedded Systems presents the state of the art of the development of embedded systems and in particular concentrates on the modeling and analysis of these systems by looking at model driven engineering MDE2 SysML UML MARTE and AADL A case study based on a pacemaker is presented which enables the reader to observe how the different aspects of a system are addressed using the different approaches All three systems are important in that they provide the reader with a global view of their possibilities and demonstrate the contributions of each approach in the different stages of the software lifecycle Chapters dedicated to

analyzing the specification and code generation are also presented   Model Driven Engineering for Distributed Real-Time Embedded Systems 2009 Jean-Philippe Babau,Mireille Blay-Fornarino,Jöel Champeau,Sylvain Robert,Antonino Sabetta,2013-03-01 Model Driven Engineering for Distributed Real Time Embedded Systems 2009 Advances Standards Applications and Perspectives Model based development methods and supporting technologies can provide the techniques and tools needed to address the dilemma between reducing system development costs and time and developing increasingly complex systems This book provides the information needed to understand and apply model drive engineering MDE and model drive architecture MDA approaches to the development of embedded systems Chapters written by experts from academia and industry cover topics relating to MDE practices and methods as well as emerging MDE technologies Much of the writing is based on the presentations given at the Summer School MDE for Embedded Systems held at Brest France in September 2004   Real-Time UML Workshop for Embedded Systems Bruce Powel Douglass,2014-02-05 Written as a workbook with a set of guided exercises that teach by example this book gives a practical hands on guide to using UML to design and implement embedded and real time systems A review of the basics of UML and the Harmony process for embedded software development two on going case examples to teach the concepts a small scale traffic light control system and a large scale unmanned air vehicle show the applications of UML to the specification analysis and design of embedded and real time systems in general A building block approach a series of progressive worked exercises with step by step explanations of the complete solution clearly demonstrating how to convert concepts into actual designs A walk through of the phases of an incremental spiral process posing the problems and the solutions for requirements analysis object analysis architectural design mechanistic design and detailed design   Cyber-Physical System Design from an Architecture Analysis Viewpoint Shin Nakajima,Jean-Pierre Talpin,Masumi Toyoshima,Huafeng Yu,2017-05-10 Providing a wide variety of technologies for ensuring the safety and dependability of cyber physical systems CPS this book offers a comprehensive introduction to the architecture centric modeling analysis and verification of CPS In particular it focuses on model driven engineering methods including architecture description languages virtual prototyping and formal analysis methods CPS are based on a new design paradigm intended to enable emerging software intensive systems Embedded computers and networks monitor and control the physical processes usually with the help of feedback loops where physical processes affect computations and vice versa The principal challenges in system design lie in this constant interaction of software hardware and physics Developing reliable CPS has become a critical issue for the industry and society because many applications such as transportation power distribution medical equipment and tele medicine are dependent on CPS Safety and security requirements must be ensured by means of powerful validation tools Satisfying such requirements including quality of service implies having formally proven the required properties of the system before it is deployed The book is concerned with internationally standardized modeling languages such as AADL SysML and MARTE As the effectiveness of the technologies is

demonstrated with industrial sample cases from the automotive and aerospace sectors links between the methods presented and industrial problems are clearly understandable Each chapter is self contained addressing specific scientific or engineering problems and identifying further issues In closing it includes perspectives on future directions in CPS design from an architecture analysis viewpoint   Real-Time Simulation Technologies: Principles, Methodologies, and Applications Katalin Popovici,Pieter Mosterman,2017-12-19 Real Time Simulation Technologies Principles Methodologies and Applications is an edited compilation of work that explores fundamental concepts and basic techniques of real time simulation for complex and diverse systems across a broad spectrum Useful for both new entrants and experienced experts in the field this book integrates coverage of detailed theory acclaimed methodological approaches entrenched technologies and high value applications of real time simulation all from the unique perspectives of renowned international contributors Because it offers an accurate and otherwise unattainable assessment of how a system will behave over a particular time frame real time simulation is increasingly critical to the optimization of dynamic processes and adaptive systems in a variety of enterprises These range in scope from the maintenance of the national power grid to space exploration to the development of virtual reality programs and cyber physical systems This book outlines how for these and other undertakings engineers must assimilate real time data with computational tools for rapid decision making under uncertainty Clarifying the central concepts behind real time simulation tools and techniques this one of a kind resource Discusses the state of the art important challenges and high impact developments in simulation technologies Provides a basis for the study of real time simulation as a fundamental and foundational technology Helps readers develop and refine principles that are applicable across a wide variety of application domains As science moves toward more advanced technologies unconventional design approaches and unproven regions of the design space simulation tools are increasingly critical to successful design and operation of technical systems in a growing number of application domains This must have resource presents detailed coverage of real time simulation for system design parallel and distributed simulations industry tools and a large set of applications   **A Journey of Embedded and Cyber-Physical Systems** Jian-Jia Chen,2020-07-30 This Open Access book celebrates Professor Peter Marwedel s outstanding achievements in compilers embedded systems and cyber physical systems The contributions in the book summarize the content of invited lectures given at the workshop Embedded Systems held at the Technical University Dortmund in early July 2019 in honor of Professor Marwedel s seventieth birthday Provides a comprehensive view from leading researchers with respect to the past present and future of the design of embedded and cyber physical systems Discusses challenges and potential solutions from theoreticians and practitioners on modeling design analysis and optimization for embedded and cyber physical systems Includes coverage of model verification communication software runtime systems operating systems and real time computing   Real-time UML Bruce Powel Douglass,2000   *Doing Hard Time* Bruce Powel Douglass,1999 Doing Hard Time is written to facilitate the daunting process of developing real time

systems It presents an embedded systems programming methodology that has been proven successful in practice The process outlined in this book allows application developers to apply practical techniques garnered from the mainstream areas of object oriented software development to meet the demanding qualifications of real time programming Bruce Douglass offers ideas that are up to date with the latest concepts and trends in programming By using the industry standard Unified Modeling Language UML as well as the best practices from object technology he guides you through the intricacies and specifics of real time systems development Important topics such as schedulability behavioral patterns and real time frameworks are demystified empowering you to become a more effective real time programmer *Model Driven Engineering for Distributed Real-Time Embedded Systems 2009* Jean-Philippe Babau,Mireille Blay-Fornarino,Jöel Champeau,Sylvain Robert,Antonino Sabetta,2010-09-14 Model based development methods and supporting technologies can provide the techniques and tools needed to address the dilemma between reducing system development costs and time and developing increasingly complex systems This book provides the information needed to understand and apply model drive engineering MDE and model drive architecture MDA approaches to the development of embedded systems Chapters written by experts from academia and industry cover topics relating to MDE practices and methods as well as emerging MDE technologies Much of the writing is based on the presentations given at the Summer School MDE for Embedded Systems held at Brest France in September 2004 *Real-Time Software Design for Embedded Systems* Hassan Gomaa,2016-05-26 This tutorial reference takes the reader from use cases to complete architectures for real time embedded systems using SysML UML and MARTE and shows how to apply the COMET RTE design method to real world problems The author covers key topics such as architectural patterns for distributed and hierarchical real time control and other real time software architectures performance analysis of real time designs using real time scheduling and timing analysis on single and multiple processor systems Complete case studies illustrating design issues include a light rail control system a microwave oven control system and an automated highway toll system Organized as an introduction followed by several self contained chapters the book is perfect for experienced software engineers wanting a quick reference at each stage of the analysis design and development of large scale real time embedded systems as well as for advanced undergraduate or graduate courses in software engineering computer engineering and software design <u>Model-Based Engineering of Embedded Real-Time Systems</u> Holger Giese,Gabor Karsai,Edward A. Lee,Bernhard Rumpe,Bernhard Schätz,2010-10-09 Thetopicof Model BasedEngineeringofReal TimeEmbeddedSystems brings together a challenging problem domain real time embedded systems and a lution domain model based engineering It is also at the forefrontof integrated software and systems engineering as software in this problem domain is an essential tool for system implementation and integration Today real time bedded software plays a crucial role in most advanced technical systems such as airplanes mobile phones and cars and has become the main driver and cilitator for innovation Development evolution veri cation con guration and maintenance of

embedded and distributed software nowadays are often serious challenges as drastic increases in complexity can be observed in practice Model based engineering in general and model based software development in particular advocates the notion of using models throughout the development and life cycle of an engineered system Model based software engineering re forces this notion by promoting models not only as the tool of abstraction but also as the tool for veri cation implementation testing and maintenance The application of such model based engineering techniques to embedded real time systems appears to be a good candidate to tackle some of the problems arising in the problem domain **Real-Time Embedded Systems** Jiacun Wang,2017-07-10 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 programing designing for reliability and designing for safety Explains how to make engineering trade offs of power use and performance Investigates practical 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 **Embedded and Real Time System Development: A Software Engineering Perspective** Mohammad Ayoub Khan,Saqib Saeed,Ashraf Darwish,Ajith Abraham,2013-11-19 Nowadays embedded and real time systems contain complex software The complexity of embedded systems is increasing and the amount and variety of software in the embedded products are growing This creates a big challenge for embedded and real time software development processes and there is a need to develop separate metrics and benchmarks Embedded and Real Time System Development A Software Engineering Perspective Concepts Methods and Principles presents practical as well as conceptual knowledge of the latest tools techniques and methodologies of embedded

software engineering and real time systems Each chapter includes an in depth investigation regarding the actual or potential role of software engineering tools in the context of the embedded system and real time system The book presents state of the art and future perspectives with industry experts researchers and academicians sharing ideas and experiences including surrounding frontier technologies breakthroughs innovative solutions and applications The book is organized into four parts Embedded Software Development Process Design Patterns and Development Methodology Modelling Framework and Performance Analysis Power Management and Deployment with altogether 12 chapters The book is aiming at i undergraduate students and postgraduate students conducting research in the areas of embedded software engineering and real time systems ii researchers at universities and other institutions working in these fields and iii practitioners in the R D departments of embedded system It can be used as an advanced reference for a course taught at the postgraduate level in embedded software engineering and real time systems   Embedded System Design Peter Marwedel,2017-07-26 A unique feature of this textbook is to provide a comprehensive introduction to the fundamental knowledge in embedded systems with applications in cyber physical systems and the Internet of things It starts with an introduction to the field and a survey of specification models and languages for embedded and cyber physical systems It provides a brief overview of hardware devices used for such systems and presents the essentials of system software for embedded systems including real time operating systems The author also discusses evaluation and validation techniques for embedded systems and provides an overview of techniques for mapping applications to execution platforms including multi core platforms Embedded systems have to operate under tight constraints and hence the book also contains a selected set of optimization techniques including software optimization techniques The book closes with a brief survey on testing This third edition has been updated and revised to reflect new trends and technologies such as the importance of cyber physical systems and the Internet of things the evolution of single core processors to multi core processors and the increased importance of energy efficiency and thermal issues   *A Journey of Embedded and Cyber-Physical Systems* Jian-Jia Chen,2020-09-11 This Open Access book celebrates Professor Peter Marwedel s outstanding achievements in compilers embedded systems and cyber physical systems The contributions in the book summarize the content of invited lectures given at the workshop Embedded Systems held at the Technical University Dortmund in early July 2019 in honor of Professor Marwedel s seventieth birthday Provides a comprehensive view from leading researchers with respect to the past present and future of the design of embedded and cyber physical systems Discusses challenges and potential solutions from theoreticians and practitioners on modeling design analysis and optimization for embedded and cyber physical systems Includes coverage of model verification communication software runtime systems operating systems and real time computing   *Embedded System Design* Peter Marwedel,2010-11-16 Until the late 1980s information processing was associated with large mainframe computers and huge tape drives During the 1990s this trend shifted toward information processing with personal computers or PCs The trend

toward miniaturization continues and in the future the majority of information processing systems will be small mobile computers many of which will be embedded into larger products and interfaced to the physical environment Hence these kinds of systems are called embedded systems Embedded systems together with their physical environment are called cyber physical systems Examples include systems such as transportation and fabrication equipment It is expected that the total market volume of embedded systems will be significantly larger than that of traditional information processing systems such as PCs and mainframes Embedded systems share a number of common characteristics For example they must be dependable efficient meet real time constraints and require customized user interfaces instead of generic keyboard and mouse interfaces Therefore it makes sense to consider common principles of embedded system design Embedded System Design starts with an introduction into the area and a survey of specification models and languages for embedded and cyber physical systems It provides a brief overview of hardware devices used for such systems and presents the essentials of system software for embedded systems like real time operating systems The book also discusses evaluation and validation techniques for embedded systems Furthermore the book presents an overview of techniques for mapping applications to execution platforms Due to the importance of resource efficiency the book also contains a selected set of optimization techniques for embedded systems including special compilation techniques The book closes with a brief survey on testing Embedded System Design can be used as a text book for courses on embedded systems and as a source which provides pointers to relevant material in the area for PhD students and teachers It assumes a basic knowledge of information processing hardware and software Courseware related to this book is available at http ls12 www cs tu dortmund de marwedel **Real-Time Embedded Systems** Xiaocong Fan,2015-02-25 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 constraintsThe 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 **Real-Time Systems Development with RTEMS and Multicore Processors** Gedare Bloom,Joel Sherrill,Tingting Hu,Ivan Cibrario Bertolotti,2020-11-22 The proliferation of multicore processors in the embedded market for Internet of Things IoT and Cyber Physical Systems CPS makes developing real time embedded applications increasingly difficult What is the underlying theory that makes multicore real time possible How does theory influence application design When is a real time operating system RTOS useful What RTOS features do applications need How does a mature RTOS help manage the complexity of multicore hardware Real Time Systems Development with RTEMS and Multicore Processors answers these questions and more with exemplar Real Time Executive for Multiprocessor Systems RTEMS RTOS to provide concrete advice and examples for constructing useful feature rich applications RTEMS is free open source software that supports multi processor systems for over a dozen CPU architectures and over 150 specific system boards in applications spanning the range of IoT and CPS domains such as satellites particle accelerators robots racing motorcycles building controls medical devices and more The focus of this book is on enabling real time embedded software engineering 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 The Open Access version of this book available at http www taylorfrancis com has been made available under a Creative Commons Attribution ShareAlike 4 0 CC BY SA International license **Embedded Systems Development** Alberto Sangiovanni-Vincentelli,Haibo Zeng,Marco Di Natale,Peter Marwedel,2013-07-19 This book offers readers broad coverage of techniques to model verify and validate the behavior and performance of complex distributed embedded systems The authors attempt to bridge the gap between the three disciplines of model based design real time analysis and model driven development for a better understanding of the ways in which new development flows can be constructed going from system level modeling to the correct and predictable

generation of a distributed implementation leveraging current and future research results

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