Preface

This book collects the efforts developed by a series of researchers, presented at AMAST Workshops on Real-Time Systems. The authors whose papers were selected for this book are major players in this area, and they were given the opportunity to refine the text of their papers as a result of the lively discussions that took place during the workshops. The refining of the papers continued all through the editing process as well. The papers were carefully selected and revised by the editors and grouped into six parts debating subjects on the modeling and analysis, verification, synthesis, tools, and applications of real-time systems. The editors considered that these divisions made the book more coherent, and therefore, more readable.

It is almost futile to say that there is a large amount of research and literature on the subject of real-time systems. The subject is of great importance and it is resuscitating large interest in the research community. Great efforts have been made towards a clear understanding of the nature, features and particularities of real-time systems. As a result, a series of approaches of the field problems have been attempted. The variety of the latter spans over a vast spectrum of theoretical frameworks, from finite state machines to mathematical models expressed in various versions of the lambda calculus — and so are also the practical methodologies that have resulted by applying the above. As real-time systems are, as the name shows, systems, a systemic approach is needed, which unfortunately is very difficult to set. The difficulty stems from the combination of processes, some modeled by a set of differential/difference equations, and others by logic statements and their computer control algorithms, which usually involve first-order and/or temporal logic statements. The above facts have led to an arabesque of

mathematical symbols and "theories" generated for the purpose of finding an appropriate model for the above combination of processes. It is needless to say that the field has attracted the attention of mathematicians, computer engineers, and computer and control theory scientists. It is also needless to say that the application of theoretical findings has had a large echo in the designers' and implementers' of real-time systems communities activating in the domains of telecommunications, power generation, metallurgy, aviation, and many other industries. Confronted with the difficulty of the field, the practitioners' community is in permanent expectation of new approaches and results, which should show them the light: a unified theory and practice capturing the essence of designing correct and at least sound real-time applications. As in other fields, designers and implementers of real-time applications expect to map in a coherent way the theoretical conquests to the reality of their projects. Thus, any book in this field should be in great demand. Related to the above, a fact must be mentioned: "*the book*" is not yet out. Here, the book we are trying to set is a reasonable combination of theory and practice, amalgamating a series of trends in the area of real-time systems in a readable sequence. However, it is clear to us that almost each chapter of this book can be easily developed into a book on its own. This reflects the diversity of problems and aspects that are currently under investigation in the area of real-time systems. We evaluate that this book is representative for the research efforts, which have been deployed in recent times in this area.

The first part of the book is a snapshot of the research done in the area of theory of real-time systems debating models of time, distributed, probabilistic, and process algebra models, and finally transition systems, at the time of the workshops.

The second part groups together the papers related to real-time system verification. This aspect is researched from different angles by using symbolic model checking, automated transition systems, process algebra methods, and for unpredictable real-time systems using suspension automata.

Part three contains subjects related to synthesis methods of real-time systems, while in part four the semantics expressed by urgent timed process algebras and the compositional semantics of real-time systems are studied.

Part five presents different programming paradigms and frameworks for real-time systems like the Llull system, the OSA model, and an algebraic implementation of the model checking methodology.

Part six is dedicated to the reality of real-time systems and contains

industrial applications of some methodologies, considered appropriate by the authors, for providing a solution to the problem described.

As mentioned above, the combination of real world processes (continuous in their nature), man-made processes and devices (sometimes discrete) with one or many computers controlling the above processes, leads to a combination of continuous and/or discrete models which have to be dealt with by a computer. The difficulty of dealing with such a combination is aggravated by the fact that a computer does not yet have a unitary model as a process. It is also aggravated by the complexity of the computer system and by the sometimes severe safety conditions of the overall application. These are some of the challenges that have to be faced by a researcher or a practitioner when dealing with the design, implementation, and testing of a real-time system.

Obviously, there are plenty of models of time, execution models, logics, languages, theories, and applications that attempt to overcome these challenges. The literature of the domain already mentions a series of approaches to the modeling of real-time systems, including: automata theory, real-time process algebra, lambda calculus in real-time, and timed transition systems, to quote just a few.

Very often all of these may seem contradictory and practitioners may have difficulties in obtaining a clear picture of the direction they have to take in the design process of real-time systems. This might be explained by the lack of unified models and techniques. Although abstract and formal methods, provide very strong and versatile tools for a designer, they are only applied by academics. This state of the theoretical and practical developments in the area of real-time systems indicates that much work is needed before the field can mature with a unified and accessible theory available for practitioners.

No book will ever present a final solution to the multitude of problems mentioned above. The best we can hope for is that by presenting different aspects of real-time programming systems as they were researched by the authors, the book will help to enrich the general knowledge in this area, stimulating the creativity of other researchers.

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