# Special Issue on Real-Time Systems Design

## Guest Editors' Introduction

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Through decennia, computers have became smaller, faster, more affordable and reliable. Besides the "number-crunching" applications they found their use and eventually became indispensable in the control of technical processes. Generally, such computers are embedded in, i.e. become a part of, such systems. Their operation mode is called "real-time"; its most common definition is that they must be permanently ready to react to requests from the environment within a predefined time frame. Failure to meet that requirement can result in degraded performance (soft real-time) or system failure (hard real-time) with the same consequences as in the case of a functional error.

Unfortunately, state-of-the-art in embedded real-time systems design is far from being satisfactory: usually off-the-shelf hardware components are inadequately composed into microprocessor based control systems, which in turn are programmed by commonly known and widely available general-purpose programming (often assembly) languages and, in the best case, verified by testing for their functional behaviour only.

The papers in this special issue are mainly dealing with the domain of hard real-time. Most of them were originally submitted to the Special Session on Real-Time Systems Design of the IEEE International Symposium on Industrial Electronics held on July 12-16, 1999 in Bled, Slovenia, organized by Matjaž Colnarič. Since the Session was successful with 12 papers presented, no no-shows, and arousing considerable interest among the participants of the Symposium, it was Vlado Glavinić's idea to select the most representative papers and publish them in a special issue of *CIT – Journal of Computing and Information Technology.*

After the permission to re-print the papers was granted by IEEE, for what we would herewith like to express our sincere gratitude, we asked the authors to re-work the papers. We were pleasantly surprised that all of them significantly re-worked and improved the original papers based on the editors' comments so that each of them is now covering a specific topic. Thus, instead of being reprints, the papers can, without any doubt, be considered original works. We are also happy that one of the most eminent scientists in the domain Prof. Dr. Dr. Wolfgang A. Halang agreed to contribute the introducing survey paper.

We would further like to thank the reviewers who all did a thorough, and some of them even an outstanding job in improving final version of the papers. Those were (in alphabetic order) Jim E. Cooling, Roman Gumzej, Wolfgang A. Halang, Bojan Novak, Carlos E. Pereira, Bran Selic, Theodor Tempelmeier and Domen Verber.

As already mentioned, the survey paper was contributed by Wolfgang A. Halang. Professor Halang chose to give an overview of the domain in an interesting and sometimes critical or even provocative manner. He carefully chose original references for certain topics, some of them more than 25 years old, emphasizing that a lot of the problems have essentially been solved a long time ago. The message of the paper is that

it is time to concentrate on practically usable solutions instead of on sophisticated research of artificially invented problems.

The second paper (Gumzej, Verber, Colnarič, Babau and Skubich) presents results of a joint project within the framework of the French-Slovene bi-lateral agreement Proteus. An attempt of joining two complementary approaches for real-time applications design is presented, the advantages are elaborated and drawbacks identified.

In her paper, Koroušić Seljak is elaborating on hardware-software co-design possibilities to implement complex scheduling approaches, a combination of evolutionary computation-based method and traditional earliest-deadline first policy.

Schwarz, Jelemenska, Huang, Aubry and Babau concentrate on the specification of the tasking behaviour of a real-time system. Using Shaw's CRSM model and expressing its features in form of an executable visual programming language the most important properties can be a-priori verified.

The paper by Glavinić, Groš and Colnarič is the result of joint research of the groups at the Faculty of Electrical Engineering and Computing of the University of Zagreb, Croatia and the Faculty of Electrical Engineering and Computer Science of the University of Maribor, Slovenia, showing a VHDL implementation of a consistent processor architecture for hard real-time applications. The goal aimed at in the work is to obtain strict predictability of temporal behaviour of tasks' code execution.

A similar topic is elaborated by a research group from Valencia, Spain in the paper by Sáez, Vila, Crespo and Garcia. Contrary to the previous paper, which is dealing with the detailed implementation of the low level processor features, here the authors concentrate rather on higher layer functions like hardware support for scheduling.

Finally, Budin, Jakobović and Golub explore in their paper possibilities of employing genetic algorithms in imprecise computing. The idea is to use coarse results when exact ones are not ready in due time, in order to provide for timely completion of real-time tasks.

We sincerely hope that this special issue will be but a modest contribution to common awareness of the guidelines and problems of consistent embedded real-time systems design, which have been neglected for too long a time.

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