10th IEEE Real-time and Embedded Technology and Applications Symposiumy

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1 Introduction

The 10th IEEE Real-time and embedded technology and applications symposium was held in Toronto, Canada, May 26th-28th, 2004, at Le Royal Meridien, King Edward, Toronto. This location was originally chosen for RTAS 2003. However, fears regarding the extent of the SARS epidemic in Toronto at the time caused RTAS 2003 to migrate to Washington DC, with a promise to return to Toronto on its 10th anniversary in 2004.

The 10th anniversary conference introduced several important changes to the format and scope of its predecessors. The goal was to encourage a much broader participation of real-time and embedded system researchers and practitioners. Towards that end, the conference migrated from a single track to a multitrack format. Papers for each track were selected by a separate technical program committee. A balance was sought among the different topics in terms of the number and quality of submissions. The four tracks comprizing RTAS 2004 were:

- *Real-time infrastructure and development:* This thrust continued from previous years with a focus on embedded and real-time systems that exhibit significant timing constraints. The track covered fundamental infrastructure, system support, and theoretic foundations for real-time computing. Paper topics included real-time computing platforms and development tools and techniques, such as real-time resource management, real-time operating systems, middleware, support for QoS, novel kernel-level mechanisms, power-aware real-time systems, real-time software component models, scheduling, and performance feedback control. The technical program committee for this track, chaired by Tarek Abdelzaher (University of Virginia) included key researchers in the field of real-time computing, predominantly from academia.

- *Embedded Applications:* This track featured papers predominantly on industrial real-time and embedded applications. The focus was on practical issues and concerns that arise in deployed systems in various industrial and military environments. Papers in this track represented automotive, avionics, telecom, industrial control, robotics, and sensor applications. These papers presented new challenges, new model problem formulations, and different constraints associated with the aforementioned application domains. Attention was paid to technology transition lessons learned. The track technical program committee, chaired by David Sharp (Boeing, St. Louis), included prominent practitioners and researchers primarily from industry.

- *Real-time control:* This new track was added to emphasize the role of control in real-time computing, and foster an interaction between computing and control researchers. Topics covered the use of real-time control methods within infrastructures as well as end-user applications. Papers included the interaction of feedback control and scheduling, nonlinear and uncertain real-time systems, modeling and simulation of performance control, resource-constrained control, resource-aware control, robotics, and hybrid control. The track was chaired by Karl-Erik Arzen (Lund University). The technical program committee was predominantly composed of control experts.

- *QoS in Open Systems:* This track was added to recognize that the domain of real-time computing has broadened from primarily hard real-time closed embedded systems such as avionics and automotive applications to new open environments with other types of performance constraints such as the Internet and mobile computing systems. In such open environments independently developed system components and applications share common resources (aften across a network). Exact load and resource characterization is difficult to attain. Yet, some form of performance assurances are needed

typically in the face of large uncertainty. Papers addressed performance guarantees under uncertainty, combining/trading-off time and other performance metrics along different dimensions such as dependability, mobility, and security. Application domians such Web-based systems, wireless and mobile computing, ad hoc networks, sensor networks, peer-to-peer computing, were especially welcome. The technical program committee for this track was co-chaired by Yongguang Zhang (HRL Labs) and Srikanth Krishnamurthy (University of California, Riverside). It featured a broad scope of interests with emphasis on networking (both wired and wireless) as well as quality of service issues.

The RTAS conference attracted more than 170 attendees from both academia and industry.

2 RTAS Program

The final RTAS program was composed of 62 papers chosen out of 205 submissions. Of the 205 papers received, 79 papers were submitted to the real-time infrastructure and development track, 46 to embedded applications, 33 to real-time control, and 47 to QoS in open systems. In retrospect, it was also informative to categorize these papers by keywords in order to understand the degree to which RTAS 2004 represented the different research areas solicited. Consistently with tradition, the most frequently encountered keyword was "Scheduling". Keywords "QoS" and "Distributed Systems" followed closely, found on more than 50 papers each. Keywords "Operating Systems" and "Networks" were encountered around 40 times each. "Middleware" was found on approximately 30 papers, closely followed by "Resource Constrained Control". The topics "Profiling", "Fault-Tolerance", "Formal Menthods", and "Hybrid Systems" was counted each around 10 times. The least repesented categories were "Languages" and "File Systems" encountered on fewer than 5 submissions.

Each paper was reviewed in the track it was submitted to by at least three reviewers and in many cases by four. Individual tracks met separately to decide on accepted papers. These papers were then composed into a common schedule with two parallel sessions. While the review process was carried out on a per track basis to ensure the most appropriate reviewer expertise for each paper, the final program intentionally mixed papers from different tracks within the individual sessions to encourage a broader interaction between communities with similar interests. The program also included a keynote speech by Dr. Douglas Locke, entitled "Real-time and Embedded Systems: Past, Present, and Future." and a presentation of the best student paper award. The awards was received by Lin Gu and John Stankovic for their paper "Radio-Triggered Wake-Up Capability for Sensor Networks."

In addition to full paper presentations and the keynote speaker, RTAS 2004 also featured two work-in-progress sessions were a total of 24 short papers were presented. The goal of the work-in-progress session was to introduce early research with interesting innovative ideas and great promise that might not have matured yet to the extent of a full publication.

The conference was preceeded by two parallel workshops, namely the 2nd RTAS Workshop on Model-Driven Embedded Systems (MoDES 2004), and a Workshop on the usage of the UML profile for Scheduling, Performance and Time (SIVOES 2004). The former (MoDES 2004) was a follow up to the first MoDES workshop at RTAS 2003 with the purpose of closing the gap between research and practice in model-driven embedded computing. According to the workshop organizers, the goals of this workshop were to "(1) review state-of-the-art research leading toward an integrated view of model-driven composition of systems with static and run-time assurances and/or control of real-time, fault-tolerance, security, footprint, and other crucial properties; and (2) capture real world challenges in these areas that hinder transition of recent related research to industrial practice." According to its CFP, the other workshop (SIVOES 2004) was meant to offer a forum for exchanging experiences of using the UML profile for Scheduling, Performance and Time. It was intended to collect requirements and suggest improvements to the existing UML profile with the purpose of putting together a new RfP.

3 Acknowledgements

RTAS 2004 attracted the largest number of submissions of any conference on real-time computing to date. This success is attributed to a concerted effort of a large team of indiduals. In particular, the authors would like to acknowledge the publicity chairs, Luis Almeida, Anton Cervin, and Chenyang Lu, the local arrangement chair, H.-Arno Jacobsen, the general chairs, Greg Bollella and Doug Schmidt, as well as the area chairs for their effort in organizing the conference. Many thanks to the workshop chairs, the reviewers and program committee members, and of course the attendees for making RTAS 2004 a success. The program of RTAS 2004 was organized by Tarek Abdelzaher and David Sharp.