FOUNDATIONS OF DEPENDABLE COMPUTING
System Implementation

edited by

Gary M. Koob
Clifford G. Lau

Foundations Of Dependable Computing System Implementation

Stefan Poledna

Foundations Of Dependable Computing System Implementation:

Foundations of Dependable Computing Gary M. Koob,Clifford G. Lau,2013-04-17 Foundations of Dependable Computing System Implementation explores the system infrastructure needed to support the various paradigms of Paradigms for Dependable Applications Approaches to implementing support mechanisms and to incorporating additional appropriate levels of fault detection and fault tolerance at the processor network and operating system level are presented A primary concern at these levels is balancing cost and performance against coverage and overall dependability As these chapters demonstrate low overhead practical solutions are attainable and not necessarily incompatible with performance considerations The section on innovative compiler support in particular demonstrates how the benefits of application specificity may be obtained while reducing hardware cost and run time overhead A companion to this volume published by Kluwer subtitled Models and Frameworks for Dependable Systems presents two comprehensive frameworks for reasoning about system dependability thereby establishing a context for understanding the roles played by specific approaches presented in this book s two companion volumes It then explores the range of models and analysis methods necessary to design validate and analyze dependable systems Another companion to this book published by Kluwer subtitled Paradigms for Dependable Applications presents a variety of specific approaches to achieving dependability at the application level Driven by the higher level fault models of Models and Frameworks for Dependable Systems and built on the lower level abstractions implemented in a third companion book subtitled System Implementation these approaches demonstrate how dependability may be tuned to the requirements of an application the fault environment and the characteristics of the target platform Three classes of paradigms are considered protocol based paradigms for distributed applications algorithm based paradigms for parallel applications and approaches to exploiting application semantics in embedded real time control systems   **Foundations of Dependable Computing** Gary M. Koob,Clifford G. Lau,2007-08-19 Foundations of Dependable Computing System Implementation explores the system infrastructure needed to support the various paradigms of Paradigms for Dependable Applications Approaches to implementing support mechanisms and to incorporating additional appropriate levels of fault detection and fault tolerance at the processor network and operating system level are presented A primary concern at these levels is balancing cost and performance against coverage and overall dependability As these chapters demonstrate low overhead practical solutions are attainable and not necessarily incompatible with performance considerations The section on innovative compiler support in particular demonstrates how the benefits of application specificity may be obtained while reducing hardware cost and run time overhead A companion to this volume published by Kluwer subtitled Models and Frameworks for Dependable Systems presents two comprehensive frameworks for reasoning about system dependability thereby establishing a context for understanding the roles played by specific approaches presented in this book s two companion volumes It then explores the range of models and analysis methods necessary to design validate and analyze

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professionals and practitioners who wish to understand the issues involved in the design and development of RTDBS Real Time Database Systems Issues and Applications fulfills this need This book presents the spectrum of issues that may arise in various real time database applications the available solutions and technologies that may be used to address these issues and the open problems that need to be tackled in the future With rapid advances in this area several concepts have been proposed without a widely accepted consensus on their definitions and implications To address this need the first chapter is an introduction to the key RTDBS concepts and definitions which is followed by a survey of the state of the art in RTDBS research and practice The remainder of the book consists of four sections models and paradigms applications and benchmarks scheduling and concurrency control and experimental systems The chapters in each section are contributed by experts in the respective areas Real Time Database Systems Issues and Applications is primarily intended for practicing engineers and researchers working in the growing area of real time database systems For practitioners the book will provide a much needed bridge for technology transfer and continued education For researchers this book will provide a comprehensive reference for well established results This book can also be used in a senior or graduate level course on real time systems real time database systems and database systems or closely related courses *Real-Time Database Systems* Kam-Yiu Lam,Tei-Wei Kuo,2006-04-18 In recent years tremendous research has been devoted to the design of database systems for real time applications called real time database systems RTDBS where transactions are associated with deadlines on their completion times and some of the data objects in the database are associated with temporal constraints on their validity Examples of important applications of RTDBS include stock trading systems navigation systems and computer integrated manufacturing Different transaction scheduling algorithms and concurrency control protocols have been proposed to satisfy transaction timing data temporal constraints Other design issues important to the performance of a RTDBS are buffer management index accesses and I O scheduling Real Time Database Systems Architecture and Techniques summarizes important research results in this area and serves as an excellent reference for practitioners researchers and educators of real time systems and database systems **Imprecise and Approximate Computation** Swaminathan Natarajan,2007-08-26 Real time systems are now used in a wide variety of applications Conventionally they were configured at design to perform a given set of tasks and could not readily adapt to dynamic situations The concept of imprecise and approximate computation has emerged as a promising approach to providing scheduling flexibility and enhanced dependability in dynamic real time systems The concept can be utilized in a wide variety of applications including signal processing machine vision databases networking etc For those who wish to build dynamic real time systems which must deal safely with resource unavailability while continuing to operate leading to situations where computations may not be carried through to completion the techniques of imprecise and approximate computation facilitate the generation of partial results that may enable the system to operate safely and avert catastrophe Audience Of special interest to researchers May be used

as a supplementary text in courses on real time systems **Real-Time Systems** Hermann Kopetz,2006-04-18 7 6 Performance Comparison ET versus TT 164 7 7 The Physical Layer 166 Points to Remember 168 Bibliographic Notes 169 Review Questions and Problems 170 Chapter 8 The Time Triggered Protocols 171 Overview 171 8 1 Introduction to Time Triggered Protocols 172 8 2 Overview of the TTP C Protocol Layers 175 8 3 TheBasic CNI 178 Internal Operation of TTP C 181 8 4 8 5 TTP A for Field Bus Applications 185 Points to Remember 188 Bibliographic Notes 190 Review Questions and Problems 190 Chapter 9 Input Output 193 Overview 193 9 1 The Dual Role of Time 194 9 2 Agreement Protocol 196 9 3 Sampling and Polling 198 9 4 Interrupts 201 9 5 Sensors and Actuators 203 9 6 Physical Installation 207 Points to Remember 208 Bibliographic Notes 209 Review Questions and Problems 209 Chapter 10 Real Time Operating Systems 211 Overview 211 10 1 Task Management 212 10 2 Interprocess Communication 216 10 3 Time Management 218 10 4 Error Detection 219 10 5 A Case Study ERCOS 221 Points to Remember 223 Bibliographic Notes 224 Review Questions and Problems 224 Chapter 11 Real Time Scheduling 227 Overview 227 11 1 The Scheduling Problem 228 11 2 The Adversary Argument 229 11 3 Dynamic Scheduling 231 x TABLE OF CONTENTS 11 4 Static Scheduling 237 Points to Remember 240 Bibliographic Notes 242 Review Questions and Problems 242 Chapter 12 Validation 245 Overview 245 12 1 Building aConvincing Safety Case 246 12 2 Formal Methods 248 12 3 Testing *Hard Real-Time Computing Systems* Giorgio C Buttazzo,2007-08-19 Real time computing plays a crucial role in our society since an increasing num ber of complex systems rely in part or completely on processor control Ex amples of applications that require real time computing include nuclear power plants railway switching systems automotive electronics air traffic control telecommunications robotics and military systems In spite of this large application domain most of the current real time systems are still designed and implemented using low level programming and empirical techniques without the support of a scientific methodology This approach results in a lack of reliability which in critical applications may cause serious environmental damage or even loss of life This book is a basic treatise on real time computing with particular emphasis on predictable scheduling algorithms The main objectives of the book are to introduce the basic concepts of real time computing illustrate the most sig nificant results in the field and provide the basic methodologies for designing predictable computing systems useful in supporting critical control applica tions The book is written for instructional use and is organized to enable readers without a strong knowledge of the subject matter to quickly grasp the material Technical concepts are clearly defined at the beginning of each chapter and algorithm descriptions are reinforced through concrete examples illustrations and tables **Fault-Tolerant Real-Time Systems** Stefan Poledna,2007-11-23 Real time computer systems are very often subject to dependability requirements because of their application areas Fly by wire airplane control systems control of power plants industrial process control systems and others are required to continue their function despite faults Fault tolerance and real time requirements thus constitute a kind of natural combination in process control applications Systematic fault tolerance is based on redundancy which is used to mask

failures of individual components The problem of replica determinism is thereby to ensure that replicated components show consistent behavior in the absence of faults It might seem trivial that given an identical sequence of inputs replicated computer systems will produce consistent outputs Unfortunately this is not the case The problem of replica non determinism and the presentation of its possible solutions is the subject of Fault Tolerant Real Time Systems The Problem of Replica Determinism The field of automotive electronics is an important application area of fault tolerant real time systems Systems like anti lock braking engine control active suspension or vehicle dynamics control have demanding real time and fault tolerance requirements These requirements have to be met even in the presence of very limited resources since cost is extremely important Because of its interesting properties Fault Tolerant Real Time Systems gives an introduction to the application area of automotive electronics The requirements of automotive electronics are a topic of discussion in the remainder of this work and are used as a benchmark to evaluate solutions to the problem of replica determinism

Responsive Computer Systems: Steps Toward Fault-Tolerant Real-Time Systems Donald Fussell,Miroslaw Malek,2012-12-06 Responsive Computer Systems Steps Towards Fault Tolerant Real Time Systems provides an extensive treatment of the most important issues in the design of modern Responsive Computer Systems It lays the groundwork for a more comprehensive model that allows critical design issues to be treated in ways that more traditional disciplines of computer research have inhibited It breaks important ground in the development of a fruitful modern perspective on computer systems as they are currently developing and as they may be expected to develop over the next decade Audience An interesting and important road map to some of the most important emerging issues in computing suitable as a secondary text for graduate level courses on responsive computer systems and as a reference for industrial practitioners   Real-Time Database and Information Systems: Research Advances Azer Bestavros,Victor Fay-Wolfe,2012-12-06 Real time systems are defined as those for which correctness depends not only on the logical properties of the produced results but also on the temporal properties of these results In a database real time means that in addition to typical logical consistency constraints such as a constraint on a data item s value there are constraints on when transactions execute and on the freshness of the data transactions access The challenges and tradeoffs faced by the designers of real time database systems are quite different from those faced by the designers of general purpose database systems To achieve the fundamental requirements of timeliness and predictability not only do conventional methods for scheduling and transaction management have to be redesigned but also new concepts that have not been considered in conventional database systems or in real time systems need to be added Real Time Database and Information Systems Research Advances is devoted to new techniques for scheduling of transactions concurrency management transaction logging database languages and new distributed database architectures Real Time Database and Information Systems Research Advances is primarily intended for practicing engineers and researchers working in the growing area of real time database and information retrieval systems For practitioners the

book will provide a much needed bridge for technology transfer and continued education For researchers the book will provide a comprehensive reference for well established results The book can also be used in a senior or graduate level course on real time systems real time database systems and database systems or closely related courses **Event-Triggered and Time-Triggered Control Paradigms** Roman Obermaisser,2006-01-27 Event Triggered and Time Triggered Control Paradigms presents a valuable survey about existing architectures for safety critical applications and discusses the issues that must be considered when moving from a federated to an integrated architecture The book focuses on one key topic the amalgamation of the event triggered and the time triggered control paradigm into a coherent integrated architecture The architecture provides for the integration of independent distributed application subsystems by introducing multi criticality nodes and virtual networks of known temporal properties The feasibility and the tangible advantages of this new architecture are demonstrated with practical examples taken from the automotive industry Event Triggered and Time Triggered Control Paradigms offers significant insights into the architecture and design of integrated embedded systems both at the conceptual and at the practical level **Deadline Scheduling for Real-Time Systems** John A. Stankovic,Marco Spuri,Krithi Ramamritham,Giorgio C Buttazzo,2012-12-06 Many real time systems rely on static scheduling algorithms This includes cyclic scheduling rate monotonic scheduling and fixed schedules created by off line scheduling techniques such as dynamic programming heuristic search and simulated annealing However for many real time systems static scheduling algorithms are quite restrictive and inflexible For example highly automated agile manufacturing command control and communications and distributed real time multimedia applications all operate over long lifetimes and in highly non deterministic environments Dynamic real time scheduling algorithms are more appropriate for these systems and are used in such systems Many of these algorithms are based on earliest deadline first EDF policies There exists a wealth of literature on EDF based scheduling with many extensions to deal with sophisticated issues such as precedence constraints resource requirements system overload multi processors and distributed systems Deadline Scheduling for Real Time Systems EDF and Related Algorithms aims at collecting a significant body of knowledge on EDF scheduling for real time systems but it does not try to be all inclusive the literature is too extensive The book primarily presents the algorithms and associated analysis but guidelines rules and implementation considerations are also discussed especially for the more complicated situations where mathematical analysis is difficult In general it is very difficult to codify and taxonomize scheduling knowledge because there are many performance metrics task characteristics and system configurations Also adding to the complexity is the fact that a variety of algorithms have been designed for different combinations of these considerations In spite of the recent advances there are still gaps in the solution space and there is a need to integrate the available solutions For example a list of issues to consider includes preemptive versus non preemptive tasks uni processors versus multi processors using EDF at dispatch time versus EDF based planning precedence constraints among tasks resource constraints periodic versus aperiodic versus sporadic

tasks scheduling during overload fault tolerance requirements and providing guarantees and levels of guarantees meeting quality of service requirements Deadline Scheduling for Real Time Systems EDF and Related Algorithms should be of interest to researchers real time system designers and instructors and students either as a focussed course on deadline based scheduling for real time systems or more likely as part of a more general course on real time computing The book serves as an invaluable reference in this fast moving field **Forthcoming Books** Rose Arny,1995-02 **Dependable Computing for Critical Applications 2** John F. Meyer,Richard D. Schlichting,2012-12-06 This volume contains the papers presented at the Second International Work ing Conference on Dependable Computing for Critical Applications sponsored by IFIP Working Group lOA and held in Tucson Arizona on February 18 20 1991 In keeping with the first such conference on this topic which took place at the University of California Santa Barbara in 1989 this meeting was like wise concerned with an important basic question Can we rely on Computers In more precise terms it addressed various aspects of computer system de pendability a broad concept defined as th e trustworthiness of computer service such that reliance can justifiably be placed on this service Given that this term includes attributes such as reliability availability safety and security it is our hope that these papers will contribute to further integration of these ideas in the context of critical applications The program consisted of 20 papers and three panel sessions The papers were selected from a total of 61 submissions at a November 1990 meeting of the Program Committee in Ann Arbor Michigan We were very fortunate to have a broad spectrum of interests represented with papers in the final program coming from seven different countries representing work at universities corporations and government agencies The process was greatly facilitated by the diligent work of the Program Committee and the quality of reviews provided by outside referees In addition to the paper presentations there were three panel sessions or ganized to examine particular topics in detail **Foundations of Dependable Computing** Gary M. Koob,Clifford G. Lau,2013-03-21 Foundations of Dependable Computing Models and Frameworks for Dependable Systems presents two comprehensive frameworks for reasoning about system dependability thereby establishing a context for understanding the roles played by specific approaches presented in this book s two companion volumes It then explores the range of models and analysis methods necessary to design validate and analyze dependable systems A companion to this book published by Kluwer subtitled Paradigms for Dependable Applications presents a variety of specific approaches to achieving dependability at the application level Driven by the higher level fault models of Models and Frameworks for Dependable Systems and built on the lower level abstractions implemented in a third companion book subtitled System Implementation these approaches demonstrate how dependability may be tuned to the requirements of an application the fault environment and the characteristics of the target platform Three classes of paradigms are considered protocol based paradigms for distributed applications algorithm based paradigms for parallel applications and approaches to exploiting application semantics in embedded real time control systems Another companion book published by Kluwer subtitled System

Implementation explores the system infrastructure needed to support the various paradigms of Paradigms for Dependable Applications Approaches to implementing support mechanisms and to incorporating additional appropriate levels of fault detection and fault tolerance at the processor network and operating system level are presented A primary concern at these levels is balancing cost and performance against coverage and overall dependability As these chapters demonstrate low overhead practical solutions are attainable and not necessarily incompatible with performance considerations The section on innovative compiler support in particular demonstrates how the benefits of application specificity may be obtained while reducing hardware cost and run time overhead **Software Fault Tolerance: A Tutorial** ,2000 **Networking and Information Technology Research and Development** National Science and Technology Council (U.S.). Interagency Working Group on Information Technology Research and Development,2002 **Dependable Computing** Ravishankar K. Iyer,Zbigniew T. Kalbarczyk,Nithin M. Nakka,2024-04-18 Dependable Computing Covering dependability from software and hardware perspectives Dependable Computing Design and Assessment looks at both the software and hardware aspects of dependability This book Provides an in depth examination of dependability fault tolerance topics Describes dependability taxonomy and briefly contrasts classical techniques with their modern counterparts or extensions Walks up the system stack from the hardware logic via operating systems up to software applications with respect to how they are hardened for dependability Describes the use of measurement based analysis of computing systems Illustrates technology through real life applications Discusses security attacks and unique dependability requirements for emerging applications e g smart electric power grids and cloud computing Finally using critical societal applications such as autonomous vehicles large scale clouds and engineering solutions for healthcare the book illustrates the emerging challenges faced in making artificial intelligence AI and its applications dependable and trustworthy This book is suitable for those studying in the fields of computer engineering and computer science Professionals who are working within the new reality to ensure dependable computing will find helpful information to support their efforts With the support of practical case studies and use cases from both academia and real world deployments the book provides a journey of developments that include the impact of artificial intelligence and machine learning on this ever growing field This book offers a single compendium that spans the myriad areas in which dependability has been applied providing theoretical concepts and applied knowledge with content that will excite a beginner and rigor that will satisfy an expert Accompanying the book is an online repository of problem sets and solutions as well as slides for instructors that span the chapters of the book

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Table of Contents Foundations Of Dependable Computing System Implementation

1. Understanding the eBook Foundations Of Dependable Computing System Implementation
    - The Rise of Digital Reading Foundations Of Dependable Computing System Implementation
    - Advantages of eBooks Over Traditional Books
2. Identifying Foundations Of Dependable Computing System Implementation
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Foundations Of Dependable Computing System Implementation
    - User-Friendly Interface

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